Royal College of Nursing

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The management of pressure ulcers in primary and secondary care

A Clinical Practice Guideline

22 September 2005

This guideline has been developed by the Royal College of Nursing

This work was undertaken by the Royal College of Nursing (RCN) Quality Improvement Programme (QIP), and the Guideline Development Group (GDG) convened to develop the Guideline. Funding for the health economics analysis of this Guideline was received from the National Institute for Health and Clinical Excellence (NICE), and this work was undertaken by the Centre for Health Economics (CHE) at the University of York. The RCN is host to the National Collaborating Centre for Nursing and Supportive Care (NCC-NSC) which receives partnership support from the: Centre for Evidence-Based Nursing; Centre for Statistics in Medicine; Clinical Effectiveness Forum for Allied Health Professionals; College of Health; Health Care Libraries (University of Oxford); Health Economics Research Centre; and UK Cochrane Centre.

This Guideline should be read in conjunction with the NICE guideline for risk assessment and prevention of pressure ulcers (beds, mattresses and support surfaces) (NICE, 2003) and is a further addition to clinical guidelines forming the Wound Care Suite.

Other relevant guidelines and documents:

- *Nutritional support in adults: oral supplements, enteral and parental feeding*.Currently out for public consultation and can be found at the following link: http://www.nice.org.uk/page.aspx?o=33921
- *National Service Framework for children, young people and maternity services* (2004) DH. http://www.dh.gov.uk/PolicyAndGuidance/HealthAndSocialCareTopics/ChildrenServices/ChildrenServicesInformation/ChildrenServicesInformationArticle/fs/en?CONTENT_ID=4089111&chk=U8Ecln
- *National Service Framework for older people* (2001) DH. http://www.dh.gov.uk/PublicationsAndStatistics/Publications/PublicationsPolicyAndGuidance/PublicationsPAmpGBrowsableDocument/fs/en?CONTENT_ID=4096710&chk=yLadyI

Disclaimer

Clinical guidelines have been defined as systematically developed statements that are designed to assist clinicians, patients and carers in making decisions about appropriate treatments for specific conditions and aspects of care.

As with all clinical guidelines, recommendations may not be appropriate for use in all circumstances. Decisions to adopt any particular recommendations must be made by the practitioners in the light of:

- available resources
- local services, policies and protocols
- the patient's circumstances and wishes
- available personnel and support surfaces
- clinical experience of the practitioner, and
- knowledge of more recent research findings.

When implementing evidence-based guidance it is important that all health care professionals understand the local context in which they work and existing quality improvement structures.

Where the term "carer" is used in the Guideline, this refers to unpaid carers as opposed to paid carers such as care workers.

Guideline Development Group membership and acknowledgements

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Stakeholder organisations

The following stakeholders are registered with NICE. All were invited to comment on all drafts of these guidelines.

Cochrane Wounds Group
Acute Care Collaborating Centre
Chronic Conditions Collaborating Centre
Mental Health Collaborating Centre 1
Mental Health Collaborating Centre 2
NCC for Cancer
Nursing & Supportive Care Collaborating Centre
Primary Care Collaborating Centre
Women's & Children's Collaborating Centre
3M Health Care Limited
Aguettant Limited
Association of British Health-Care Industries
Association of the British Pharmaceuticals Industry (ABPI)
BES Rehab Ltd
Coloplast Limited
ConvaTec
Forest Laboratories UK Limited
Huntleigh Healthcare Ltd
Independent Healthcare Association
Johnson & Johnson Medical
Kaymed
KCI Medical Ltd
Maersk Medical
Medical Support Systems Limited
Molnlycke Health Care
Nutricia Ltd (UK)
Park House Healthcare Limited
Pegasus Limited
Smith & Nephew Healthcare
SSL International plc
Surgical Dressing Manufacturers Association
Surgical Materials Testing Laboratory (SMTL)
Talley Group Ltd
Tempur-Med
Tyco Healthcare
Vernon Carus Limited
Westmeria Healthcare Ltd
Addenbrooke's NHS Trust
Anglesey Local Health Board
Ashford and St Peter’s Hospitals NHS Trust
Barnet PCT
Buckinghamshire Hospitals NHS Trust
Cambridgeshire & Peterborough Mental Health Partnership NHS Trust
Craven, Harrogate & Rural District PCT
Croydon Primary Care Trust
Gloucestershire Hospitals NHS Trust
Guy’s & St Thomas’ NHS Trust
Herefordshire Primary Care Trust
Kingston Primary Care Trust

Knowsley Primary Care Trust
Leeds Teaching Hospitals NHS Trust
Luton and Dunstable Hospital NHS Trust
Mid Staffordshire General Hospitals NHS Trust
National Nurses Nutrition Group
North Middlesex University Hospital NHS Trust
Northumberland Care Trust
Nottingham City PCT
Nuffield Orthopaedic Centre NHS Trust
Princess Alexandra Hospital NHS Trust
Rotherham Primary Care Trust
Royal Liverpool Children's NHS Trust
Royal National Orthopaedic Hospital NHS Trust
Sheffield Teaching Hospitals NHS Trust
South Birmingham Primary Care Trust
South Devon Healthcare Trust
South Essex Partnership NHS Trust
South West Kent PCT
Surrey & Sussex NHS Trust
Tameside and Glossop Acute Services NHS Trust
The Dudley Group of Hospitals NHS Trust
The Medway NHS Trust
The Royal West Sussex Trust
Trafford Primary Care Trusts
University College London Hospitals NHS Trust
Vale of Aylesbury PCT
West Norfolk PCT
West of Cornwall Primary Care Trust
African & Caribbean Diabetes Association
Help the Aged
Help the Hospices
L'Arche UK
Limbless Association
Marie Curie Cancer Care
National Council for Disabled People, Black, Minority and Ethnic Community (Equalities)
Relatives and Residents Association
Sue Ryder Care
All Wales Senior Nurses Advisory Group (Mental Health)
Association of Surgeons of Great Britain and Ireland
British Association for Parenteral & Enteral Nutrition (BAPEN)
British Association of Dermatologists, The
British Dietetic Association
British Geriatrics Society
British Healthcare Trades Association
British Psychological Society, The
British Society for Antimicrobial Chemotherapy
British Society of Rehabilitation Medicine
Chartered Society of Physiotherapy
College of Occupational Therapists
Community District Nurses Association
Faculty of Public Health
Health Protection Agency
Hospital Infection Society
National Association of Theatre Nurses

Nightingale Care Beds Ltd
Nuffield Hospitals Acute Care
Royal Association of Disability and Rehabilitation
Royal College of General Practitioners
Royal College of General Practitioners, Wales
Royal College of Nursing (RCN)
Royal College of Paediatrics and Child Health
Royal College of Physicians of London
Royal College of Surgeons of England
Royal Pharmaceutical Society of Great Britain
Skin Care Campaign
Society of Chiropodists & Podiatrists
Southern Alliance of Tissue Viability Nurses
Spinal Injuries Association
Stoke Mandeville NHS Trust
The National Association of Assistants in Surgical Practice
The Royal Society of Medicine
Tissue Viability Nurses Association
Tissue Viability Nurses Forum (South)
Tissue Viability Society (UK)
Wound Care Society
British National Formulary (BNF)
Department of Health
Healthcare Commission
Medicines and Healthcare Products Regulatory Agency (MHRA)
National Patient Safety Agency
National Public Health Service – Wales
NHS Modernisation Agency, The
NHS Quality Improvement Scotland
Scottish Intercollegiate Guidelines Network (SIGN)
Welsh Assembly Government (formerly National Assembly for Wales)

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Abbreviations

Technical terms

ARR	absolute relative risk
ARr	absolute risk reduction
BMI	body mass index
CI	confidence intervals
DH	Department of Health
GDG	Guideline Development Group
GRP	Guideline Review Panel
HTA	health technology assessment
NNT	number needed to treat
OR	odds ratio
QALY	quality-adjusted life year
RCT	randomised controlled trial
RR	relative risk (risk ratio)
RD	risk difference
SEM	standard error of the mean
PU	pressure ulcer

Organisations

CHE	Centre for Health Economics, University of York
CRD	Centre for Reviews and Disseminations, University of York
CWG	Cochrane Wounds Group
DH	Department of Health
GIN	Guidelines International Network
JBI	Joanna Briggs Institute
MHRA	Medicines and Healthcare Products Regulatory Agency
NCC-NSC	National Collaborating Centre for Nursing and Supportive Care
NICE	National Institute for Health and Clinical Excellence
RCN	Royal College of Nursing
SIGN	Scottish Intercollegiate Guidelines Network
UKC	UK Cochrane

General glossary

Absolute risk reduction	The difference between the observed event rates (proportions of individuals with the outcome of interest) in the two groups.
Basic dressings	Dressings that may cover a wound but do not create an optimum healing environment – e.g. gauze, paraffin gauze and simple dressing pads.
Bias	Influences on a study that can lead to invalid conclusions about a treatment or intervention. This may result from flaws in the design of a study or in the analysis of results, and may result in either an underestimate or an overestimate of the effect. Bias can occur at different stages in the research process – for example in the collection, analysis, interpretation, publication or review of the research.
Case-control study	A study in which the effects of an exposure in a group of patients (cases) who have a particular condition is compared with the effects of the exposure in a similar group of people who do not have the clinical condition (the latter is called the control group).
Case report	Detailed report on one patient (case), usually covering the course of that person's disease and response to treatment.
Case series	Description of several cases of a given disease or condition, usually covering the course of that disease and response to treatment. There is no comparison (control) group of patients.
Carer	An individual who provides unpaid care as opposed to paid carers – for example care workers.
Cohort	A group of people sharing some common characteristics – e.g. patients with the same disease or condition – followed up in a research study for a specified period of time.

Clinical effectiveness	The extent to which an intervention – for example a support surface or treatment – produces health benefits, that is more good than harm.
Cochrane collaboration	An international organisation in which people retrieve, appraise and review available evidence of the effect of interventions in health care. The Cochrane Database of Systematic Reviews contains regularly updated reviews on a variety of issues. The Cochrane library contains the Central Register of Controlled Trials (CENTRAL), and a number of other databases which are regularly updated, and is available as a CD-Rom or on the internet (www.cochranelibrary.com).
Cohort study	An observations study that takes a group (cohort) of patients and follows their progress over time to measure outcomes, such as disease or mortality rates, and make comparisons according to the treatments or interventions that patients receive. Thus, within the study group, subgroups of patients are identified and these groups are compared with respect to outcome – for example comparing mortality between groups that did or did not receive treatment. Cohorts can be assembled in the present and followed into the future (a concurrent or prospective cohort study) or identified from past record and followed forward from that time up to the present (a historical or retrospective cohort study). Patients are not randomly allocated to subgroups; these may be quite different in their characteristics and therefore adjustments must be made when analysing the results to ensure that the comparison between groups is as fair as possible.
Co-interventions	Interventions or treatments other than the treatment under study that are applied differently to the treatment and control groups.
Co-morbidity	Co-existence of a disease or diseases in a study population in addition to the condition that is the subject of study.
Concordance	A consultation process between a health care professional and a patient where the focus is on the consultation process rather than specific patient behaviour. There is an underlying ethos of a shared approach to decision-making.

Confidence intervals	A way of expressing certainty about the findings from a study or group of studies using statistical techniques. A confidence interval (CI) describes a range of possible effects (of a treatment or intervention) that is consistent with the results of a study or group of studies. A wide confidence interval indicates a lack of certainty or precision about the true size of the clinical effect and is seen in studies with too few patients. Where it is narrow this indicates precision and is found in studies with larger patient samples. It is usual to interpret a 95% CI as the range of effects within which we are 95% confident that the true effect lies.
Cost-benefit analysis	A type of economic evaluation where both costs and benefits of health care treatments are measured in the same monetary units. If benefits exceed cost, the evaluation would recommend the treatment.
Cost-effectiveness	A type of economic evaluation that assesses the additional costs and benefits of doing something. In cost-effectiveness analysis, the cost and benefit of different treatments are compared. When a new treatment is compared with the current care, its additional costs divided by its additional benefit is called the cost-effectiveness ratio. Benefits are measured in natural units – for example cost per additional pressure ulcer healed or prevented.
Cost-utility analysis	A special form of cost-effectiveness analysis where benefit is measured in quality-adjusted life years. A treatment is assessed in terms of its ability to extend or improve quality of life.
Cost impact	The total cost to the person, the NHS or to society.
Discounting	The process of converting future pounds and future health outcomes to their present value.
Debridement	The removal of dead (devitalised) tissue, cell debris or foreign material from a wound.
Dead tissue	Dead tissue can present in a variety of forms. Dead (necrotic) tissue varies in appearance according to moisture

	content. When dry it presents as black eschar (hard leather-like material). If moisture content rises the eschar becomes brown, then yellow, before breaking down to slough (yellow/grey fibrous tissue with a gelatinous surface attached to the wound bed).
Double-blind study	A study in which neither the subject (patient) nor the observer (investigator or clinician) is aware of which treatment or intervention the subject is receiving. The purpose of blinding is to protect against bias.
Economic evaluation	Comparative analysis of alternative courses of action in terms of both their costs and consequences.
Effectiveness	The extent to which interventions achieve health improvements in real practice settings.
Efficacy	The extent to which medical interventions achieve health improvements under ideal circumstances.
Epidemiological study	A study which looks at how a disease or clinical condition is distributed across geographical areas.
Eschar	Brown or black necrotic, devitalised tissue; can be loose or firmly adhered, hard, soft or soggy.
Evidence-based	The process of systematically finding, appraising and using research findings as the basis for clinical decisions.
Evidence-based clinical practice	Evidence-based clinical practice involves making decisions about the care of individual patients based on the best available research evidence rather than on personal opinion or common practice (which may not always be evidence-based). Evidence-based clinical practice involves integrating individual clinical expertise and patient preferences with the best available evidence from research.
Evidence table	A table with information extracted from research papers usually summarising the results of a collection of studies. Together this information represents the supporting evidence for a recommendation in a guideline.

Experimental study	A research study designed to test whether a treatment or intervention has an effect on the course or outcome of a condition or disease, where the conditions of testing are to some extent under the control of the investigator. Controlled trials and randomised controlled trials are examples of experimental studies.
Extrinsic	Factors which are external to the individual.
Follow-up	Observation over a period of time of an individual, group or population whose relevant characteristics have been assessed in order to observe changes in health status or health-related variables.
Gold standard	A method, procedure or measurement that is widely accepted as being the best available.
Health professional	Includes nurses, allied health professionals and doctors.
Health economics	A field of economics that examines the benefits of health care interventions – for example medicines – compared with their financial costs.
Health technology assessment	The process by which evidence on the clinical effectiveness and the costs and benefits of using a technology in clinical practice is systematically evaluated.
Heterogeneity	Or lack of homogeneity. The term is used in meta-analysis and systematic review when the results or estimates of effects of treatment from separate studies seem to be very different, in terms of size of treatment effects and adverse treatment effects. Such results may occur as a result of differences between studies in terms of the patient population, outcome measures, definitions of variables or duration of follow up.
Homogeneity	This means that the results of the studies in a systematic review or meta-analysis are similar and there is no evidence of heterogeneity. Results are usually regarded as

	homogenous when the differences between studies are those which can reasonably be expected between studies.
Incidence	The number of new cases of illness commencing, or of persons falling ill, during a specified time period in a given population.
Intervention	Health care action intended to benefit the patient – for example drug treatment, dressings, physiological therapy.
Intrinsic	Factors which present within the individual.
Logistic regression model	A data analysis technique to derive an equation to predict the probability of an event given one or more predictor variables. This model assumes that the natural logarithm of the odds for the event (the logit) is a linear sum of weighted values of the predictor variable. The weights are derived from data using the method of maximum likelihood.
Meta-analysis	A statistical method of summarising the results from a group of similar studies.
Modern dressings	Dressings that aim to create the optimum wound healing environment – e.g. hydrocolloids, hydrogels, foams, films, alginates and soft silicones.
Number needed to treat	The number of patients who need to be treated to prevent one event.
Odds ratio	Odds in favour of being exposed in subjects with the target disorder divided by the odds in favour of being exposed in control subjects (without the target disorder).
Predictive validity	A risk assessment tool would have high predictive validity if the predictions it makes of pressure ulcer development in a sample became true – i.e. it has both high sensitivity and specificity.
Prevalence	The proportion of persons with a particular disease within a given population at a given time.

Quality-adjusted life expectancy	Life expectancy using quality-adjusted life years rather than nominal life years.
Quality-adjusted life years	A measure of health outcome which assigns to each time period a weight, ranging from 0–1, corresponding to the health-related quality of life during that period, where a weight of 1 corresponds to optimal health, and a weight of 0 corresponds to a health state judged as equivalent to death. These are then aggregated across time periods.
Randomised controlled trial	A clinical trial in which the treatments are randomly assigned to subjects. The random allocation eliminates bias in the assignment of treatment to patients and establishes the basis for the statistical analysis.
Relative risk	An estimate of the magnitude of an association between exposure and disease, which also indicates the likelihood of developing the disease among persons who are exposed relative to those who are not. It is defined as the ratio of incidence of disease in the exposed group divided by the corresponding incidence in the non-exposed group.
Retrospective cohort study	A study in which a defined group of persons with an exposure, and an appropriate comparison group who are not exposed, are identified retrospectively and followed from the time of exposure to the present, and in which the incidence (or mortality) rates for the exposed and unexposed are assessed.
Sensitivity	In diagnostic testing, this refers to the chance of having a positive test result given that you have the disease or condition. A 100% sensitivity means that all those with the disease will test positive, but this is not the same the other way round. A patient could have a positive test result but not have the disease or condition – this is called a false positive. The sensitivity of a test is also related to its negative predictive value (true negatives) – a test with a sensitivity of 100% means that all those who get a negative test result do not have the disease. To fully judge the accuracy of a test, its specificity must also be considered.

Specificity	In diagnostic testing, this refers to the chance of having a negative test result given that you do not have the disease. A 100% specificity means that those without the disease will test negative but this is not the same the other way round. A patient could have a negative test result but still have the disease or condition – this is called a false negative. The specificity of a test is also related to its positive predictive value (true positives) – a test with a specificity of 100% means that all those who get a positive test result definitely have the disease or condition. To fully judge the accuracy of a test, its sensitivity must also be considered.
Statistical power	The ability of a study to demonstrate an association or causal relationship between two variables, given that an association exists – for example, 80% power in a clinical trial means that the study has 80% chance of ending up with a p value of less than 5% in a statistical test (statistically significant).
Systematic review	A way of finding, assessing and using evidence from studies (usually randomised, controlled trials) to obtain a reliable overview.
User	Any one using the guideline.
Validity	The extent to which a variable or intervention measures what it is supposed to measure or accomplish. The internal validity of a study refers to the integrity of the design. The external validity of a study refers to the appropriateness by which its results can be applied to non-study patients or populations.
Wound bed preparation	Management of the wound to promote endogenous healing or to facilitate the effectiveness of therapeutic interventions.

This glossay is partially based on *Clinical epidemiology glossary* by the Evidence Based Medicine Working Group, www.ed.ualberta.ca/ebm; *Information for National Collaborating Centres and Guideline Development Groups* (NICE, 2001) and the glossary from the Patient Involvement Unit at NICE.

Contents

1 EXECUTIVE SUMMARY

The Royal College of Nursing (RCN) and National Institute for Health and Clinical Excellence (NICE or the Institute) collaborated to develop a clinical guideline on the management of pressure ulcers in primary and secondary care. Identification of the topic emerged from a consultation process with RCN members and referral of the topic by the Department of Health and Welsh Assembly Government. This document describes the methods used for developing the guidelines and presents the resulting recommendations. It is the source document for the NICE (abbreviated version for health professionals) and *Information for the public* (patient and carer) versions of the guidelines, which will be published by NICE. The Guideline was produced by a multidisciplinary Guideline Development Group (GDG) and the development process was wholly undertaken by the RCN.

The main areas examined by the Guideline are:

- holistic assessment for the risk of delayed healing or complications of having a pressure ulcer
- the ulcer assessment
- pressure-relieving support surfaces for the treatment of pressure ulcers
- mobility, positioning and re-positioning for the treatment of pressure ulcers
- dressings and topical agents for the treatment of pressure ulcers
- debridement for the treatment of pressure ulcers
- nutritional support
- surgery for the treatment of pressure ulcers
- therapeutic ultrasound for the treatment of pressure ulcers
- electrotherapy and electromagnetic therapy for the treatment of pressure ulcers, and
- topical negative pressure for the treatment of pressure ulcers.

Recommendations for good practice based on the best available evidence of clinical and cost-effectiveness are presented. Literature searching details, including cut-off dates, are reported in the methods section for each topic area. Update searches were performed for each area not less than six months prior to submission of the first consultation draft. Recommendations contained in this document are those considered to be central to the management of pressure ulcers. This is a guide to that management not a textbook of care.

Health care professionals should use their clinical judgement and consult with patients when applying the recommendations, which aim at reducing the negative personal, physical, social and financial impact of pressure ulcers.

On completion of the process NICE will publish the versions for health professionals (*Quick reference guide*) and for patients and carers (*Information for the public*), which combine and replace the guideline for risk assessment and prevention of pressure ulcers (beds, mattresses and support surfaces (NICE, 2003).

2 PRINCIPLES OF PRACTICE AND SUMMARY OF GUIDELINE RECOMMENDATIONS

2.1 Principles of practice

The principles outlined below describe the ideal context in which to implement the recommendations in this Guideline. They reflect original research and development work previously produced by the RCN, and enable clinicians using evidence-based guidance to contextualise and understand the importance of preparation and planning before using this evidence-based tool.

2.1.1 Person-centred care

- Patients and carers should be made aware of the Guideline and its recommendations, and be referred to the version *Information for the public*.
- Patients and carers should be involved in shared decision-making about the management of pressure ulcers.
- Health professionals are advised to respect and incorporate the knowledge and experience of people who have had, or have, a pressure ulcer.
- Patients and carers should be informed about any potential risks, and/or complications, of having a pressure ulcer.

2.2 A collaborative interdisciplinary approach to care

- All members of the interdisciplinary team should be aware of the Guideline and all care should be documented in the patient's health care records.
- The approach to care should be interdisciplinary, involving all those needed in the management of pressure ulcers.

2.3 Organisational issues

- There should be an integrated approach to the management of pressure ulcers with a clear strategy and policy supported by management.
- Care should be delivered in a context of continuous quality improvement where improvements to care following Guideline implementation are the subject of regular feedback and audit.
- Commitment to, and availability of, education and training are needed to ensure that all staff, regardless of profession, are given the opportunity to update their knowledge and are able to implement the Guideline recommendations.

- The health care team should have undergone appropriate training and have demonstrated competence in pressure ulcer management.
- Staffing levels and skill mix should reflect the needs of patients, and are paramount to providing high-quality services for individuals with pressure ulcers.
- Priority should be given to the provision and allocation of resources in the management of patients with a pressure ulcer/s.

2.4 Summary of Guideline recommendations

Key recommendations

The following recommendations have been identified as priorities for implementation.

- Record the pressure ulcer grade using the European Pressure Ulcer Advisory Panel Classification System. **[D]**

- All pressure ulcers graded 2 and above should be documented as a local clinical incident. **D[GPP]**

- Patients with pressure ulcers should receive an initial and ongoing pressure ulcer assessment. Where a cause is identified strategies should be implemented to remove/reduce these. Ulcer assessment should include: **[D]**
    - cause of ulcer
    - site/location
    - dimensions of ulcer
    - stage or grade
    - exudate amount and type
    - local signs of infection
    - pain
    - wound appearance
    - surrounding skin
    - undermining/tracking (sinus or fistula)
    - odour, and
    - involvement of clinical experts – e.g. tissue viability nurse.

  This should be supported by tracings and or photography (calibrated with a ruler).

- Patients with pressure ulcers should have access to pressure-relieving support surfaces and strategies – for example, mattresses and cushions – 24 hours a day, and this applies to all support surfaces. **[D]**

- All individuals assessed as having a grade 1-2 pressure ulcer should, as a minimum provision, be placed on a high-specification foam mattress or cushion with pressure-reducing properties combined with very close observation of skin changes, and a documented positioning and repositioning regime. **[D]**

- If there is any perceived or actual deterioration of affected areas or further pressure ulcer development, an alternating pressure (AP) (replacement or overlay) or sophisticated continuous low pressure (CLP) system – for example low air loss, air fluidised, air flotation, viscous fluid – should be used. **[D]** (NB: For individuals requiring bed rails, alternating pressure (AP) overlay mattresses should be placed on a reduced-depth foam mattress to maintain their safety.)

- Depending on the location of ulcer, individuals assessed as having grade 3-4 pressure ulcers – including intact eschar where depth, and therefore grade, cannot be assessed – should, as a minimum provision, be placed on an alternating pressure mattress (replacement or overlay) or sophisticated continuous low pressure system – for example low air loss, air fluidised, viscous fluid). **[D]**

- If alternating pressure equipment is required, the first choice should be an overlay system, unless other circumstances such as patient weight or patient safety indicate the need for a replacement system. **[D]**

- Create the optimum wound healing environment by using modern dressings – for example hydrocolloids, hydrogels, hydrofibres, foams, films, alginates, soft silicones – in preference to basic dressing types – for example gauze, paraffin gauze and simple dressing pads. **[D]**

3 BACKGROUND TO THE CURRENT GUIDELINES

Background to commissioning the Guideline

NICE (or the Institute) worked collaboratively with the RCN Quality Improvement Programme to develop this Guideline on the management of pressure ulcers in primary and secondary care for use in the NHS in England and Wales. This follows referral of the topic by the Department of Health and the Welsh Assembly Government and the identification of pressure ulcer treatment as a priority topic for nurses by RCN members. The RCN Institute, through its Quality Improvement Programme, has a long-standing and well-respected reputation for national guideline development and implementation work. It has established strong links with key organisations in the field of evidence-based information, both nationally (SIGN) and internationally (GIN and JBI).

The Guideline will provide recommendations for good practice based on the best available evidence to the Guideline Development Group of clinical and cost-effectiveness. This Guideline follows on from the recently published NICE guideline *Risk assessment and prevention of pressure ulcers* (NICE, 2001) and a guideline on the use of pressure-relieving support surfaces (beds, mattresses and overlays) for the prevention of pressure ulcers in primary and secondary care completed in October 2003. It is anticipated that these inter-related topics will provide a compilation of NICE guidance on pressure ulcer care and will form part of the Wound Care Suite of related guidance.

The Institute's clinical guidelines will support the implementation of National Service Frameworks (NSFs) in those aspects of care where a framework has been published. The statements in each NSF reflect the evidence that was used at the time the framework was prepared. The clinical guidelines and technology appraisals published by the Institute after an NSF has been issued will have the effect of updating the framework.

Clinical guidelines have been defined as systematically developed statements that assist clinicians, patients and carers in making decisions about appropriate treatments for specific conditions and aspects of care.

3.1 Clinical need for the guideline

The presence of a pressure ulcer creates a number of significant difficulties – psychologically, physically and clinically – to patients, carers and their families. Clinicians working in a variety of clinical and non-clinical settings, including primary

care and acute trusts, also face challenges when providing holistic, person-centred services for the assessment and treatment of pressure ulcers. These challenges include clinical decisions on methods of assessment and treatments to be used for individuals with an existing pressure ulcer.

Pressure ulcers are more likely to occur in those who: are seriously ill; are neurologically compromised (i.e. individuals with spinal cord injuries); have impaired mobility (Allman, 1997; Berlowitz and Wilking, 1990; Berlowitz et al., 1997; Bianchetti et al., 1993) or who are immobile (including those wearing a prostheses, body brace or plaster cast); suffer from impaired nutrition (Ek et al., 1990, 1991; Casey, 1997; Banks, 1998; Casey, 1998a,b), obesity (Gallagher, 1997), poor posture, or use equipment such as seating or beds which do not provide appropriate pressure relief. Pressure ulcers affect sub-groups in society, including those with spinal cord injury (Krause, 1997; Elliot, 1999; Vesmarovich et al., 1999; Kirsch, 2001), the elderly (Hefley and Radcliffe, 1990; Waltman et al., 1991; Krainski, 1992; Orlando, 1998; Pase and Hoffman, 1998; Spoelhof, 2000; Thomas, 2001; Ronda and Falce, 2002) and pregnant mothers (Prior, 2002). Pressure ulcers have been associated with an increased incidence of infection including osteomyelitis (Darouiche et al., 1994).

Research indicates that pressure ulcers represent a major burden of sickness and reduced quality of life for patients, their carers (Hagelstein and Banks, 1995; Franks et al., 1999; Franks et al., 2002) and their families (Benbow, 1996; Elliott et al., 1999). Often patients require prolonged and frequent contact with the health care system, and suffer much pain (Emflorgo, 1999; Freeman, 2001; Flock, 2003; Healy, 2003; Manfredi et al., 2003), discomfort and inconvenience (Franks et al., 1999).

The presence of pressure ulcers has been associated with a two- to four-fold increase of risk of death in older people in intensive care units (Thomas et al., 1996; Clough, 1994; Bo et al., 2003).

Estimates on pressure ulcer incidence and prevalence from hospital-based studies vary widely according to the definition and grade of ulcer, the patient population and care setting. Based on data that are available, new pressure ulcers are estimated to occur in 4–10% of patients admitted to acute hospitals in the UK (Clark and Watts, 1994), the precise rates depending on case mix. In the community, new pressure ulcers affect an unknown proportion of people as reliable data is not available.

The financial costs to the NHS are considered to be substantial (Bennett et al., 2004). In 1993, the estimated cost of preventing and treating pressure ulcers in a 600-bed general hospital was between £600,000 and £3 million a year (Touché Ross, 1993). The cost of treating a grade 4 pressure ulcer was calculated in 1999 to be £40,000 a year (Collier, 1999). More recent cost data suggest that treating ulcers varies from £1,064 for a grade 1 ulcer to £10,551 for a grade 4 ulcer with total costs in the UK

estimated as being £1.4–£2.1 billion annually, equivalent to 4% of the total NHS expenditure (Bennett et al., 2004).

3.2 What are pressure ulcers?

Pressure ulcers, commonly referred to as pressure sores, bed sores, pressure damage, pressure injuries and decubitus ulcers, are areas of localised damage to the skin, which can extend to underlying structures such as muscle and bone (Allman, 1995, 1997). Damage is believed to be caused by a combination of factors including pressure, shear forces, friction and moisture (Allman, 1997). Pressure ulcers can develop in any area of the body (Rycroft-Malone and McInnes, 2000). In adults damage usually occurs over bony prominences, such as the sacrum. Presentation in infants and children is more likely to occur, for example, on the occipital area or ears (Willock et al., 1999; Murdock, 2002; Jones et al., 2001).

Definitions and classifications

Definition and classification of pressure ulcers were agreed with the Guideline Development Group at the second group meeting, and will serve to update definitions and classifications used in related published NICE and RCN guidance, *Pressure ulcer prevention: pressure ulcer risk assessment and prevention, including the use of pressure-relieving support surfaces (beds, mattresses and overlays) for the prevention of pressure ulcers in primary and secondary care* (NICE, 2003), available at www.nice.org.uk and www.rcn.org.uk .

A pressure ulcer is defined as:

an area of localised damage to the skin and underlying tissue caused by pressure, shear, friction and/or a combination of these. EPUAP(2003) European Pressure Ulcer Advisory Panel www.epuap.org.uk .

Classification of pressure ulcer severity

Grade 1: non-blanchable erythema of intact skin. Discolouration of the skin, warmth, oedema, induration or hardness may also be used as indicators, particularly on individuals with darker skin.

Grade 2: partial thickness skin loss involving epidermis, dermis, or both. The ulcer is superficial and presents clinically as an abrasion or blister.

Grade 3: full thickness skin loss involving damage to or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia.

Grade 4: extensive destruction, tissue necrosis, or damage to muscle, bone, or supporting structures with or without full thickness skin loss.

†EPUAP (2003) classification system. www.epuap.org.uk

3.3 Groups at risk

- Those who are seriously ill, neurologically compromised, i.e. individuals with spinal cord injuries, have impaired mobility or who are immobile (including those wearing a prosthesis, body brace or plaster cast), or who suffer from impaired nutrition, obesity, poor posture, or use equipment such as seating or beds which do not provide appropriate pressure relief.
- Older people and pregnant women are also at risk.

3.4 Interventions under consideration

The guideline will consider interventions such as:
pressure-relieving support surfaces and supports, including specialised seating and postural support; dressings; removal of devitalised or contaminated tissue (debridement); surgery; nutritional support; electrotherapy; therapeutic ultrasound; low-level laser therapy; topical negative pressure (TPN); and topical antimicrobials.

† *A range of classification systems are used throughout the literature. The one described above is generally accepted.*

4 AIMS OF THE GUIDELINE

The aims of the Guideline are to:

- evaluate and summarise the clinical and cost-effectiveness evidence for the management of pressure ulcers in primary and secondary care
- highlight gaps in the research evidence
- formulate evidence-based and, where possible, cost-effective clinical practice recommendations for the management of pressure ulcers based on the best evidence available to the GDG.

4.1 Who the guideline is for

This Guideline is intended to support decision-making in health professionals who have direct contact with and take decisions on the treatment of patients with pressure ulcers. It is also written for people with pressure ulcers and their carers. An *Information for the public* version of this Guideline will be produced containing all the key information from the recommendations.

4.2 Groups covered by the guideline

The Guideline recommendations will apply to all patient groups (adults, older people, infants, children and young people) in primary and secondary care.

4.3 Groups not covered

[†]There are no restrictions.

4.4 Health care setting

This Guideline will make recommendations for care given by health professionals who have direct contact with and make decisions about the treatment of patients with pressure ulcers, including those with multiple pathologies, and those suffering from chronic and acute disease, and terminal illness. Recommendations will apply equally across the primary and secondary care interface, including specialist units. The Guideline will also help to guide and inform patients and carers about the

[†] *Whilst there are no restriction in terms of inclusion/ exclusion criteria it is clear that the research evidence in some areas and for some groups , e.g. infants, children and pregnant women, is very limited.*

management of pressure ulcers by increasing awareness of strategies to both assess and treat individuals with pressure ulcers and prevent re-occurrence.

This is an NHS guideline. Although it will address the interface with other services, such as those provided by social services, the independent sector, secure settings and the voluntary sector, it will not include services exclusive to these sectors.

4.5 Interventions covered

This Guideline will make clinical and cost-effective recommendations on pressure ulcer treatment, based on the best evidence available to the GDG. The recommendations will cover treatments such as:

- pressure-relieving support surfaces and supports, including specialised seating and postural support
- dressings
- removal of devitalised or contaminated tissue (debridement)
- surgery
- nutritional support
- electrotherapy
- therapeutic ultrasound
- low-level laser therapy
- topical negative pressure, and
- topical antimicrobials.

4.6 Interventions not covered

The Guideline will be relevant to, but will not cover, other aspects of pressure ulcer-risk assessment and prevention (such as identifying patients at risk of developing a pressure ulcer, the use of risk-assessment scales, risk factors for the development of pressure ulcers, general skin inspection, and staff education and training). Recommendations for these areas are included in other guidance produced by the Institute (see Section 6)[†]. This Guideline should be used in conjunction with NICE guidance on related topics.

Wound healing

The process by which tissue repair takes place is termed wound healing. It comprises a continuous sequence of inflammation and repair, in which epithelial, endothelial, inflammatory cells, platelets and fibroblasts briefly come together outside their normal

[†] *Due to the size of the scope, timelines and resources to complete the guideline it has not been possible to include all interventions indicated in the treatment of pressure ulcers. The topic areas included are those prioritised and agreed through the formal NICE consultation process.*

domains, interact to restore a semblance of their usual discipline and, having done so, resume their normal function.

The process of wound repair differs little from one kind of tissue to another and is to some extent independent of the form of injury. Although the different elements of the wound healing process occur in a continuous, integrated manner, the overall process can be divided into three overlapping phases.

STAGES OF WOUND HEALING

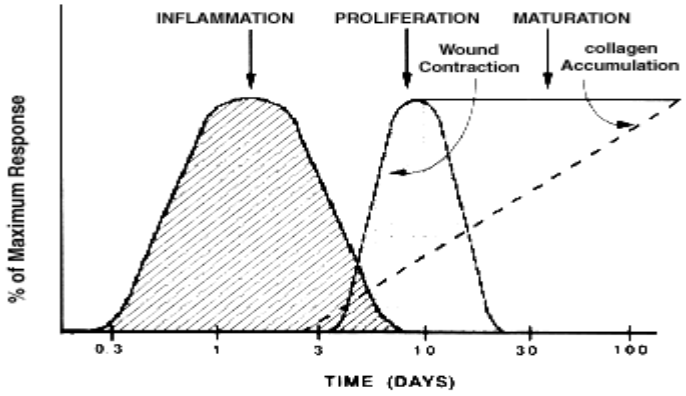

Fig. 1 Stages of wound healing. Wound healing can be arbitrarily divided into three phases: inflammation, proliferation and maturation

- Inflammatory
- Proliferate
- Maturation and remodelling

Some wounds will heal with routine wound care – for example wounds with even edges that come together spontaneously (minor cuts) or can be brought together. Wounds with rough edges and tissue deficit (a crater) may take longer to heal. When there is a crater and the edges of a wound are not brought together (left open intentionally), bumpy granulation tissue grows from the exposed tissue. The granulation tissue is eventually covered by skin that grows over the wound from the cut edges to the center. When healing is complete, the granulation tissue develops into tough scar tissue. Wounds heal in three stages.

Inflammatory stage

This stage occurs during the first few days. The wounded area attempts to restore its normal state (homeostasis) by constricting blood vessels to control bleeding. Platelets

and thromboplastin make a clot. Inflammation (redness, heat, swelling) also occurs and is a visible indicator of the immune response. White blood cells clean the wound of debris and bacteria.

Proliferate stage

After the inflammatory stage, the proliferate stage lasts about three weeks (or longer, depending on the severity of the wound). Granulation occurs, which means that special cells called fibroblasts make collagen to fill in the wound. New blood vessels form. The wound gradually contracts and is covered by a layer of skin.

Maturation and remodelling stage

This stage may last up to two years. New collagen forms, changing the shape of the wound and increasing strength of tissue in the area. Scar tissue, however, is only about 80% as strong as the original tissue. The body's ability to heal during this stage is impaired in the elderly.

Normal wound healing in acute wounds is a co-ordinated and rapid process. This process is impaired in chronic wounds. In chronic wounds the cells become unresponsive to chemical messengers, such as cytokines and growth factors, and such wounds have a prolonged inflammatory response (Van de Berg et al., 1995; Stanley and Osler, 2001).

4.7 Guideline Development Group

The Guideline recommendations were developed by a multidisciplinary and lay Guideline Development Group (GDG) convened by the RCN and NICE with membership approved by NICE. Members include representatives from:

- patient groups
- nursing
- medicine
- surgery
- allied health
- researchers, and
- staff from the RCN.

The GDG met thirteen times between April 2003 and May 2005. Full details of the GDG members can be found on the NICE website (www.nice.org.uk) and at the start of this Guideline.

All members of the GDG were required to make formal declarations of interest at the outset, which were recorded. GDG members were also asked to declare interest at

the beginning of each GDG meeting. This information is recorded in the meeting minutes and kept on file at the RCN.

5 METHODS USED TO DEVELOP THE GUIDELINE

5.1 Summary of development process

The methods used to develop this Guideline are based on those published by NICE – *Guideline development methods: information for National Collaborating Centres and guideline developers* (NICE, 2004). The structure of the recommendations section (section 6) – i.e. recommendations, evidence statements, evidence narrative and Guideline Development Group commentary – came from McIntosh et al. (2001) and has been used in recently published guidelines by the NCC-NSC.

The following sources of evidence were used to inform the guideline:

- Cullum N, Deeks J, Sheldon, TA, Song F and Fletcher AW (2004) Beds, mattresses and cushions for pressure sore prevention and treatment (Cochrane Review) in: *The Cochrane Library*, Issue 1, Chichester, UK: John Wiley & Sons, Ltd.
- Bradley M, Cullum N, Nelson EA, Petticrew M, Sheldon T and Torgerson D (1999b) Systematic reviews of wound care management: (2) Dressings and topical agents used in the healing of chronic wounds. *Health Technology Assessment*,3(17),pt. 2.
- Bradley M, Cullum N and Sheldon T (1999a) The debridement of chronic wounds. *Health Technology Assessment*,3(17),pt. 1.
- Langer G, Schloemer G, Knerr A, Kuss O and Behrens J (2004) Nutritional interventions for preventing and treating pressure ulcers (Cochrane Review) in: *The Cochrane Library,* Issue 3, Chichester, UK: John Wiley & Sons, Ltd.
- Flemming K and Cullum N (2000) Therapeutic ultrasound for pressure sores. *The Cochrane Database of Systematic Reviews*, Issue 4.
- Flemming K and Cullum N (2001) Electromagnetic therapy for treating pressure sores. *The Cochrane Database of Systematic Reviews*, Issue 1.
- Evans D and Land L (2001) Topical negative pressure for treating chronic wounds. *The Cochrane Database of Systematic Reviews*, Issue 1.

The stages used to develop this guideline were as follows:

- develop scope of guideline
- convene multidisciplinary GDG
- review questions set
- identify sources of evidence
- retrieve potential evidence
- evaluate potential evidence relating to cost/economics, quality of life and epidemiology for eligibility, quality and relevance

- extract relevant data from studies meeting methodological and clinical criteria
- interpret each paper taking into account the results – including, where reported, the beneficial and adverse effects of the interventions, cost, comfort and acceptability to patients, level of evidence, quality of studies, size and precision of effect, and relevance and generalisability of included studies to the scope of the Guideline
- prepare evidence reviews and tables which summarise and grade the body of evidence
- formulate conclusions about the body of available evidence based on the evidence reviews by taking into account factors above
- develop and utilise formal consensus methods to generate a consensus statement for areas lacking sufficient research evidence
- agree final recommendations and apply recommendation gradings
- submit first drafts (full version) of guidelines for feedback from NICE registered stakeholders
- consideration by GDG of stakeholders' comments
- submit final drafts of all Guideline versions (including *Information for the public* version, algorithm and audit criteria) to NICE for second stage of consultation
- consideration by GDG of stakeholders comments
- final copy submitted to NICE.

The main clinical questions addressed were as follows:

What assessment process(es)/tools should be used to identify modifiable risk factors/complications for those with pressure ulcers?
Epidemiological systematic review of prospective cohort studies

What are the modifiable risk factors for individuals with existing pressure ulcers?
Epidemiological systematic review of prospective cohort studies.

What assessment process(es)/tools should be used to assess a pressure ulcer?
Narrative review of studies assessing wound measurement.

What is the evidence that pressure-relieving support surfaces (beds, mattresses or overlays and seating cushions) are effective and cost-effective in treating pressure ulcers?
Systematic review of effectiveness.

What is the most effective positioning (sitting and lying) technique for people with pressure ulcers?
Systematic review of effectiveness.

What is the evidence that dressings are effective and cost-effective in treating pressure ulcers?
Systematic review of effectiveness.

What is the evidence that debridement is effective and cost-effective in treating pressure ulcers?
Systematic review of effectiveness.

What is the evidence that nutritional support is effective and cost-effective in treating pressure ulcers?
Systematic review of effectiveness.

What is the evidence that topical antimicrobials are effective and cost-effective in treating pressure ulcers?
Systematic review of effectiveness.

What is the evidence that surgical interventions are effective and cost-effective in treating pressure ulcers?
Narrative review of case series.

Additional questions addressed by the evidence reviews included:

Are there any differences in comfort and acceptability rating?

Have there been any adverse events or patient complaints/comments for any of the included interventions?

Is there any information about the ease of use and acceptability of interventions for patients, carers or nursing staff?

What studies have been done looking at the quality of life implications of having a pressure ulcer for both patients and carers in a broad sense of quality of life?

What studies have been done that measure quality of life implications of pressure ulcers that we can use to compare the implications of having a pressure ulcer with other health problems?

Are there any studies looking at the implications of quality of life of different equipment use?

RCN staff worked with an information specialist from the Centre for Reviews and Disseminations at the University of York to develop the search strategies for the topic areas covered in this Guideline. The information scientist ran the searches and all results were saved and stored in bibliographical software. RCN staff sifted all topic areas and conducted systematic reviews, either fully in cases where there were no existing reviews, or updated in cases where there were existing reviews or health technology appraisals. The RCN graded the evidence and composed successive drafts of the recommendations and the full guideline documents – which includes the full version of guidelines, NICE *Quick reference guide* (QRG) and *Information for the public* version – based on the evidence reviews, and GDG input and deliberations. The GDG formulated and graded the recommendations.

The methods for each review are reported in section 6. The results are also reported in section 6.

More details of the individual trials can be found in the evidence tables found in Appendix A.

The resulting recommendations are in section six for each review area.

5.2 Clinical effectiveness review methods

The search strategies and databases used are presented in Appendix B. All searches were comprehensive and included a large number of databases (see Appendix B). All search strategies were adapted for smaller or simpler databases, or for web-based sources, which did not allow complex strategies or multi-term searching.

A combination of subject heading and free text searches were used for all areas. Free text terms were checked on the major databases to ensure that they captured descriptor terms and their exploded terms.

Extensive hand-searching was not undertaken following NICE advice that exhaustive searching on every guideline review topic is not practical and efficient (Mason et al., 2002).

Reference lists of articles were checked for articles of potential relevance.

Search strategy

Terminology

The terms for the search strategies were identified by discussion between an information officer and the research team, by scanning the background literature, and by browsing the Medline Thesaurus (MeSH). Once drafted, the initial strategy of pressure ulcer terms was circulated round the GDG for comment.

Management of references

As several databases were searched, some degree of duplication resulted. To manage this issue, the titles and abstracts of bibliographic records were downloaded and imported into bibliographic management software to remove duplicate records. Further studies were identified by examining the reference lists of all included articles.

Preliminary literature search

An initial search was undertaken by an RCN Research and Development Fellow to:

- identify any existing guidelines, systematic reviews and Health Technology Assessments (HTAs) covering pressure ulcer management to prevent duplication, and
- *estimate* the potential size of the literature for this topic area.

All databases were searched from inception date, which varies for each database.

The following databases and websites were searched using keyword search terms:

- British Nursing Index (OVID) (up to 2002,10)
- Cinahl (OVID) (up to 2002, 10)
- Cochrane Library Issue 3. 2002 (internet)
- The Database of Abstracts and Reviews of Effectiveness (DARE) (up to 2002, 10)
- eGuidelines (up to 2002, 10)
- Health Technology Assessment database (HTA) (up to 2002, 10)
- National Guideline Clearing House (up to 2002, 11)
- New Zealand Guidelines Group (up to 2002, 10)
- Sign – Scottish Intercollegiate Guidelines Network (up to 2002, 10)
- Specialist Trials Register of Cochrane Wounds Group (up to 2002, 10) .

Main literature searches

The following databases were searched:

- Medline (OVID)
- Medline In-Process Citations (OVID)

- Embase (OVID)
- Cinahl (OVID)
- British Nursing Index (OVID)
- Health Management Information Consortium (SilverPlatter)
- Database of Abstracts of Reviews of Effectiveness (DARE) (internal CRD interface)
- AMED (OVID)
- Cochrane Library (internet)
- System for Information of Grey Literature in Europe (SIGLE) (SilverPlatter)

Search dates are reported in the relevant review.

A search of the Cochrane Wounds Group specialist trials register was undertaken for each of the reviews.

Sifting process

Articles were retrieved and stored in an Endnote library and were subject to the following sifting process.

1st sift: Remove any irrelevant material based on title/abstract.

2nd sift: Identify material that potentially met eligibility criteria based on title/abstract.

3rd sift: Order full papers if they appear relevant and eligible, and where relevance/eligibility was not clear from the abstract or the abstract was not available but the title was relevant.

4th sift: Appraise full articles that met eligibility criteria.

Data abstraction

Data from included trials were extracted by one or two reviewers into pre-prepared data extraction tables. Discrepancies were discussed and resolved.

The following data were extracted from each study:

- patient inclusion/exclusion criteria
- care setting
- key baseline variables by group
- description of the interventions and numbers of patients randomised to each intervention
- description of any co-interventions/standard care

- duration and extent of follow up
- outcomes, and
- acceptability and reliability if reported.

If data were missing from reports, then attempts were made to contact the authors to complete the information necessary for the critical appraisal. If studies were published more than once, the most detailed report was used as the basis of the data extraction.

No statistical analysis of inter-rater reliability of dual data extraction was performed. Differences were resolved by discussion.

Masked assessment, whereby data extractors are blind to the details of journal and authors, was not undertaken because there is no evidence to support the claim that this minimises bias (Cullum et al., 2003).

Once individual papers were retrieved, the articles were checked for methodological rigour (using quality checklists appropriate for each study design), applicability to the UK and clinical significance. Assessment of study quality concentrated on dimensions of internal validity and external validity. Information from each study which met the quality criteria was summarised and entered into evidence tables.

All data extraction forms are contained in Appendix A.

Appraisal of methodological quality

The methodological quality of each trial in the effectiveness reviews was assessed by two researchers. The following quality criteria were used:

- description of inclusion and exclusion criteria used to derive the sample from the target population
- description of *a priori* sample size calculation
- evidence of allocation concealment at randomisation
- description of baseline comparability of treatment groups
- outcome assessment stated to be blinded
- outcome measurement, and
- clear description of main interventions.

Methods of measuring wound healing can be subjective in the studies included in the reviews of this Guideline but had to incorporate at least one objective assessment – such as change in ulcer size, rate of healing, frequency of complete healing or time to complete healing – to meet the inclusion criteria.

Change in ulcer size is presented as a percentage or absolute change over a period of time. Objective methods of measuring changes on wound size include tracing the

ulcer outline followed by counting grids on graph paper, weighing uniform-density tracing paper, planimetry or computerised image analysis.

A single standard outcome measure for wound healing does not exist. Both objective and subjective measures are widely used by researchers. However the validity of many of these measurements remain the subject of ongoing investigation and debate.

Objective measures of healing are usually based on wound area. Planimetry, often aided by computer analysis, is the most frequently used method of calculating wound area. Other methods, such as the measurement of wound diameter or weight of a tracing drawn around the area of the wound, are also used. Measurements of wound volume are infrequently reported in the literature; these methods are often cumbersome and their accuracy has not been proven. Computerised image analysis may prove to be a useful technique in the future for the assessment of wound volume, as the equipment becomes more affordable and portable.

Even though objective measures reduce or eliminate subjective biases and reduce random measurement errors, they have certain inherent biases if the patients being compared have wounds with different baseline size. A change in wound area is often expressed as the percentage change which, unlike the absolute change in area, takes into account the initial size of the wound. For two wounds healing at the same linear rate (as measured by diameter reduction), percentage area calculations will show a larger change for a small wound than for a big wound. The converse is true when the absolute change in area is measured, as for any unit reduction in wound radius, a bigger area reduction will occur for a large wound.

This has important consequences for the validity of trial results where there is poor comparability in initial wound size at baseline between the treatment groups. In large trials, randomised allocation should ensure that the mean wound size and variance in each group is similar. In a small trial random allocation is unlikely to result in an even distribution of wound sizes. In a trial where there is poor comparability between groups for wound size at baseline, and the outcome is based on the change in area, the result can only be considered valid if it is obtained either: against the anticipated direction of the bias for wound size; or where percentage area change and absolute area change are in the same direction. If baseline data are not given then it is not possible to determine the direction of bias and the validity of the result cannot be determined. Despite the potential for objective outcomes to be biased by differences in wound size at baseline, they remain the most reliable assessment of wound healing as, unlike subjective measures, they reduce the biases of the assessor which cannot be estimated.

Data synthesis

For each trial, relative risk (RR) was calculated for outcomes such as complete healing. When sufficient detail allowed their calculation, 95% confidence intervals (95% CI) were included. NNT were calculated where possible and appropriate. The results from replicated studies were plotted onto graphs and discussed by narrative review. Unique comparisons were not plotted and the relative risk is stated in the text. Individual study details are presented in the evidence tables (Appendix A). Where there was more than one trial comparing similar interventions using the same outcome, and in the absence of obvious methodological or clinical heterogeneity, statistical heterogeneity was tested for by chi-squared test. In the absence of significant statistical heterogeneity, studies with similar comparisons were pooled using a fixed effects model (Clarke, 1999). If heterogeneity was observed, both random and fixed effects models were used to pool the data. All calculations were made using Revman 4.2.3 software.

5.3 Cost-effectiveness review methods

Aims

The aim of this section is to assess the economic evaluation literature on pressure ulcer management interventions. While the clinical effectiveness sections systematically assess the evidence on whether products can and do work, this section also considers the resource use and cost implications associated with interventions. To assess cost-effectiveness, alternative treatment options are compared in terms of their costs and effects. The technique is used to assess whether an intervention is worth using, compared with other uses to which the same resources could be put.

Background

Pressure ulcers have a substantial impact on the health-related quality of life of patients, and in terms of the financial burden on the health service, patients and their families, and society as a whole. Recent cost estimates suggest that the cost of treating a pressure ulcer varies from £1,064 for a grade 1 pressure ulcer to £10,551 for a grade 4[i] pressure ulcer, with higher grade pressure ulcers taking longer to heal and being associated with a higher incidence of complications (Bennett et al., 2004). Bennett et al. (2004) estimated that in the UK the annual cost of treating pressure ulcers is between £1.4 and £2.1 billion (price year 2000), that is about 4% of total NHS expenditure.

A plethora of interventions are available for the treatment and management of pressure ulcers. However, it is not always clear what works best, given the resource use and cost implications of different pressure ulcer treatments.

Previous systematic reviews, in which pressure ulcer interventions are assessed, found little evidence available on the cost-effectiveness of different treatment options (Bradley et al., 1999ab; Cullum et al., 2001; O'Meara et al., 2000). The importance of obtaining economic evidence in this area has been reiterated with calls for additional research that incorporates economic evaluations in high-quality clinical trials (Cullum et al., 2001). As has been suggested before: *"Measures of clinical effectiveness alone are rarely sufficient to guide health care decision-makers, since small incremental improvements in clinical effectiveness may not be worth the costs"* (O'Meara et al., 2000). In recognition of this the RCN, in collaboration with NICE, have funded this Guideline to include a review of the cost-effectiveness evidence in this field. The benefits of incorporating health economics within NICE guidelines were discussed and formalised within the Guideline development methods (Richardson et al., 2004). As stated: *"Clinicians already take resources and value for money into account in clinical decisions, and the incorporation of good-quality health economic evidence into clinical guidelines can help make this more consistent."*

Methods

Search questions

Searches for economic evaluations were undertaken to assess the cost-effectiveness evidence on ten different questions:

A. What assessment process tools are most cost-effective in identifying modifiable risk factors/complications associated with treating pressure ulcers?
B. What assessment tools are most cost-effective in assessing pressure ulcers?
C. What is the cost-effectiveness evidence on pressure-relieving support surfaces to treat pressure ulcers?
D. What is the cost-effectiveness evidence on pressure ulcer dressings to treat pressure ulcers?
E. What is the cost-effectiveness evidence on pressure ulcer debridement strategies?
F. What is the cost-effectiveness evidence on nutritional support to treat pressure ulcers?
G. What is the cost-effectiveness evidence on adjunct therapies in the treatment of pressure ulcers?
H. What is the cost-effectiveness evidence on topical antimicrobials used to treat pressure ulcers?
I. What is the cost-effectiveness evidence on surgical interventions to treat pressure ulcers?

J. What is the cost-effectiveness evidence on mobility and positioning techniques to treat pressure ulcers?

Databases searched

For each question the following databases were searched from inception date to early 2004 followed by an update search in August-September 2004 (see Appendix B for full details):

- Medline (1966-) (OVID interface)
- Medline In-Process Citations (OVID interface)
- Embase (1980-) (OVID interface)
- Cinahl (1982-) (OVID interface)
- British Nursing Index (1985-) (OVID interface)
- Health Management Information Consortium (OVID interface)
- AMED (1985-) (OVID interface)
- PsycInfo (1872-) (SilverPlatter interface)
- System for Information of Grey Literature in Europe (SIGLE) (1980-) (SilverPlatter interface).

Where possible, searches were limited to retrieve literature published in English, and to omit animal studies and letters, comments and editorial publication types.

As well as searches undertaken to answer specific questions, three specialist economics databases were searched to retrieve all references to pressure ulcers from inception date to September 2004:

- EconLit (1969-) (SilverPlatter interface)
- HEED (CD-rom)
- NHS Economic Evaluation Database (NHS EED) (1994-) (CRD administration database)

This search is referred to in this document as the core search.

Search terms

Given the number of questions and databases searched, all search strategies are presented in Appendix B. The information officer, in consultation with the health economist, identified *economics terms* to use in the strategy. Terms were based on the NHS EED health economics filter strategy (CRD Report 6 (2nd Edition 2001)) with additional quality of life terms. On assessment the quality of life terms were found to introduce high numbers of irrelevant records so the records, once loaded into

Endnote bibliographic management software, were filtered for assessment by searching on core economic terms:
cost* or economic* or price* or expenditure* or pharmacoeconomic* or budget* or quality*

The *pressure ulcer terms* for the search strategies were identified via discussion between an information officer and the guideline research team, by scanning the background literature, and by browsing the MEDLINE Thesaurus (MeSH). Once drafted, the initial strategy of pressure ulcer terms was circulated round the GDG for comment.

For Question A the search results from the clinical effectiveness results were used, as they had not been restricted by study design. The results were loaded into Endnote and searched there using economics terms to identify a subset of references of potential relevance to the health economist.

Questions B, C and J were searched separately. Questions D, E, F, G, H and I were combined into a single search strategy to maximise efficient use of searching time.

Selection criteria

For a study to be *included* in the review the following criteria were applied.

- The study assessed interventions to manage and treat pre-existing pressure ulcers.
- The study compared the costs and effects of two or more interventions.
- The interventions that were assessed compared A, B, C, D, E, F, G, I or J.
- The study had a sample size of two individuals or more.

For a study to be *excluded* from the review the following criteria were applied.

- The study assessed interventions to prevent pressure ulcers.
- The study did not report on costs associated with the interventions.
- The study did not report on outcomes associated with the interventions.
- The study was only available as a conference abstract or conference presentation.
- The study was not written in English and no translation of the data into English was available.

Data extraction

Data on the eligible economic evaluations were abstracted (see Appendix A) for presentation purposes. Study details were provided including the method of economic evaluation used, the study design, the results and an overview of the conclusions with brief comments.

Quality assessment

Eligible studies were quality assessed using a quality checklist by Drummond et al. (1996) (see Appendix C). This checklist asks 35 questions about the study design, data collection, and analysis and interpretation aspects of the economic evaluation.

Economic evaluation review

The types of economic evaluations reviewed were full economic evaluations: cost-utility analysis, cost-benefit analysis, cost-effectiveness analysis and cost-minimisation analysis studies *and* partial economic evaluations including cost-consequence analysis Full economic evaluations combine costs and health effects whereas, for cost-consequence analysis, costs are reported separately from health effects.

As implied by the names of the different types of economic evaluations, they differ in the way that health effects are measured. Health effects for use in cost-utility analyses measure individual or society-based preferences for a set of health states. A utility associated with a particular health state may be adjusted by the length of time spent in that state to calculate a generic outcome such as a Quality-Adjusted Life Year (QALY).

Like health effects measured in cost-utility analysis, the effects measured in cost-benefit analysis are also generic, in the sense that they can be used to compare effects across interventions. The difference, compared to cost-utility analysis, is that they are reported in monetary terms. Techniques such as contingent valuation may be used to obtain people's willingness to pay for the effects associated with a particular health state.

The health effects in cost-effectiveness analysis are measured in the most appropriate natural or physical units such as, in this case, time to complete heal of the pressure ulcer. If the effects are shown to be equivalent then a cost-minimisation analysis may be performed, however, in practice this is very rare. Finally, cost-consequence analysis involves the use of multiple outcome measures and these are not combined with cost (Drummond et al., 1997).

A treatment is deemed cost-effective (a collective term which may be used for all full economic evaluations) based on the following decision criteria:

- If a treatment has lower costs and more health effects than its comparator it is cost-effective and cost-saving (area (iv) in Figure 2).
- If a treatment has higher costs and more health effects than its comparator (area (ii) in Figure 2) it may be cost-effective, however incremental cost-effectiveness analysis is required. The question then becomes whether the extra costs are worth the extra effects. If so, the treatment is considered to be cost-effective. If not, the resources used to provide the treatment may produce higher-valued effects elsewhere.
- If a treatment has lower costs and lower health effects than its comparator (area (iii) in Figure 2) it may be cost-effective, however incremental analysis is required.
- If a treatment has higher costs and lower health effects than its comparator (area (i) in Figure 2) it is not cost-effective.

Incremental cost-effectiveness or incremental net health benefit (if a monetary measurement of health effect is used) is calculated by comparing the difference in cost of treatment 1 to treatment 2 with the difference in outcome of treatment 1 to treatment 2 (see Figure 2).

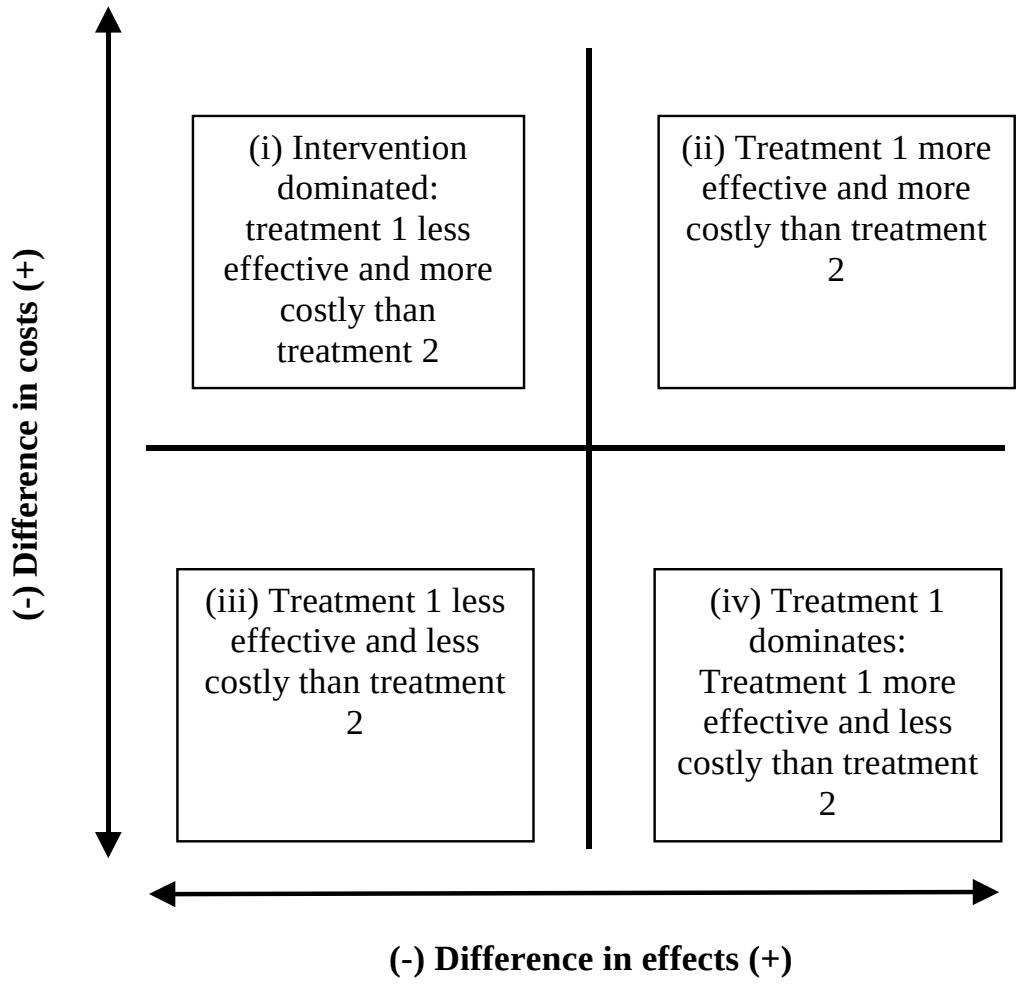

Figure 2: Cost-effectiveness plane

Findings

Literature search

Search results and management of references

As several databases were searched, some degree of duplication resulted. To manage this issue, the titles and abstracts of bibliographic records were downloaded and imported into Endnote bibliographic management software to remove duplicate records. In total, 3,049 abstracts were assessed for eligibility.

The number of unique records loaded into Endnote are shown below:

A. See clinical effectiveness searches + 703
B. 417
C. 487
D, E, F, G, H, I. 989
J. 304
Core. 149
Total. 3,049

The selection criteria were applied to the abstracts stored in Endnote and 185 studies were ordered. The selection criteria were then applied to each paper and a total of 26 economic evaluations were included in the review including the following:

Intervention	Numbers of studies reviewed
Assessment tools	0
Pressure-relieving support surfaces (beds, mattresses and overlays), mobility and positioning	3
Dressings and topical agents including debridement	21
Adjunct therapies (topical negative pressure, therapeutic ultrasound, electrotherapy and electromagnetic therapy)	2
Antimicrobials	0
Nutritional support	0
Surgical interventions	0

Table 1: Economic evaluations

5.4 Submission of evidence process

Stakeholders registered with NICE, listed at the beginning of the document, were invited to submit a list of evidence for consideration to ensure that relevant material to inform the evidence base was not missed. The criteria for the evidence included:

- systematic reviews
- randomised controlled trials (RCTs) that examine clinical or cost-effectiveness and/or quality of life, and economic analyses based on these findings
- representative epidemiological observational studies
- qualitative studies/surveys that examine patient/carer experiences
- studies of any design which have attempted to formally:
    - assess the cost-effectiveness/utility of pressure ulcer treatment
    - assess the cost of having a pressure ulcer
    - assess quality of life or used cost-utilities in relation to pressure ulcer management.

Information not considered as evidence included:

- studies with weak designs when more robust study designs are available
- commercial in confidence material
- unpublished secondary endpoint trial data, data-on-file and economic modelling
- promotional literature
- papers, commentaries or editorials that interpret the results of a published study
- representations or experiences of individuals not collected as part of properly designed research.

Initial submissions were received from:

- British Healthcare Trades Association
- Nutricia Ltd
- Coloplast
- Hill-Rom
- College of Occupational Therapists
- Pegasus UK

Submissions were followed up to request the full references.

5.5 Evidence synthesis and grading

For the update of the clinical effectiveness reviews, data from existing trials of effectiveness were synthesised with new trials. If there were sufficient trials to warrant the re-analysis of existing meta-analyses, this was done. The data from included studies pertaining to costs, economic evaluation, epidemiology and quality of life were also qualitatively synthesised into a narrative format. Information from the reviews on costs, economic evaluations and epidemiology was used in the economic modelling. All included studies are summarised in evidence tables (Appendix A) as well as discussed in the appropriate evidence reviews.

Evidence gradings were assigned to each evidence review using the evidence hierarchy shown below (Table 2), which is the only hierarchy recommended by NICE at the time of writing. (It should be noted that the hierarchy strictly applies to questions of effectiveness.)

Table 2: Levels of evidence

1++	High-quality meta-analyses, systematic reviews of RCTs, or RCTs with very low risk of bias.
1+	Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with low risk of bias.
1-	Meta-analyses, systematic reviews of RCTs, or RCTs with high risk of bias*
2++	High-quality systematic reviews of case-control or cohort studies. High-quality case-control or cohort studies with very low risk of confounding bias or chance and high probability that relationship is causal.
2+	Well-conducted case-control or cohort studies with low risk of confounding bias or chance and a moderate probability that relationship is causal.
2-	Case-control or cohort studies with a high risk of confounding bias or chance and a significant risk that the relationship is not causal*
3	Non-analytic studies – for example case reports, case-series.
4	Expert opinion, formal consensus. *Studies with a level of evidence - should not be used as a basis for making a recommendation.

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The evidence tables and reviews were distributed to GDG members for comment on the interpretation of the evidence and grading.

5.6 Results of clinical effectiveness evidence retrieval and appraisal

Study quality

A summary of the methodological quality of each study of the trials is shown in Appendix C.

Characteristics of excluded studies are shown in Appendix D.

Comparisons

The comparisons, relevant to this Guideline, able to be made on the basis of the included studies were:

5.7 Formulating and grading recommendations

For the GDG to formulate a clinically useful recommendation, it was agreed that the following factors be considered:

- The best available evidence with preference given to empirical evidence over expert judgement, including:
  - a profile of the cost data
  - results of economic modelling
  - effectiveness data taking into account the strength of evidence (the level, quality, precision) as well as the size of effect and relevance of the evidence
  - where reported, data on additional outcomes such as comfort, adverse effects and patient acceptability
  - a comparison between the outcomes for alternative interventions where possible.
- The feasibility of interventions, including the cost of the intervention, acceptability to clinicians, patients and carers and appropriateness of the support surface.
- The balancing of benefits against risks – including, where reported, all patient-relevant endpoints (including adverse effects, comfort and acceptability where reported) – and the results of the economic modelling.
- The applicability of the evidence to groups defined in the scope of the Guideline, having considered the profile of patients recruited to the trials, and data obtained from our review of the epidemiological data and quality of life literature.

This information was presented to the group in the form of evidence tables and accompanying summaries which were discussed at GDG meetings. Where the GDG identified issues which impacted on considerations of the evidence and the ability to formulate implementable and pragmatic guideline recommendations, these were summarised in the GDG commentary sections.

Issues with the available data identified by the GDG included:
Issues with the data, interpretation of the evidence and the wording were discussed until there was agreement on the wording and grading.

Where the GDG decided that further higher level evidence was essential before any recommendations could be considered, recommendations for future research were made (see section 7). The group then ranked these in order of importance so that the top five could be included in the NICE version.

The grading of the recommendations was agreed at GDG meetings using the scheme below.

Table 3: Recommendation grading

A	At least one meta-analyses, systematic review, or RCT rated as 1++, and directly applicable to the target population *or* A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+, directly applicable to the target population and demonstrating overall consistency of results Evidence drawn from a NICE technology appraisal
B	A body of evidence including studies rated as 2++, directly applicable to the target population and demonstrating overall consistency of results *or* Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results, *or* Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4**,** *or* Extrapolated evidence from studies rated as 2+, *or* Formal consensus
D(GPP)	A good practice point (GPP) is a recommendation for best practice based on the experience of the Guideline Development Group

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The recommendations with accompanying evidence reviews are presented in section 6 and can be found in a summarised version in the quick reference guide for this guideline.

Formal consensus methods

Background

Clinicians often need to make decisions even where there is a variable or undetermined evidence base. Limiting recommendations to where evidence exists may reduce the scope of guidelines and thus limit their value to clinicians (Eccles et al., 1996). Woolf (1992) describes three methods of guideline development but also adds that in reality these are not mutually exclusive and it is possible to draw from each one.

In *evidence-based guideline development* recommendations are based on a systematic review of the literature, and make explicit reference and linkage to the level of supporting evidence, which should enable clinicians to make decisions about adhering to them. Grimshaw et al. (1995) argue that in cases where there is a strong level of supporting evidence clinicians should have a very good reason for choosing not to comply with them. However, as Woolf (1992) states, while this approach can be credited with enhancing the scientific rigour of guidelines, in the absence of acceptable evidence, one is unable to produce recommendations.

Woolf (1992) suggests that the most common method of guideline development is *informal consensus*. This method is probably most frequently used at a local level where committees formulate recommendations without drawing on research evidence (Grimshaw and Hutchinson, 1995). By definition, this method tends to be based on poorly defined criteria and lacks the adoption of explicit consensus. Consequently, the resulting guidelines tend to be subjective and ill-defined in nature.

Formal consensus development methods, such as Delphi or Nominal Group Technique, provide a structure to the group decision-making process by, for example, adopting rating methods to represent the extent of agreement about predefined issues or questions. In reality, given situations such as poor or lacking evidence, guideline developers have to adopt strategies based on a framework that utilises facets of more than one guideline development method.

As already described, the evidence base available for this Guideline is variable. Despite published and updated systematic reviews, which form the main basis of the Guideline development, there are some areas where systematic searches of the evidence revealed little good-quality research evidence. Given this, it was decided to devise and implement a formal consensus process to augment the weaker and more variable evidence base for areas of the Guideline. The premise for this decision was that a guideline that contained both evidence-linked and consensus-based

recommendations would be more useful to practitioners than one confined to the limited outcomes of available research-based evidence.

Authors, such as Grimshaw and Russell (1993a), Shekelle et al. (1999) and Rycroft-Malone (2001), have acknowledged the use of consensus opinion to formulate recommendations in cases where there is an absence of evidence. They stress, however, that the process adopted has to be explicit and that the source of recommendations made in the resulting guideline clearly documented. Thus the process devised and used here is based on current best practice of formal consensus in guideline development and also that used in the development of the NICE-inherited guideline for the risk assessment and prevention of pressure ulcers (NICE, 2002, 2003).

GDG members were asked to rate a number of elements of statement and statements as to the level of importance or to indicate "don't know" if it was outside of their expertise or knowledge base. Ratings were aggregated, and mean and interquartile range was calculated. The results were used to develop recommendations statements, which would then enter the next phase and formal voting consensus.

Example:

The following refer to statements for risk factors of delayed healing/complications of having a pressure ulcer.

Please indicate how you rate the importance of each statement.

1. A consensus statement about the holistic assessment for those with pressure ulcers may include:

Extremes of age

Not Important	1	2	3	4 2	5 1	6	7	8 2	9 3	Very Important □

Reduced mobility

Not Important	1	2	3	4	5	6	7 1	8 1	9 8	Very Important □

*Indicates GDG responses.

A modified nominal group technique was used to finalise the recommendations and good practice points. A facilitator was used to chair the meeting. The consensus process was facilitated by computerised voting consoles, which assured anonymity

and allowed percentages to be quickly calculated. It also allowed the GDG to view the range of responses in the form of a graph immediately voting had occurred. Consensus was set at 80% unless a significant group within the GDG all voted against a recommendation – for example if all the allied health professionals, nurses or physicians voted against a recommendation, even though 80% agreement was achieved, a consensus agreement was not considered to have been reached.

Before voting on each recommendation and good practice point, discussion took place and modifications were made as necessary. Recommendations were reworded if necessary and then displayed on a screen so that GDG members could see the recommendation or good practice point on which they were voting. If consensus was achieved the GDG moved on to discuss the next recommendation or good practice point. However, if consensus was not achieved, the recommendation or good practice point was discussed a second time, modifications made to reflect the concerns of the GDG and re-voting took place. After debate on some areas, consensus was achieved for all recommendations submitted for first-stage consultation.

6. EVIDENCE REVIEWS WITH GUIDELINE RECOMMENDATIONS

6.1 The holistic assessment of individuals with pressure ulcers

Background

Pressure ulcer management approaches and techniques are continuously developing and there remains no overall consensus about them. Over the last thirty years a number of risk assessment tools and scales have been developed with the primary aim of identifying those individuals at risk of developing pressure ulcers. Interventions should then be implemented to help prevent ulceration.

The predictive validity of these assessment tools and scales in predicting which patients go on to develop pressure ulcers has been evaluated (Bergstrom, 1987; Deeks, 1996). These clearly identify variation in sensitivity, which means some tools are more effective in identifying and predicting those who are at elevated risk, and thus may go on to develop a pressure ulcer.

The importance of using risk assessment tools and scales as an adjunct to, but not a replacement for, clinical judgement has been stressed (Cullum et al., 1995; Cullum, 2001; Rycroft-Malone and McInnes, 2000). There still remains little evidence that indicates using a risk tool or scale is better than clinical judgement. The fact that they should be chosen on the basis of their suitability for a particular care setting or patient group, as well as the research evidence demonstration of their predictive validity, has also been highlighted (Cullum, 2001).

Perhaps more interestingly for this review, their effectiveness and validity for use in those individuals with established pressure ulcers is even more unclear, with indications that some perform poorly in identifying patients with existing ulcers as at risk (Williams et al., 2000). Yet these same tools and scales appear to be used widely in this patient group in both clinical and non-clinical settings in the UK. One explanation may be that the individual is recovering and is therefore no longer at risk, however the validity of this is unclear. Also research indicates that those with existing ulcers are also at elevated risk of developing further ulcers – this is not consistent with indications that some people with pressure ulcers are not found to be at risk according to some risk assessment tools.

To what extent these individuals are at further risk, not only of developing additional pressure ulcers but complications such as infections and delayed healing, is also unclear.

Reported characteristics of individuals with existing ulcers

- Activity, mobility, or functional limitation or immobility.
- Incontinent.
- Altered level of consciousness.
- Sensory impairment.
- Impaired nutrition.
- Acute illness.
- Dehydration.
- Chronic illness.
- Terminal illness.

Clinical question

What assessment process should be used to identify modifiable risk factors for people *with* existing pressure ulcers?

Objectives

The objective was to undertake a systematic review of the evidence of assessment of people with pressure ulcers to determine:

- What are the characteristics of people *with* pressure ulcers?
- What are the risk factors for people *with* pressure ulcers?
- What are the priorities for assessment?
- What is the empirical evidence that this process is effective in the management of pressure ulcers?

Selection criteria

Types of studies

Prospective cohort studies of risk factors and characteristics or complications associated with having a pressure ulcer(s), and studies of characteristics and interventions predictive of healing. Prospective cohort studies comparing assessment processes for individuals with pressure ulcers, and studies evaluating their effectiveness in individuals with pressure ulcers in the treatment of pressure ulcers.

Types of participants

All: adults and children, including those in primary and secondary care, residential homes, nursing homes, secure settings and the home.

Types of outcome

Risk factors linked to healing/delayed healing, healing, complications and predictors of healing of pressure ulcers and severity.

Search strategy

The databases searched are found in the review methods section 5 . The full search strategies are listed in Appendix B. Databases were searched in July 2003 and update searches performed in August 2004.

Appraisal of methodological quality

Criteria for inclusion (methodological quality found in Appendix C) and pre-defined principles as outlined in Appendix E .

Selection

Eligible participant population with well-defined demographic information.

High percentage of participants equal to or greater than 80% of those approached.

Identification of risk factors, characteristics and effectiveness of assessment process.

Risk factors and characteristics conceptually relevant to subject of interest.

Explicit details of how risk factor and characteristic information are measured.

Clear description of assessment process and measurements with comparison clearly defined.

Confounding

Statistical adjustment carried out; evidence of sensitivity analysis with method described.

Outcomes

Clear outcome measurements used.

Follow up

Participation rates high with explicit details of losses to follow up.

Search results

Results of search strategy	
Initial search results	2,871
N screened for relevance following sift	197
N included	3
N excluded	11

Research evidence

A total of 197 studies were identified from the sifting process and subsequently full papers ordered. This number also included those studies referenced with relevant titles but where the abstract was absent in the citation. After sifting full papers for relevance and duplicates at this stage, 183 papers were opinion pieces, editorials, anecdotal reports or fell outside the inclusion criterion for this review. Out of the five selected studies, 11 were excluded and three included.

Included studies

- The gold standard study design to investigate risk factors is the prospective cohort design. Only three studies were found which met the inclusion criteria.
- Generally the studies were medium-quality prospective cohort studies.

Allman et al. (1995)

Allman et al. (1995) carried a prospective inception cohort study to identify specific demographic, medical, functional status and nutritional characteristics that predict the development of stage 2 pressure ulcers or greater. A total of 286 patients met the inclusion criteria: admission within the past three days, age 55 years or more, expected to be confined to bed or chair for at least five days and/or hip fracture, and without grade 2 or greater pressure ulcers. The main outcome of the study was in-hospital time to develop a grade 2 or greater ulcer.

Results of multivariate analysis shows that grade 1 pressure ulcer (RR 7.52 CI 1.0-59.12), lymphopenia (RR 4.86 CI1.70-13.89), immobility (RR 2.36 CI1.14-4.85), dry skin (RR 2.31 CI 1.02-5.21) and decreased body weight (RR 2.18 CI1.05-4.52) are independent and significant risk factors for the development of grade 2 pressure ulcers in hospital patients. In this study only 24 of the original 286 has a diagnosed grade 1 pressure ulcer at baseline and it is not clear if this subgroup of patients were analysed separately. The result of this may mean that the results cannot be generalised to patients with existing pressure ulcers.

Risk factor	Risk ratio	95% CI	p
Stage 1 pressure ulcer	7.52	1.0-59.12	<0.001
Lymphopenia	4.86	1.70-13.86	<0.001
Immobility	2.36	1.14-4.85	<0.001
Dry skin	2.31	1.02-5.21	<0.001
Decrease body weight	2.18	1.05-4.52	<0.001

Results of multivariate analysis

Reed et al. (2003)

Reed et al. (2003) conducted a longitudinal prospective cohort study involving 2,771 subjects from 47 Veterans Affairs hospitals. The aim was to determine if three risk factors (low serum albumin, faecal incontinence and confusion) were significant risk factors for the development of grade 2 or greater pressure ulcers. Multivariate analysis shows low albumin OR 1.40 and confusion OR 1.45 to be both statistically significant risk factors of grade 2 ulcer development while faecal incontinence was not. While this paper shows that the identification of a stage 1 pressure ulcer is a risk factor for more severe grade 2 and above ulcers or an open wound, it does not tell of the extent to which the other identified risk factors contribute to delayed healing or more severe pressure ulcers.

Risk factor	Odds ratio	95% CI	p
Stage 1 pressure ulcer	3.13	2.41-4.06	<0.001
Malnourished	1.69	1.31-2.19	<0.001
Urinary catheter on	1.55	1.38-1.75	<0.001

admission			
DNR order	1.40	1.22-1.90	<0.001

Multiple regression analysis for development of grade 2 or greater risk factors

Williams et al. (2000)

Williams et al. (2000) undertook a prospective study of 267 subjects of which 12.8% had a pressure ulcer present on admission to an acute care environment. The study's aim was to investigate predictors of pressure ulcer presence and severity using the Braden scale for pressure ulcer risk assessment. Pressure ulcer risk was evaluated and skin inspection was performed. Demographic, physiological and laboratory data were obtained as well as medical history and patient acuity. Inter-rater reliability of data collection was reported as good. Statistical testing was performed using Statistical Package for Social Sciences (SPSS).

The study found that the mean Braden score for people without ulcers was 19.7 and 15.9 for those with ulcers (P<.05), indicating that the Braden scale either failed to highlight patients with ulcers at high risk or detected recovery in those patients with recovering ulcers. It is not possible to deduce which from the study. The study did however have a cut-off point of 16 to indicate high risk – the lower the score, the higher the risk of pressure ulcer development. Analysis of variance showed that subjects with pressure ulcers had significantly lower albumin levels, total lymphocyte count, haematocrit levels and haemoglobin levels. The paper reports this as indicating poorer nutritional status.

Subjects with pressure ulcers were also significantly older and had longer length of stay (LOS). Regression showed that albumin level, oxygen saturation and length of stay were associated with pressure ulcer presence, and that albumin level and length of stay (P <.001) accounted for 11.2% of the variance in pressure ulcer severity. Poorer nutritional status and decreased oxygen perfusion were found to be predictors of pressure ulcers on admission while nutritional status and length of stay were predictors of ulcer severity. In this study nutritional status was operationalised by using biochemical markers such as albumin and haematocrit levels as well as the subscale of the Braden scale and body mass index.

This study does not provide information on the role of co-morbidity and the presence of pressure ulcers nor on pressure ulcer severity. A high proportion of subjects (*n* = 141) were on a surgical unit; the effect of this on the presence and severity of pressure ulcers, if any, is unclear. The study claims to have calculated odds ratios for significant factors but they are not reported in the paper.

Reviewer's conclusions

The objective of this review was to determine the following:

- What are the characteristics of people *with* pressure ulcers?
- What are the risk factors for people *with* pressure ulcers?
- What are the priorities for assessment?
- What is the empirical evidence that this process is effective in the management of pressure ulcers?

It remains unclear what assessment process should be used to identify modifiable risk factors in people with *established* pressure ulcers. There is not one gold standard assessment available. There is not sufficient evidence to recommend one process or tool over another. What is clear is that the same risk assessment tools and processes are used in both populations: those people with established ulcers and those who are at risk of developing pressure ulcers. Some studies report that the predictive validity of assessment tools in those with existing ulcers is poor.

There is limited evidence reporting on the characteristics of those with *existing* ulcers on admission to a primary or secondary care environment.

What is clear from the available evidence is that the existence of a grade 1 pressure ulcer is a significant risk factor for the development of a more severe ulcer and therefore an open wound.

There is limited evidence reporting on other modifiable risk factors and complications for those with *established* pressure ulcers. Where characteristics are identified they are consequently identified as risk factors. Not all risk factors are modifiable and it is not clear whether it is the individual effects of each risk factor which is significant or the collective effect. The risk factors in individuals with ulcers are not only the risks of developing further pressure ulcers but the risks of delayed healing, and the risks of infection and complications. Further research is required to identify the risk factors of having a pressure ulcer. Rigorous intervention studies need to be carried out to determine the significance of risk factors.

The issue of effectiveness in the assessment process was not found to have been evaluated in the studies**.**

No economic evaluations assessing tools used to identify modifiable risk factors and/or complications for those with established pressure ulcers were found.

Level of evidence	Evidence statement
2+	The identification of a grade 1 pressure ulcer is a significant risk factor for the development of a more severe ulcer and therefore an open wound.

Recommendations: holistic assessment

Patients with pressure ulcers should receive an initial and ongoing holistic assessment. Both intrinsic and extrinsic factors have been identified as important factors for assessment. This assessment should include: **[D]**

- health status
  - acute, chronic and terminal illness
  - co-morbidity – e.g. diabeties and malnutrition
- mobility status
- posture (pelvic obliquity and posterior pelvic tilt)
- sensory impairment
- level of consciousness
- systemic signs of infection
- nutritional status
- previous pressure damage
- pain status
- psychological factors
- social factors
- continence status
- medication
- cognititive status, and
- blood flow.

Assessment of mobility should include all aspects of independent movement including walking, ability to reposition – for example in bed or a chair – or transfer – for example from bed to chair. **[D]**

Presence of any sensory impairment in an individual with a pressure ulcer should be recorded. **D[GPP]**

Level and duration of impaired consciousness should be recorded. **D[GPP]**

Presence of acute, chronic or terminal illness and its potential impact on ulcer healing should be recorded. **D[GPP]**

Previous pressure damage (site/location, stage or grade of previous ulcer and previous interventions) should be recorded. **[D]**

Pain assessment should include: whether the individual is experiencing pain; the causes of pain; level of pain (using an appropriate tool); location and management interventions. **[D]**

In the presence of systemic and clinical signs of infection in the patient with a pressure ulcer, systemic anti-microbial therapy should be considered. **D[GPP]**

Psychological assessment should include concordance and abilities of the individual to self-care (mood, motivation and aptitude). **[D]**

Assessment of social factors should include the suitability of the home environment, level of supportive provision and the involvement of local support services. **[D]**

Continence assessment should include whether the individual is continent of urine, faeces and continence interventions, which may affect ulcer healing and impair the function of pressure-relieving support surfaces – for example pads or bedding. **D[GPP]**

Holistic assessment is the responsibility of the inter-disciplinary team and should be carried out by health care professionals. **[D]**

Guideline Development Group commentary

Intervention	**Commentary**
	The EPUAP is the classification tool of choice as it identifies not only the skin colour change of grade 1 pressure ulcers but also other physiological signs resulting from tissue damage that many other tools ignore – namely the changes in skin temperature and skin texture due to the inflammation process. Many clinicians identify any redness as a grade 1 pressure ulcer. A level of redness is normal – for example following crossed legs where the lower leg has a red mark when the upper leg is removed. This is not the redness of a grade 1 pressure ulcer – and it is not hot to touch etc. The classification system is about what the skin/tissue looks like and is not related to patient group/environment/context – these items are part of pressure ulcer risk assessment tools.
Research recommendations	
Well-designed, large-scale, prospective cohort studies, including those with pressure ulcers and including relevant identified risk factors, to show how the identified risk factors lead to more severe ulcers or delayed healing or complications.	

6.2 Ulcer assessment

Background

The assessment of the pressure ulcer together with the holistic assessment is the basis for initiating, developing, maintaining and evaluating the plan of care for an individual with a pressure ulcer. The assessment of the pressure ulcer should provide information or data to facilitate the communication of information about the severity of the pressure ulcer and the change of the pressure ulcer over time.

The research identifies many subjective methods of assessing both wound characteristics and wound healing (Cutler et al., 1993; Griffin et al., 1993; Melhuish et al., 1994; Thomas and Humphreys, 1994 ; Plassmann, 1995 ; Shubert, 1997; Bates-Jensen, b, 1992, 1993 , 1995; and Houghton and Kincaid, 2000).

However it is a consistently accurate assessment of pressure ulcers which is key to monitoring changes in pressure ulcer characteristics that will determine treatment interventions. A number of characteristics are identified in the literature (Bohannon and Pfaller, 1983; Bulstode et al., 1987; Cooper, 1990; Ayello, 1992; Bates-Jensen, 1992; Emparanza et al., 2000; Gardner, 2001) as important indices to include in the pressure ulcer assessment. These include: location, size, depth, stage, condition of wound edges, tunnelling or undermining, signs of infection, necrotic tissue, exposed bone, granulation tissue presence, epithelialisation, exudates and odour. The importance and relevance of these indices to ensure the most effective outcomes is the focus of this review together with a clearer understanding of the consistency and accuracy of these measurements in pressure ulcer assessment.

To date there is not one method of assessing pressure ulcer status that is used universally. Yet the importance of a thorough, accurate, consistent and objective assessment of pressure ulcers is strongly advocated (Verhonick, 1961; Bohannon and Pfaller, 1983; Bulstode et al., 1987; Gosnell, 1977; Garrigues, 1987; Preston, 1987; Maklebust, 1987; Ayello, 1992; Emparanza et al., 2000; Gardner, 2001). A number of tools have been developed specifically to assess pressure ulcer status. However there remain contentious issues about their validity and reliability. It is now almost ten years since the publication of the Agency for Health Care Research and Quality (AHRQ, formerly AHCRQ) guidelines on pressure ulcer prevention and management, in which a classification system for pressure ulcers was recommended as well as indices to include in the assessment of a pressure ulcer (www.ahcpr.gov/).

Despite these national guidelines there remain problems among health care professionals in the communication of pressure ulcer status (Garrigues, 1987; Preston, 1987; Maklebust, 1987; Ayello, 1992; Emparanza et al., 2000; Gardner,

2001). Assessment of the ulcer together with the holistic assessment is viewed as fundamental in ensuring the right interventions or treatment modalities are applied (Bates-Jensen et al., 1992). A number of evidence-based tools have been developed and are widely used to assess the status of pressure ulcers. They include the Pressure Sore Status Tool (Bates-Jensen et al., 1992, 1995a, 1995b and 1997), the Pressure Ulcer Scale for Healing (Thomas et al., 1997), the Sussman Wound Healing Tool (Sussman and Swanson, 1997), the Sessing Scale (Ferrell et al., 1995) and the Wound Healing Scale (Krasner, 1997).

To what extent these tools are valid and reliable for implementation and use in general UK populations is not clear. A recent review (Woodbury et al., 1999) suggests that generally the validity and reliability of such tools are variable. However Woodbury et al. (1999) suggest that there is sufficient published evidence for the Pressure Sore Status Tool and the Sessing Scale to be considered as valid and reliable.

Many of the techniques advocated in the literature are reported to be inappropriate for routine use in a clinical environment. There are many high and low-tech methods of assessing pressure ulcers status – e.g. size, depth and volume of pressure ulcers using scaling gauges, dental impression material, sodium chloride, ultrasound, tracings, photographs, planimeter and video image analysis among others. The effectiveness of these is not clear from the small studies evaluated. It is also not clear what benefit they have to patients or how they link to wound healing, ensuring that pressure ulcers are assessed accurately to inform the clinical decision-making process.

Clinical question

What assessment process should be used to most accurately assess a pressure ulcer?

Objectives

The objective was to undertake a systematic review of the evidence of pressure ulcer assessment to determine:

- What are the wound characteristics of pressure ulcers?
- What is the significance of these in pressure ulcer assessment?
- What are the priorities for pressure ulcer assessment?
- What are the existing evidence-based tools/instruments for assessment/evaluation of pressure ulcers?

- What is the empirical evidence that these processes are effective in the management of pressure ulcers?

Selection criteria

Types of studies

Diagnostic studies reporting the reliability, accuracy and impact of pressure ulcer diagnostic tools/processes; studies comparing methods of pressure ulcer assessment, and evaluating their effectiveness in individuals with pressure ulcers in the treatment of pressure ulcers. Studies comparing methods of measurement.

Types of participants

All: adults and children, including those in primary and secondary care, residential homes, nursing homes, secure settings and the home.

Types of outcome

Staging performance, sensitivity, specificity, reliability, accuracy and impact linked to healing/delayed healing, healing, complications and pressure ulcers, and severity.

Search strategy

The databases searched are found in the methods section 5) . The full search strategies are listed in Appendix B. Databases were searched in July 2003 and update searches performed in August 2004.

Appraisal of methodological quality

Criteria for inclusion (methodological quality is reported in the evidence tables) and pre-defined principles as outlined in Appendix E.

Selection

Eligible participant population with well-defined demographic information.

High percentage of participants equal to or greater than 80% of those approached.

Identification of effectiveness of assessment process

Clear description of assessment process and measurements with comparison clearly defined.

Confounding

Statistical adjustment carried out; evidence of sensitivity analysis with method described.

Outcomes

Clear outcome measurements used.

Search results

Results of search strategy	
Initial search results	1,759
N screened for relevance following sift	165
N included	5
N excluded	2

Research evidence

A total of 165 studies were identified from the sifting process as potentially relevant to the topic and subsequently full papers ordered. This number also included those studies referenced with relevant titles but where the abstract was absent in the citation. After sifting full papers for relevance and duplicates at this stage, 153 papers were opinion pieces, editorials, anecdotal reports or fell outside the inclusion criterion for this review. Out of the seven selected studies, two were excluded and five included.

Included studies

- The gold standard systematic review for this type of clinical question is a systematic review of diagnostic and screening tests. While it was intended to conduct this type of review, it must be acknowledged that diagnostic reviews are a newly developing methodology.
- The research evidence on this topic area (assessing the diagnostics of pressure ulcer assessment) is limited.

- Where studies have addressed and assessed issues such as accuracy, sensitivity and specificity, these tend to be small studies and heterogenic; they use varied ulcer measurement parameters and it is not clear how representative these data are. Also raw data are too limited in the appraised papers to allow any further analysis.
- Where a tool or instrument has been evaluated in terms of reliability these have been included in the evidence tables.

Cutler et al. (1993)

This was a cross-sectional study to evaluate and compare the various methods of measuring the characteristics of pressure ulcers, namely area. The study included a population of initially 20 patients with 17 remaining on completion. There was a mix of male and female patients; few other demographic details are explicit in the study. Ulcers were judged as at stage 3 or 4 with a size range between 2 and 150cm^2. Patients with signs of infection, exposed bone or cellulitus were excluded from the study. Numbers excluded were not included in the reporting.

All ulcer assessments were performed by the same research nurse. Initial baseline assessment was taken with weekly assessments thereafter. Compared measurements included direct measurement at the bedside of longest length, longest width and depth at the deepest point of the ulcers. Tracings and photographs were calibrated with a ruler. All measurements detected a statistically significant change in wound size and volume at week four assessment. Sub-group analysis showed that in the <10cm^2 group a statistically significant change in wound size was detected earlier than in the >10cm^2 group.

Griffin et al. (1993)

This study aimed to compare test-retest reliability of measurements obtained by the use of photographic methodology and those obtained by transparency method, and to compare wound surface area measurements obtained. Twenty patients were included in the study, 18 male and two female, from a rehabilitation centre in Memphis. Measurements were made of 22 ulcers identified, all in the pelvic region. The range of wound size was 688mm +/- 228mm.

Three photographs were taken at each wound assessment and three tracings were taken of each wound at each assessment. Both sets of tracing were digitalised. Test-retest reliability was obtained measuring five ulcers using both methodologies and repeating assessments after one hour. To compare the two methodologies all 22 ulcers were measured on a single occasion. To compare the two methodologies over time, 16 ulcers were measured at five-day intervals for 20 days (four occasions).

Test-retest reliability ICC =.99, comparison on a single occasion PCC =.99 and comparison over time r=.996 – .999 p = .001. No evidence of superiority was found with the two methodologies.

Houghton (2000)

This study examined the validity and reliability of using photographs of wounds to accurately assess wound status. Thirteen patients with pressure ulcers and 46 with leg ulcers were included in the study. Ulcers that had extensive tunnelling or undermining were too deep and could not be visualised, so were excluded from the study. Measurements were performed by a trained health care professional. It was a blinded assessment but details are not explicit.

Six measurement parameters were assessed using the photographic method: wound edges, necrotic tissue/type and amount, skin colour, granulation tissue type and epithelialisation. Total scores were assigned by one trained rater viewing 56 photographs of 13 pressure ulcers on two separate occasions ICC +0.96. Intrarater reliability for scores were assigned on two occasions for 81 photographs of 34 leg ulcers ICC = 0.86. Wound size estimates from photographs ICC = 0.96. Interrater reliability for pressure ulcers ICC =0.75. Correlation for the same observer for individual domain r = 0.75 and with the exception of skin colour r = 0.56. The between raters correlation for six domains r = 0.75 with the exception of wound edges r= 0.68. The concurrent validity was assessed for the Pressure Sore Status Tool and PWAT r+ 0.70 for PSST and r= 0.66 for six domain PWAT. PSST was used as a reference standard in this research, and the photographic method had good interrater and intrarater reliability with scores ICC = 0.75. Reliability was found to be higher for pressure ulcers than leg ulcers in this study. This could be explained by the fact that the PSST is a pressure ulcer specific assessment tool.

Shubert (1997)

This study evaluated pressure ulcer surface area measurement using four different methods. The number of patients was not clear. It was set in the Division of Geriatric Medicine, University Hospital Huddinge, Sweden. Demographic details were limited. Four measurements were used and included: direct measurement with digital planimeter, length and width measurement, number of whole squares, and number of whole and partial squares. Planimeter was used as the reference standard. A total of 373 different pressure ulcers were measured in the study.

Measurement of length and width gave values significantly higher than the reference value 31%, p = 0.001. Counting the number of whole squares gave a significantly lower value than the reference standard –13%, p=0.001. Counting the number of

whole and partial squares inside the boundary line gave values that were much closer to the reference value +1%. Counting the number of whole and partial squares within the tracing area gave the best estimate of wound size.

Plassmann and Jones (1998)

This was a controlled trial comparing the performance of the MAVIS instrument against three traditional methods of wound measurement for area and volume. The three traditional techniques included: use of ruler, transparency tracing and alginate for volume measurement. Precision was established on mock wounds made using plaster cast and each was measured 20 times for each technique. There were fifty patients, although demographic detail was limited. Among excluded patients were those with painful ulcers, undermining, and extremely flexible, small and large ulcers. Measurements were taken by structured light. Area and volume measurements were taken simultaneously. Results were reported in graphical form without clear axis. It was reported that MAVIS gave overall more precise results for area and volume than the other three methods.

Quality of the studies

The quality assessment for each study is reported in the evidence table for each study. There are not well-established quality criteria for assessing some of the designs included in this narrative review. Generic assessment tools (Appendix E) were used to assess each study according to study design. Generally the studies' aims were clear and although the sample sizes were small, with the exception of Shubert (1997), they were justified. Statistical methods were well described in all the studies with clear rationale for their use. There was limited reporting in the studies on excluded patients and those that did not finish the study.

Reviewer's conclusion

The original objective was to undertake a diagnostic review of the evidence of pressure ulcer assessment to determine:

- What are the wound characteristics of pressure ulcers?
- What are the significance of these in pressure ulcer assessment?
- What are the priorities for pressure ulcer assessment?
- What are the existing evidence-based tools/instruments for assessment/evaluation of pressure ulcers?
- What is the empirical evidence that these processes are effective in the management of pressure ulcers?

The research evidence in this area is limited and it has not been possible to conduct a diagnostic review for several reasons: 1. The research evidence in this area is limited. 2. There is a lack of a generally accepted reference standard both for the assessment of individual parameters for ulcer assessment or a pressure ulcer assessment tool. 3. The reporting of the research evidence lacks raw data for any further analysis to be performed.

While a number of tools have been developed, they have not been evaluated fully. A number of research-based pressure ulcer assessment tools, such as the PSST, have undergone a systematic process of development and their reliability has been assessed. However this review did not find evidence for the use of such tools widely in the UK, nor did it find evidence that these have been tested against an agreed gold standard. It remains unclear how these tools are linked to outcomes – i.e. the healing of pressure ulcers – as this is not reported in the literature.

Wound size, that is surface area and volume, appears to be the specific parameter that has been assessed in the literature most frequently, and is reported as being a useful marker of wound change over time. Various methods of determining this parameter are advocated in the literature; however caution should be taken when interpreting the authors' findings as they are generally from small studies. There is also considerable heterogeneity both within and between the studies to be able to combine any of these data.

The inclusion of location, stage, condition of wound edges, tunnelling or undermining, signs of infection, necrotic tissue, exposed bone, granulation tissue presence, epithelialisation, exudates and odour in the ulcer assessment is advocated in the research. However the evidence base in support of their inclusion is limited. It is also not clear from this evidence whether these parameters are, firstly, suitable to include in assessment on the basis of their being consistently identifiable by the same assessor or, secondly, identifiable at a repeated assessment by the same or different assessor either within the same patient or between patients.

It is also not clear what effect the context has on the wound assessment. Reporting of this information was limited in the research evidence. In terms of who should carry out assessments, one study found significantly better assessments carried out by trained health care professionals compared with students with limited training and experience. How often an assessment should take place is also not clear from the evidence.

No economic evaluations assessing tools used to assess a pressure ulcer were found.

Recommendations for this area of the Guideline were sought via formal consensus as outlined in the methods section.

Recommendations: ulcer assessment

The aim of the ulcer assessment is to:

- establish the severity of the pressure ulcers
- to generate a personal ulcer profile to develop a plan of care from which treatment interventions will be initiated
- to evaluate treatment interventions
- to assess for complications, and
- to communicate information about the pressure ulcer to those involved in pressure ulcer management.

Patients with pressure ulcers should receive an initial and ongoing pressure ulcer assessment. Ulcer assessment should include: **[D]**

- cause of ulcer
- site/location
- dimensions of ulcer
- stage or grade
- exudate amount and type
- local signs of infection
- pain
- wound appearance
- surrounding skin
- undermining/tracking (sinus or fistula), and
- odour.

This should be supported by photography and or tracings (calibrated with a ruler).

The pressure ulcer grade should be recorded using the European Pressure Ulcer Advisory Panel Classification System.
Pressure ulcers should not be reverse graded (retrograding). A grade 4 pressure ulcer does not become a grade 3 as it heals. As the ulcer heals it should be described as a healing grade 4 pressure ulcer.**D[GPP]**

Those carrying out ulcer assessments should consider the aims and objectives of the assessment to ensure that maximum benefit to the individual is gained. **D[GPP]**

The dimensions of the pressure ulcer should be measured recording the longest length/longest width as an estimate of surface area (use of tracings); the deepest part of the wound should also be measured using a sterile probe. **[D]**

Initial and ongoing ulcer assessment is the responsibility of the inter-disciplinary team and should be carried out by health care professionals. **[D]**

Reassessment of the ulcer should be performed at least weekly but may be required more frequently, depending on the condition of the wound and the result of holistic assessment of the patient. **[D]**

All pressure ulcers graded 2 and above should be documented as a local clinical incident. **D[GPP]**

	Guideline Development Group commentary
	Despite the lack of research evidence from which to generate recommendations the GDG felt that it was important to guide clinicians as to the most important parameters to include in an ulcer assessment. Many different variations of tools are used to gather information about pressure ulcers in a variety of NHS settings. A comprehensive and accurate assessment of the pressure ulcer was considered to be paramount to ensuring that the plan of ulcer care reflected ulcer severity.

	Research recommendations
	Research needs to focus on what methods of measurement, and which parameters, are of use to clinicians to allow accurate wound evaluation.

6.3 Support surfaces for pressure ulcer treatment

The methods described in this review were those used to update the following systematic review:

Cullum N, Deeks J, Sheldon TA, Song F and Fletcher AW (2004) Beds, mattresses and cushions for pressure sore prevention and treatment (Cochrane Review) in: *The Cochrane Library*, Issue 1, Chichester, UK: John Wiley & Sons, Ltd.

This review was used as the main source to develop recommendations for this area of the Guideline.

There is much debate in the literature and among experts about the appropriateness of the term pressure-relieving. The use in this Guideline is consistent with that of previously published NICE guidance on pressure ulcer prevention. Pressure-relieving is used as an umbrella term for all pressure-reducing and pressure-redistributing devices.

Background

A range of interventions are currently used in pressure ulcer management. Pressure-relieving support surfaces aim to reduce the magnitude and/or duration of pressure between an individual and the support surface, which is referred to as the "interface pressure". Some support surfaces may also minimise friction and shear, and may also address micro-climate needs such as temperature and moisture. Such support surfaces include cushions, mattress overlays, replacement mattresses or whole bed replacements. The cost of these interventions varies widely; from over £30,000 for some bed replacement systems to less than £100 for some foam overlays. Information on the relative clinical and cost-effectiveness of this equipment is clearly needed to enable clinicians to make evidence-based decisions for their use.

Pressure-relieving surfaces can be divided into two main categories: continuous low pressure (CLP) and alternating pressure (AP).

Continuous low pressure surfaces aim to mould around the shape of the individual to redistribute pressure over a greater surface area. Alternating pressure surfaces mechanically vary the pressure beneath the individual, so reducing the duration of the applied pressure.

CLP support surfaces can be grouped according to their construction:

- Standard foam

The conformability and resilience of foam products may vary considerably between manufacturers. Foam may be shaped, convoluted ("egg crate foam"), of various densities or of a combination of densities.

- Visco-elastic foam

This is specialised foam, available in varying densities, that moulds to body shape in response to body temperature.

- Air flotation

This is an inflated mattress replacement/overlay that manually or automatically adjusts airflow allowing immersion and redistribution of pressure. It is adjustable to individual reposition to maintain immersion and redistribution of pressures.

- Air fluidised

A constant flow of air is passed into a deep tank containing minute silicone beads retained by a permeable membrane. The agitated beads take on the properties of a fluid. Lying on the surface allows significant immersion and therefore redistribution of pressure.

- Low air loss

A constant flow of air inflates a row of permeable fabric cells. Manual or automatic adjustment of airflow allows significant immersion and therefore redistribution of pressure.

- Gel/fluid

Fluid surfaces – e.g. water-filled mattresses – which allow significant immersion and therefore redistribution of pressure. The density/viscosity of the gel/fluid will govern the degree of immersion and how stable the support surface is in terms of posture.

- Combination products

Many CLP surfaces, particularly cushions, use a variety of materials to provide optimum pressure relief and postural stability.

N.B. The type and construction of cover material may have a significant impact on the conformability of the surface.

Alternating pressure support surfaces provide pressure relief by inflating and deflating alternate air-filled cells. The inflated cells support the body while the deflated cells provide pressure relief. The duration and sequence of alternation varies between manufacturers. Such support surfaces are available as cushions, mattress overlays, and single- or multi-layer mattress replacements.

Pressure ulcer treatment strategies usually comprise a combination of pressure relief (in the form of support surfaces), positioning and repositioning, and wound management strategies including wound dressings, debridement techniques, physical

therapies, antibiotics and antiseptics. Pressure ulcer management is therefore considered to be multi-faceted and this approach to care is strongly advocated in the research literature.

Objectives

To undertake a systematic review of pressure-relieving beds, mattresses and cushions in pressure ulcer treatment.

Questions to be answered were:

- Do pressure-relieving beds, mattresses and cushions increase the healing rate of existing pressure ulcers compared to standard support surfaces?
- Which types of pressure-relieving surface are most effective in the treatment of pressure ulcers: a) in different patient groups, and b) settings?

Selection criteria

Types of studies

Randomised controlled trials (RCTs) comparing beds, mattresses and cushions which measured pressure ulcer healing as an objective measure of outcome.

Types of participants

Patients with existing pressure ulcers (of any grade) in any setting.

Types of interventions

Studies which evaluated the following interventions for pressure ulcer treatment were included:

- alternating pressure mattresses/overlays
- standard foam mattresses
- specialised foam mattresses/overlays – e.g. convoluted foam, cubed foam
- gel-filled mattresses/overlays
- fibre-filled mattresses/overlays
- water-filled mattresses/overlays
- air flotation beds
- low air loss beds
- sheepskins
- turning beds/frames
- bead beds, and

- wheelchair support surfaces.

Types of outcome measures

- Healing rates of existing ulcers: trials were included if they measured healing by some objective method – such as time to complete healing, or rate of change in the area/volume of the ulcer.
- Costs of the support surfaces.
- Patient comfort.
- Durability of the support surfaces.
- Reliability of the support surfaces.
- Acceptability of the support surfaces.

Trials which only measured surrogate outcome measures, such as interface pressure, were excluded on the basis that interface pressure measurements have not been demonstrated to reliably predict the clinical performance of support surfaces.

Search strategy

The search strategy included all trials identified up to August 2004. Databases were searched initially in November 2003 and then updated on 24 June 2004.

Main literature search

Searches were not limited by study design but were limited to retrieve literature published in English, and to omit animal studies and letters, comments and editorial publication types.

Methods of the review

Full details can be found in the methods section.

References identified from searches were reviewed by two reviewers who jointly made a decision to include or exclude a study against the eligibility criteria. References were entered into a bibliographic software package. Details of eligible studies were extracted by the primary reviewer and summarised using a data extraction sheet. Data extraction was checked by a second reviewer.

Description of studies

Fifteen eligible randomised trials were identified. Fourteen trials involved patients with pressure ulcers and assessed the treatment efficacy of pressure-relieving supports

(Allman, 1987; Caley, 1994; Clark, 1999; Day, 1993; Devine, 1995; Evans, 2000; Ferrell, 1993; Groen, 1999; Keogh, 2001; Mulder, 1994; Munro, 1989; Russell, 2000; Russell, 2003; Strauss, 1991). One further trial evaluated surface effects for both prevention and treatment of pressure ulcers in the same trial (Ewing, 1964).

Two additional trials were identified that also evaluated pressure-relieving support surfaces for both the prevention and treatment of pressure ulcers (Bennett, 1998; Lazzara, 1991). However, neither of these trials reported pressure ulcer healing data so were excluded from the review. One further eligible ongoing trial (Nelson, 2003) was also identified and these results will be incorporated in future updates of the review.

The studies included a variety of patients and settings – for example those in nursing homes, care of the elderly, medical and surgical wards.

Only one trial evaluated the use of a cushion as a pressure-relieving support surface. One trial assessed the use of sheepskins, and the remaining studies evaluated different mattresses, mattress overlays and beds.

Methodological quality of included studies

The methodological quality of the trials was generally poor. Details on the quality of each individual study are included in the Table of Included Studies (Appendix A). Adequate allocation concealment was evident in nine (60%) of the fifteen trials (Allman, 1987; Clark, 1999; Day, 1995; Devine, 1995; Evans, 2000; Ferrell, 1993; Keogh, 2001; Groen, 1999; Russell, 2003). In eight of the fifteen included trials the method of randomisation was unclear.

Blinded outcome assessment is rarely used in wound care studies and this was certainly the case in these evaluations of pressure-relieving support surfaces. It can be difficult or impossible to disguise the surface, on which a patient is, for assessment of outcome. Patients are often too ill to be removed from their bed for assessment of their pressure areas. Nevertheless, some studies minimise bias in outcome assessment by having a second assessor and presenting interrater reliability data, or by presenting photographic evidence of pressure area status, which can then be assessed by an assessor blinded to treatment. Of the 15 randomised trials in this review, we could be confident that some form of blinded outcome assessment had been used in only four trials (Allman, 1987; Evans, 2000; Strauss, 1991; Russell, 2003).

Importantly in pressure ulcer treatment trials it is essential to ensure baseline comparability for initial area of ulcers. A change in wound area is often expressed as the percentage change, which unlike the absolute change in area, takes into account the initial size of the wound. For two wounds healing at the same linear rate (as measured by diameter reduction) percentage area calculations will show a larger change for a small wound than a big wound. The converse is true when the absolute change in area is measured, since for any unit reduction in wound radius a bigger area reduction will occur for a large wound.

This has important consequences for the validity of trial results where there is poor comparability in initial wound size at baseline between the treatment groups. In large trials, randomised allocation should ensure that the mean wound size and variance in each group is similar. In a small trial random allocation is unlikely to result in an even distribution of wound sizes. In a trial where there is poor comparability between groups for wound size at baseline, and the outcome is based on the change in area, the result can only be considered valid if it is obtained either: against the anticipated direction of the bias for wound size; or where percentage area change and absolute area change are in the same direction. If baseline data are not given then it is not possible to determine the direction of bias and the validity of the result cannot be determined.

There were 15 trials of beds, mattresses and cushions for treating pressure ulcers included in this review and of these:

- eight presented data for baseline ulcer area (Allman, 1987; Clark, 1999; Day, 1993; Devine, 1995; Evans, 2000; Ferrell, 1993; Groen, 1999; Munro 1989)
- six further treatment trial reports did not present baseline ulcer areas (Caley, 1994; Keogh, 2001; Mulder, 1994; Russell, 2000; Russell, 2003; Strauss, 1991).
- one trial by Ewing (Ewing, 1964) focused on the effect of sheepskin on resolving red skin and therefore the area of the damaged skin is less important.

The other major deficiency in most of the included trials was the small sample sizes used. Although seven reports described an *a priori* sample size calculation, 12 of the 15 trials involved a total of 100 patients or fewer. The larger trials, involving over 100 patients, were Groen (1999) (120 patients), Russell (2000) (141 patients) and Russell (2003) (158 patients).

Quality was not used to weight the studies in the analysis using any statistical technique. However methodological quality was drawn upon in the narrative interpretation of the results. Methodological flaws are discussed for each study in the Table of Included Studies (Appendix A).

Results

Results of dichotomous variables are presented as relative risk (RR) with 95% confidence intervals (CI). Relative risk has been used rather than odds ratios as event rates are high in these trials and odds ratios would give an inflated impression of the magnitude of effect (Deeks, 1998). Relative risk is the rate of the event of interest – for example pressure ulcers healed – in the experimental group divided by the rate of this event in the control group, and indicates the chance of pressure ulcers healing on the experimental treatment compared with the control treatment.

As, by definition, the risk of an event occurring in the control group is 1, then the relative risk reduction associated with using an experimental treatment is 1-RR. The relative risk indicates the relative benefit of a therapy but not the actual benefit, that is it does not take into account the number of people whose pressure ulcer would have healed anyway without treatment.

The absolute risk reduction (ARR) can be calculated by subtracting the event rate in the experimental group from the event rate in the control group. The ARR tells us how much the reduction is due to the experimental treatment itself, and its inverse is the number needed to treat, or NNT. Thus a healing rate, for example, of 30% on a control treatment that was reduced to 15% with an experimental treatment, translates into an ARR of 30-15=15% or 0.15, and an NNT of 7. In other words seven patients would need to receive the experimental treatment to cure one additional pressure ulcer.

Secondary outcomes such as comfort, durability, reliability and acceptability were not well reported, and valid and reliable measures for these concepts are under-developed. Where data were presented, they appear in the Table of Included Studies (see Appendix A). However they are not incorporated in the meta-analysis.

Air-fluidised therapy (AFT)

Three trials compared AFT with a range of conventional therapies for the treatment of pressure ulcers (Allman, 1987; Munro, 1989; Strauss, 1991). These studies measured outcomes in slightly different ways and none reported the variability around the mean healing rate data. A meta-analysis of two of these studies showed significantly enhanced pressure ulcer healing associated with air-fluidised beds when used in hospital (Allman, 1987; Munro, 1989) (see Figure 3). A home-based study (Strauss, 1991) also showed a benefit from air-fluidised therapy on re-hospitalisation outcomes (see Figures 4 and 5). Munro (1989) showed no significant impact on

nursing time associated with the use of air-fluidised beds compared with standard care (see Figure 6).

Figure 3:

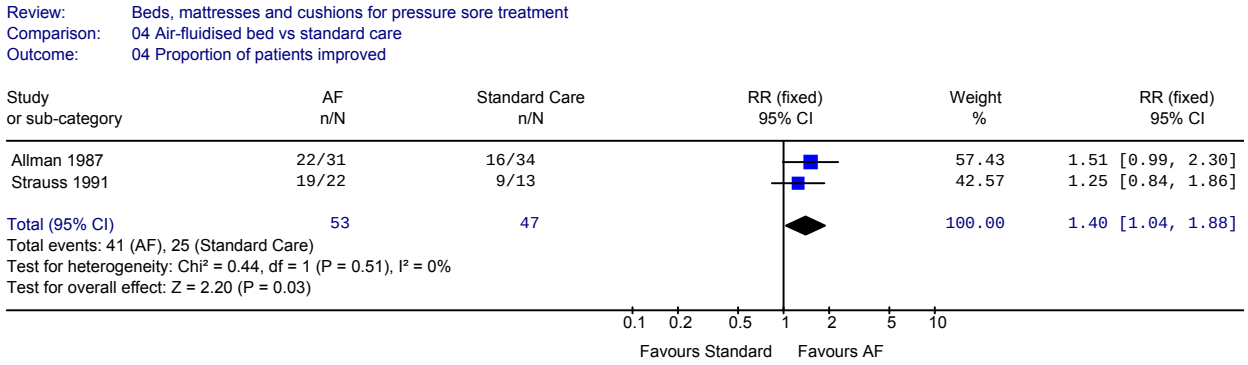


Figure 4:

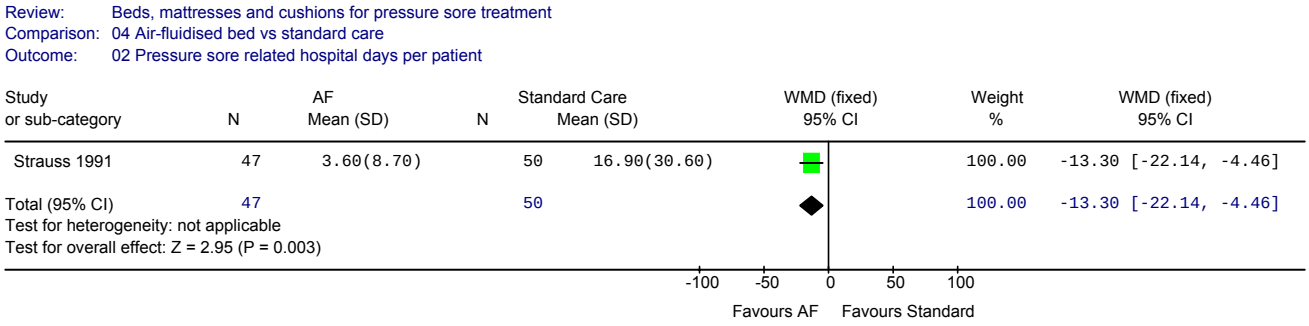


Figure 5:

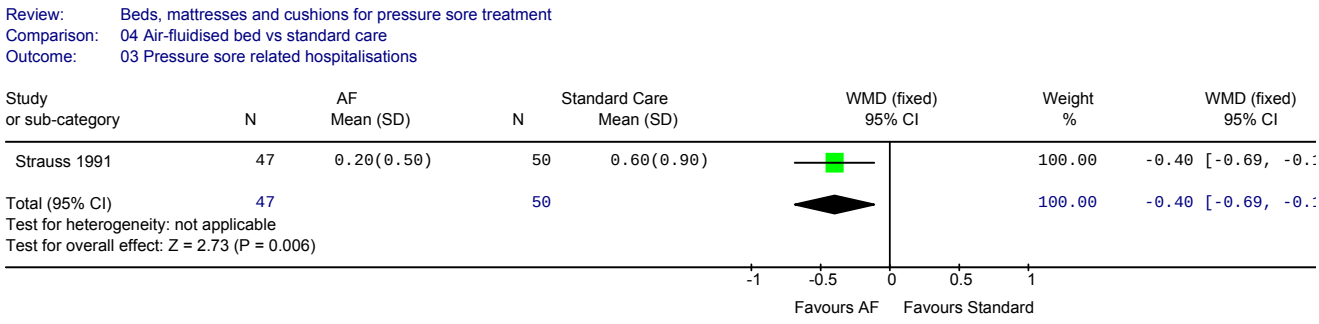
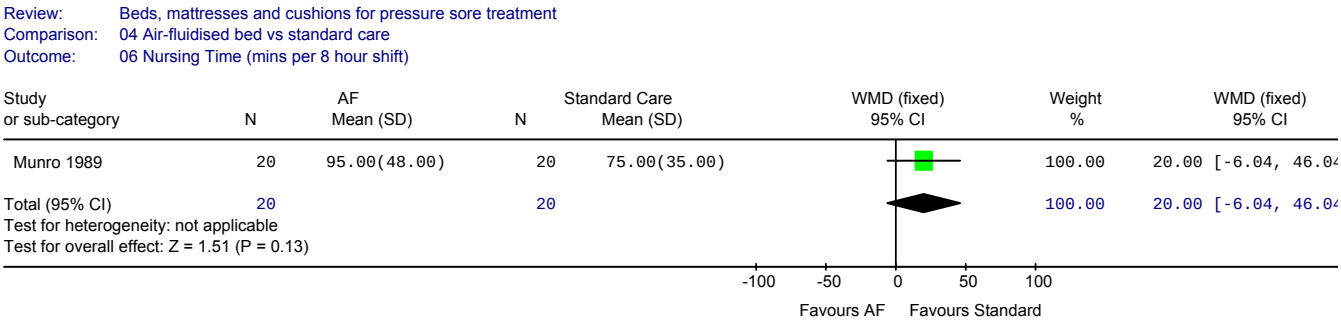


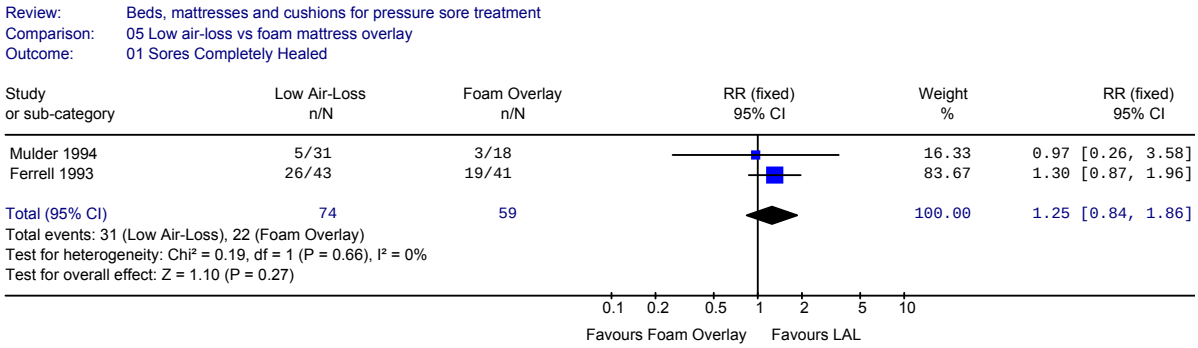
Figure 6:



Low air loss therapy (LAL)

Three trials were identified which compared LAL with a foam mattress overlay (Day, 1993; Ferrell, 1993; Mulder, 1994). The combined analysis from two trials (Ferrell, 1993; Mulder, 1994) showed pressure ulcer healing rates on the LAL bed were not significantly different to healing rates when using a corrugated foam overlay (see Figure 7). Only one trial has compared different types of low air loss support surfaces (Caley, 1994). This trial showed no significant differences in healing rates between the two interventions but was small and of questionable quality.

Figure 7:



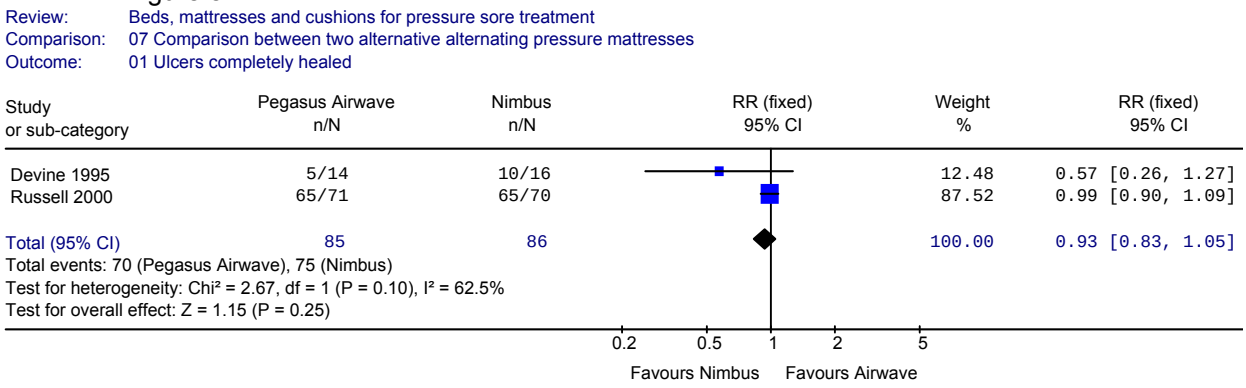
Alternating pressure (AP)

A variety of alternating pressure (AP) supports are used in hospital and in the community. The depth of the air cells and mechanical robustness can vary between support surfaces, and these factors may be important in determining effectiveness. It is worth emphasising that most of the trials of AP supports did not adequately describe the equipment being evaluated, including the size of the air cells, which may limit the utility of the evidence to clinical practice.

One small trial of 41 patients (Devine, 1995) compared the effectiveness of the Nimbus I DFS (composed of rows of figure-of-8-shaped cells) and the Pegasus Airwave for the treatment of existing pressure ulcers but found no significant difference. A more recent, larger trial (Russell, 2000) also failed to demonstrate any

significant difference in pressure ulcer healing between two newer AP support surfaces, the Nimbus 3 and the Pegasus Cairwave therapy system (see Figure 8).

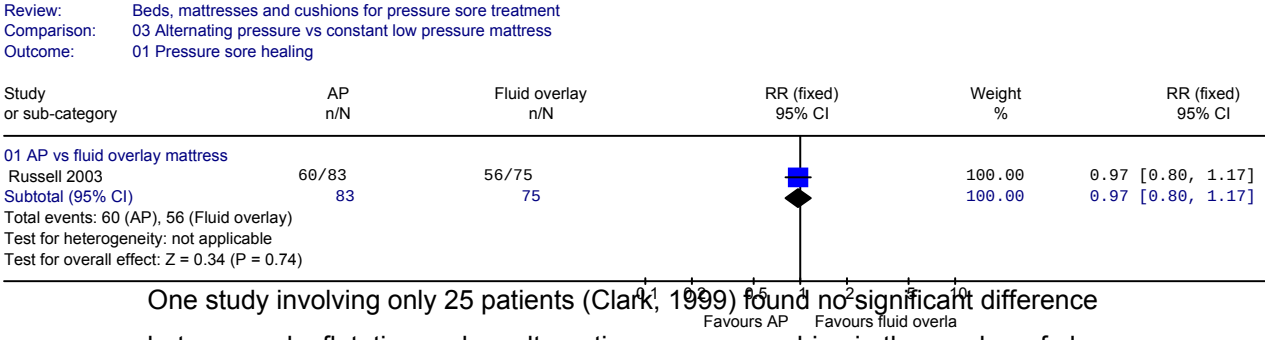
Figure 8



In a study by Evans et al. (2000), which was conducted in both hospital and nursing home patients, an alternating pressure mattress replacement system (Huntleigh Nimbus 3) resulted in no significant improvement in any measure of wound surface area when compared with either another alternating pressure mattress replacement system for hospital patients (Pegasus Biwave, Pegasus Airwave, or AlphaXcell) or an alternating mattress overlay for nursing home patients (AlphaXcell or Quattro).

A large trial of 158 patients (Russell, 2003) also compared the Nimbus 3 alternating pressure mattress with a static fluid overlay mattress, RIK static, and again found no significant difference in rates of pressure ulcer healing (see Figure 9). However, in this trial the co-intervention of re-positioning frequency was not standardised, and patients could request additional turning. As this variable appears to be disproportionate between the groups, the lack of treatment effect may be due to either the non-effect of the experimental support surface and/or the effect of the differential co-intervention distribution.

Figure 9:



One study involving only 25 patients (Clark, 1999) found no significant difference between a dry flotation and an alternating pressure cushion in the number of ulcers completely healed, as measured by either the proportion of ulcers healed (see Figure

10) or the rate of change in pressure ulcer surface area for either superficial (see Figure 11) or deep (see Figure 12) ulcers.

Figure 10:

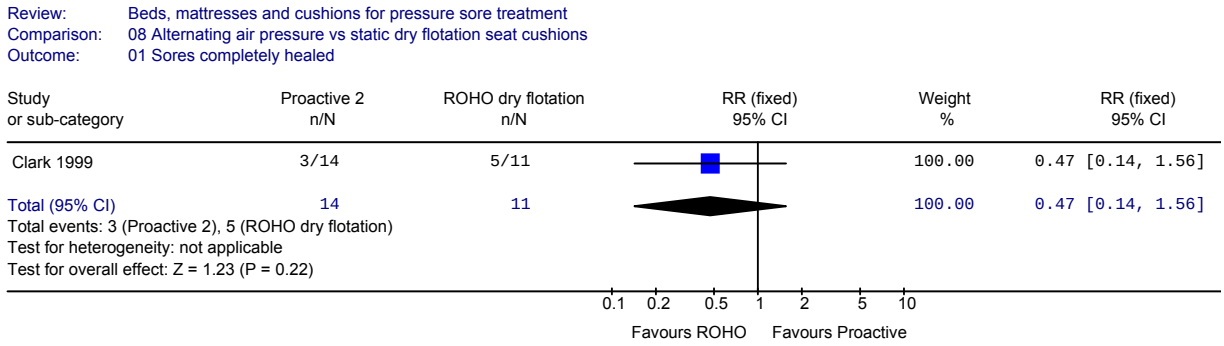


Figure 11:

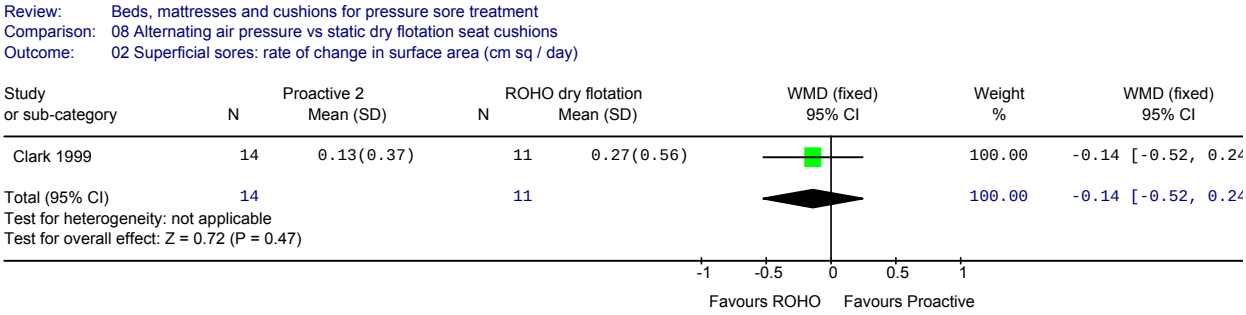
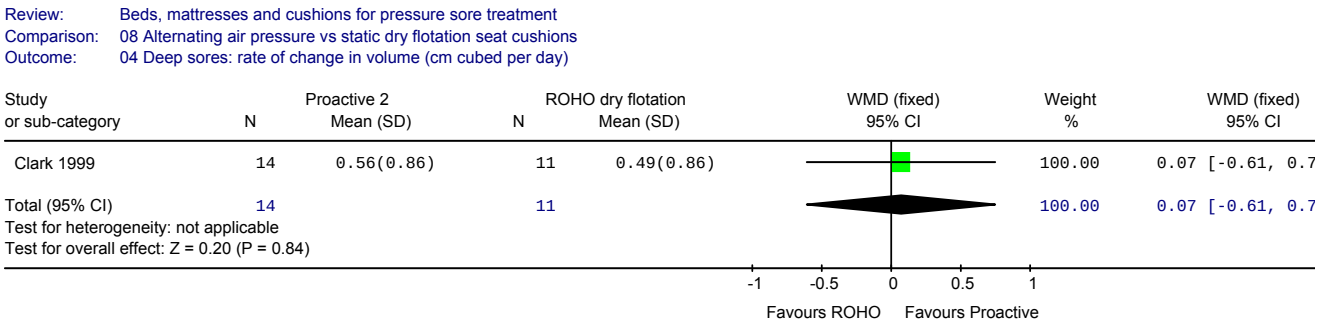


Figure 12:

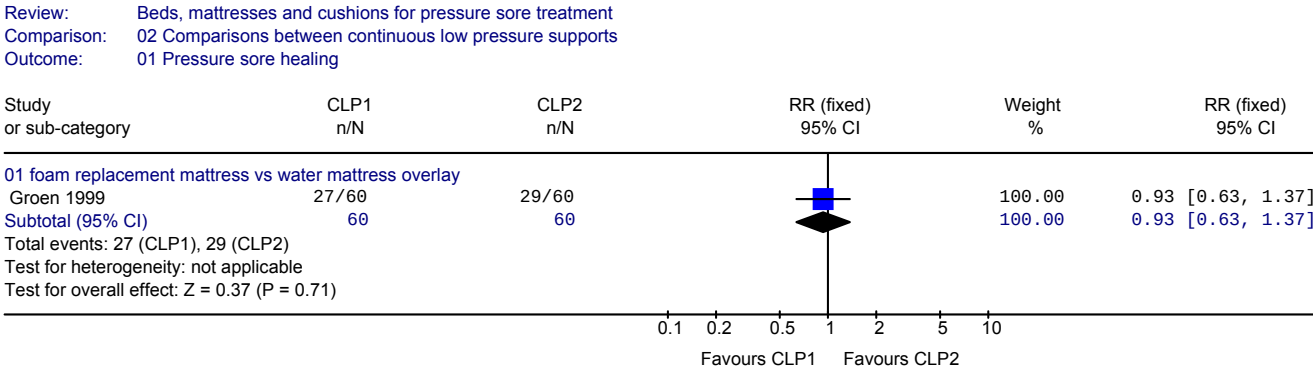


Continuous low pressure supports (CLP)

One small trial which used standard hospital mattresses with and without sheepskin overlays was inconclusive and of poor quality (Ewing, 1964).

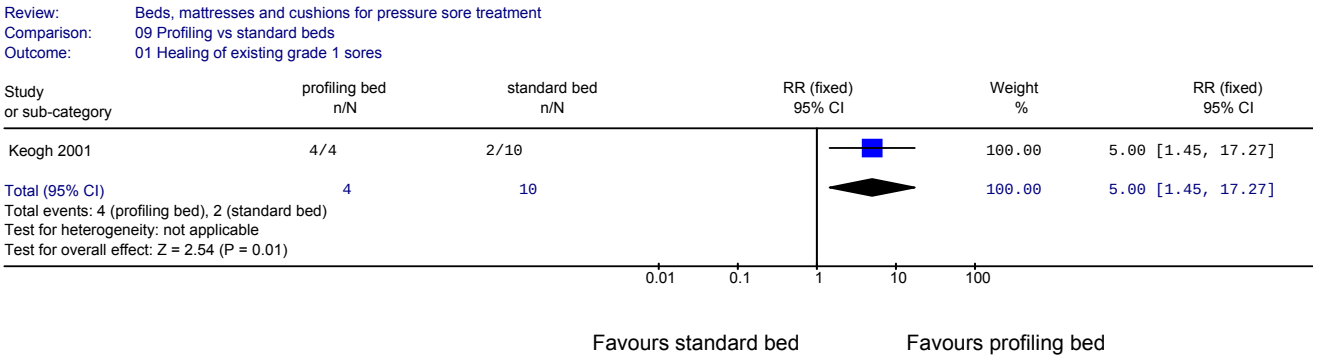
A trial of 120 nursing home patients with grade 3–4 ulcers (Groen, 1999) found no difference in ulcer healing rates between foam replacement mattresses and the Secutex water mattress overlay (see Figure 13).

Figure 13:



In the Keogh (2001) trial a bed that enabled individual profiling was compared with a standard hospital bed, both also with a pressure-reducing foam mattress or cushion. In this small trial (14 patients) the proportion of those with existing grade 1 ulcers was significantly improved using the profiling bed (see Figure 14). However these results should be interpreted with caution as they are only a small subgroup of the 100 patients randomised in the trial for which further data are unavailable.

Figure 14:



Discussion

Despite the frequency of pressure ulcer incidence and the myriad of treatment modalities, this review demonstrates the paucity of good-quality evidence that guides current clinical practice for the selection of pressure-relieving support surfaces.

The confidence with which we can draw firm conclusions from the studies detailed in this review is greatly tempered by (a) the poor quality of many of the trials and (b) the lack of replication of most comparisons.

There is some evidence to show that air flotation supports reduce the size of more established pressure ulcers compared to a modified alternating pressure support, or standard care (standard bed with CLP supports, sheepskin, gel pads, air-filled supports, water-filled mattresses and high-density foam pads).

There is no conclusive evidence to support the superiority of either alternating pressure support surfaces or continuous low pressure supports in the treatment of existing pressure ulcers.

Many of the trials included in this review are under-powered and therefore run a risk of failing to detect clinically significant differences as statistically significant. Other common methodological flaws – such as open randomisation, lack of baseline comparability and lack of blind outcome assessment – further reduce the confidence with which we can regard many of the individual study findings. Future trials should consider the findings of this review and address these deficiencies.

6.3.1 Cost-effectiveness of pressure-relieving support surfaces (beds, mattresses and overlays), mobility and positioning

Three economic evaluations of pressure-relieving support surfaces were identified for review (Branom et al., 2001; Ferrell et al., 1995; Strauss et al., 1991). One study was a full economic evaluation (Ferrell et al., 1995), the other two were partial economic evaluations.

Ferrell et al. (1995) conducted a cost-effectiveness analysis comparing low air loss therapy beds to conventional foam mattresses used in nursing homes in the US (see data extraction table 25, Appendix A). Patients with grade 2, 3 or 4 pressure ulcers were followed up until complete heal, death or transfer to another faculty. Effectiveness data to compute this included a statistically significant reduction in surface area of grade 3 and 4 pressure ulcers across the two treatments (9.9mm^2 per day vs. 0.7mm^2 per day, $p<0.02$).

Pressure ulcers took an average of 75 days to cure for low air loss therapy and 172 days for conventional foam mattresses. Use of the pressure-relieving support surfaces and associated nurse time was costed. While the lease cost per day of the

low air loss mattresses evaluated was higher than the cost per day of the conventional foam mattress, on average the low air loss bed was cost-saving due to a much shorter time to heal.

Final results were reported as cost per added day free of a pressure ulcer and were obtained by dividing the additional cost of the low air loss therapy by the additional days without an ulcer. The cost-effectiveness estimate for low air loss therapy was $26 per added day free of a pressure ulcer (1992 prices). No uncertainty associated with this estimate was reported. However, a few one-way sensitivity analyses were conducted and findings were sensitive to the lease cost of the low air loss bed as well as patient and pressure ulcer healing characteristics.

The economic evaluation was based on an analysis of the RCT reported in Ferrell et al. (1993) that is included in the clinical effectiveness review of pressure-relieving support surfaces. In the clinical effectiveness review the healing rates of this trial were combined with the Mulder et al. (1994) results. This revealed that pressure ulcer healing rates were not statistically significantly different to healing rates using a corrugated foam overlay.

Branom et al. (2001) conducted a cost-consequence analysis comparing constant force technology with low air loss therapy beds used in patient care in the US (see data extraction table 24, Appendix A). Patients with grade 3 or 4 pressure ulcers were followed up for a maximum of eight weeks. Study exit criteria included discharge from inpatient status, flap surgery and death.

Effectiveness results included: on average a smaller size pressure ulcer recorded at discharge from the study for the constant force technology group (6.6cm^3 vs. 24.6cm^3), the average amount closed at discharge from the study was higher (25.8cm^3 vs. 22.2cm^3), the average rate of closure per week was faster (3.5cm^3 vs. 2.8cm^3), the average proportion of pressure ulcers closed (60.0% vs. 39.6%) and a higher average proportion of pressure ulcers closed per week (9.0% (+/-4.8) vs. 5.0% (+/-3.7)) for the constant force technology group compared to the low air loss group.

The purchase price of constant force technology was $1,080 (price year not stated) while the daily rental cost of the low air loss mattress was $35 per day, that totalled to $1,960 over the maximum eight-week follow-up period.

In general, although costs and outcomes were not synthesised, results suggest that constant force technology dominated low air loss therapy beds since associated costs were lower and effects better. A number of caveats should be considered when drawing conclusions from this study. This is the only economic evaluation to assess the effectiveness of constant force technology beds. The study is based on a clinical

trial but patients were allocated to treatments sequentially, which is not truly random and can introduce bias. Only the costs of the mattresses were included, and the use of nursing time or other resources used in conjunction with the interventions were omitted. The total cost of the low air loss mattress was dependent on the length of use. Very limited statistical analyses were reported to investigate uncertainty associated with the results.

Strauss et al. (1995) conducted a cost-consequence analysis comparing air-fluidised therapy to conventional therapy in the US (see data extraction table 26, Appendix A). Patients with grade 3 or 4 pressure ulcers were followed up in the RCT over a considerable length of time (36 weeks). However, only 50% of patients receiving air-fluidised therapy completed the study compared to 56% in the conventional therapy group. Two nurses independently assessed outcomes, blind to treatment groups. For each patient who completed the 36-week regimen, and for whom interpretable photographs were available, the nurses assessed the photographs and clinical notes. They categorised each patient's pressure ulcer as (i) improved (ii) unchanged (iii) worse or (iv) not assessable[ii].

A higher proportion of pressure ulcers in the air-fluidised bed group were classified as improved (82% classified as improved by one nurse versus 91% by the other nurse for the air-fluidised bed group compared to 77% or 62% for the conventional therapy group), however differences were not significant. Additionally, a small proportion of pressure ulcers in this group were classified as unchanged.

The cost of treatments used was computed from the medical charges perspective, and the Medicare DRG and doctor payment perspective. Cost per patient for the former was $29,016 versus $34,747 for air-fluidised therapy compared to conventional therapy respectively, and this was not statistically significantly different. Cost per patient for the latter was $16,415 compared to $16,800 for air-fluidised therapy compared to conventional therapy respectively, and again this was not statistically significantly different.

Costs and outcomes were not synthesised and the cost-effectiveness implications are not straightforward to determine. Overall, costs per patient were similar across groups in spite of significant inpatient cost differences. No significant improvement in pressure ulcers was detected across the two groups either.

The economic evaluation was included alongside the results of the RCT on which it was based, and these results are reported in the clinical effectiveness review of

[ii] These categories were defined explicitly for the nurses

pressure-relieving support surfaces. There the air-fluidised therapy showed a statistically significant benefit compared to standard care on re-hospitalisation outcomes. Typically such an outcome would not be used in an economic evaluation since the cost of hospital stays are factored into the cost analysis.

Overview of pressure-relieving support surfaces

Although the three studies reviewed are based on level one or two effectiveness evidence, the economic evaluation quality assessments (see Appendix C) show that there were a number of study limitations. Data collection aspects for the Branom et al. (2001) and Ferrell et al. (1995) studies were moderate, but resource use and cost data for the Strauss et al. study (1991) were less strong. Analysis and interpretation of results were not strong for any of the studies, particularly in terms of exploration of the uncertainty associated with costs and outcomes reported.

6.3.2 A cost analysis of an alternating pressure mattress replacement system compared to a high-specification foam mattress with an alternating pressure overlay for the management of pressure ulcers

To inform the recommendations on pressure-relieving surfaces, the GDG suggested a comparison of two options: (i) an alternating pressure management replacement system (APMRS) with (ii) a high-specification foam mattress and an alternating pressure overlay.

No suitable comparison of products was found in the systematic review of the effectiveness literature and therefore the analysis was based on the expert opinion of the GDG. They argued that the benefits associated with each option are the same and therefore a cost-minimisation analysis was undertaken. The cost analysis was undertaken from the NHS perspective. The costs relate to the financial year 2004/5 and include 17.5% VAT.

The unit cost of the two options was calculated based on data obtained from the NHS Purchasing and Supplies Agency (NHS PASA). A number of companies supply these support surfaces and there is variation in the unit price of the products and their specifications. Therefore an average (mean) cost was obtained based on standard support surfaces. Two clinicians from the GDG checked that the products included in the costing exercise were appropriate.

Table 4: Unit cost of APMRS and a high-specification foam mattress with an alternating pressure overlay

Product	Number	Average (mean) cost	Standard Deviation	Minimum cost	Maximum cost
APMRS	24	£2,830	£1,393	£376	£5,451
High-specification foam mattress	207	£250	£140	£53	£938
Alternating pressure overlay	21	£1,128	£734	£353	£3,139

Table 4 presents the unit costs of the pressure-relieving support surfaces being analysed. The average (mean) cost of APMRS (£2,830) is more than twice that of a high-specification foam mattress used with an alternating pressure overlay (£250 + £1,128 = £1, 378).

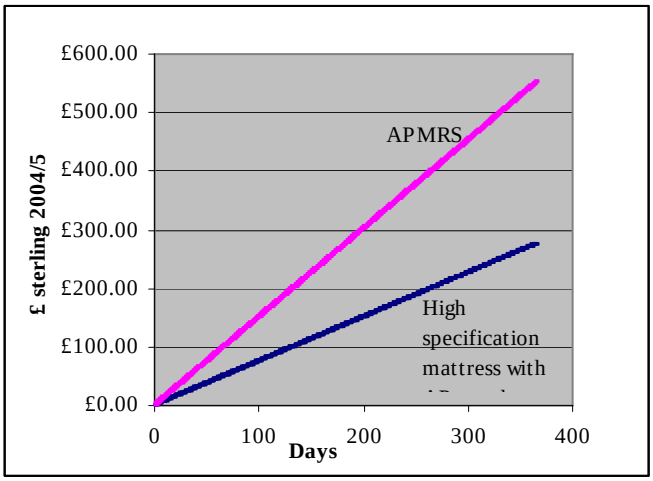
Assuming that for the five-year life span of the products, each option was used every day, the daily cost of each option would be, on average, £1.55 for the APMRS and £0.75 for the average high-specification mattress with an alternating pressure overlay. The difference in costs over a one-year period is illustrated in Figure 15 below. This information suggests that, on average, option (ii) using a high-specification foam mattress with an alternating pressure overlay provides greater value for money compared to option (i) APMRS.

NHS usage vignette	**APMRS**	**HSFM+APO**
Usage of one or other systems by 1,000 patients:	2,830,000	1, 378,000
Usage of one or other systems by 10,000 patients:	28, 300,000	13,780,000
Usage of one or other systems by 100,000 patients:	283,000,000	137,800,000

These figures taken across a five-year lifespan of the equipment then equate to per year in GRP as actual cost to the NHS based on mean calculations:

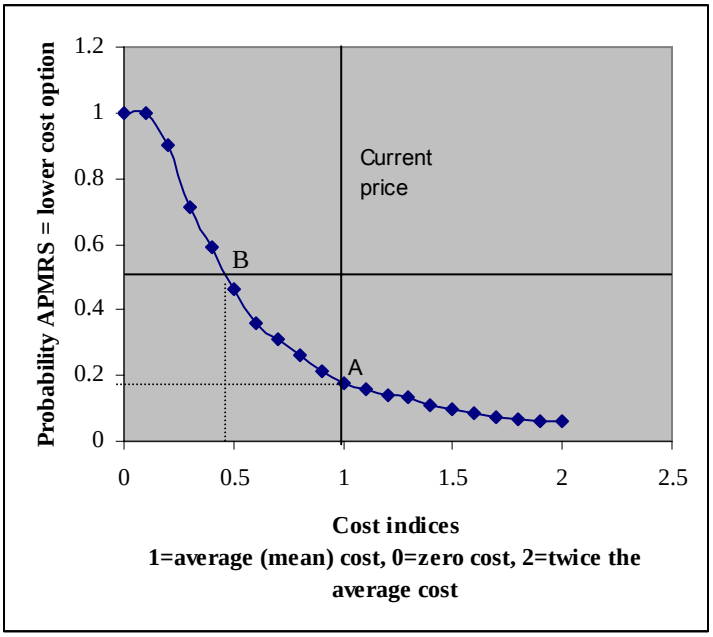
	APMRS	**HSFM+APO**
Usage of one or other systems by 1,000 patients:	566,000	275,600
Usage of one or other systems by 10,000 patients:	5,660,000	2,756,000
Usage of one or other systems by 100,000 patients:	56, 600,000	27, 560,000

Figure 15: Daily cost of APMRS compared to a high-specification foam mattress used with an alternating pressure overlay



Based on the minimum cost data in Table 4, it is worth noting that the minimum cost of APMRS supplied via the NHS PASA is £376 compared to £406 for the high-specification foam mattress and alternating pressure overlay (£53 for the mattress and £353 for the overlay). Therefore, APMRS is not always the more costly option. To take this into consideration, an additional analysis was undertaken.

Figure 16: Assessing the probability that APMRS is cost-minimising compared to a high-specification foam mattress with an alternating pressure overlay



If the individuals purchasing these options are unaware of the price of the products and the products are chosen independently then, as Figure 16 illustrates, there is a

probability of less than 20% (point A) that the APMRS option will be the lower cost option, whereas there is a probability of about 80% that the foam mattress with an alternating pressure overlay will be the lower cost option. The cost of APMRS would need to be more than halved (point B), on average, if there was to be an equal probability (50%) of APMRS being the lower cost option compared to the high-specification foam mattress with an alternating pressure overlay.

A number of assumptions underline the analysis and these are important to bear in mind when interpreting the results. A key assumption was that the benefits associated with each type of product were the same and therefore that it was appropriate to conduct a cost-minimisation analysis. No empirical effectiveness evidence was found which compared these particular pressure-relieving support surfaces. It was also assumed that the resource inputs, such as labour time, required to use either option were the same so that the only cost to be considered was the cost of the products themselves. An attempt was made to include the unit costs of standard pressure-relieving support systems. Therefore products for use on, for example, double beds and those produced specifically for bariatric patients or for children, were also excluded. The unit costs obtained from NHS PASA related to the purchase price of one product. In practice, products may be purchased in bulk and if so, the unit cost per product is likely to fall.

Evidence summaries

Level of evidence	Evidence statement
1++ 1+ 1+	**All pressure-relieving support surfaces**: No conclusive research evidence to indicate which pressure-relieving support surfaces are most effective in the treatment of pressure ulcers. **Air-fluidised therapy**: some evidence from meta-analysis of two trials indicate that ulcer healing was improved compared to modified AP and a range of other CLP supports in adults with grade 2-4 pressure ulcers (conventional therapy). **Low air loss therapy**: no evidence of a difference for complete ulcer healing found when compared to foam mattress overlays in individuals with grade 2-4 pressure ulcers.
1++ 1+	**Alternating pressure therapy**: no evidence of a difference in complete ulcer healing found comparing different alternating pressure support surfaces. No evidence of a difference found compared to static fluid overlay mattresses or cushions in the elderly with grade 2 or greater pressure ulcers. **Continuous low pressure therapy:** no evidence of a difference in ulcer healing rates for water-filled mattresses compared with foam replacement mattresses in adults with grade 3 pressure ulcers. Limited evidence of difference in ulcer healing for profiling beds compared with standard hospital beds in adults with grade 1 or greater pressure ulcers.

Recommendations: pressure-relieving support surfaces

Patients with pressure ulcers should have access to appropriate pressure-relieving support surfaces and strategies – for example mattresses, cushions, and repositioning – 24 hours a day and this applies to all support surfaces. **[D]**

Decisions about choice of pressure-relieving support surfaces for patients with pressure ulcers should be made by registered health care professionals. **[D]**

Initial choice and subsequent decisions, following re-assessments, related to the provision of pressure-relieving support surfaces for patients with pressure ulcers should be based on: **[D]**

- ulcer assessment (severity)
- level of risk: from holistic assessment
- location and cause of the pressure ulcer
- general skin assessment
- general health status
- acceptability and comfort for the patient
- lifestyle of the patient
- ability of the patient to reposition themselves
- availability of carer/health professional to reposition the patient, and
- cost consideration.

There is no conclusive research evidence that any one pressure-relieving support technology is superior to another. However professional consensus recommends that:

- all individuals assessed as having a grade 1-2 pressure ulcer should, as a minimum provision, be placed on a high-specification foam mattress or cushion with pressure-reducing properties combined with very close observation of skin changes, and a documented positioning and repositioning regime. **[D]**

- if there is any perceived or actual deterioration of affected areas or further pressure ulcer development, an AP (replacement or overlay) or sophisticated CLP system – for example low air loss, air fluidised, air flotation, viscous fluid – should be used. **[D]** N.B. For individuals requiring bed rails, AP overlay mattresses should be placed on a reduced-depth foam mattress to maintain safety.

- individuals assessed as having grade 3-4 pressure ulcers (including intact eschar where depth, and therefore grade, cannot be assessed) should, as a minimum provision, be placed on an AP mattress (replacement or overlay) or sophisticated CLP system – for example low air loss, air fluidised, viscous fluid. **[D]**

- if alternating pressure equipment is required the first choice should be an overlay system, unless other circumstances such as patient weight or patient safety indicate the need for a replacement system. N.B. To ensure maximum effect the inflated cells of the overlay must support the body weight of the patient in all bed positions (during use of backrest, knee break) and all patient positions (sitting up, side lying). **[D]**

Safe use of pressure-relieving mattresses

When selecting pressure-relieving devices consider the following factors:**D[GPP]**

1. Ensure that the mattress does not elevate the individual to an unsafe height in relation to bed rails if used. *(For individuals requiring bed rails, AP overlay mattresses should be placed on a reduced-depth foam mattress.)*
2. Ensure that the individual is within the recommended weight range for the mattress.
3. Children and alternating pressure
   - Cell size of mattress – small children can sink into gaps created by deflated cells causing discomfort and reducing efficacy.
   - Position of pressure sensors within the mattress in relation to the child – small children positioned at the top of the mattress may not register as the weight sensor is positioned in the middle of the mattress, thus producing inappropriate cell calibration.
   - Many alternating pressure mattresses have a permanently inflated head end which may place the occiput at risk in young children.

Guideline Development Group commentary

Intervention	GDG commentary
Air-fluidised therapy	AFT is now rarely used in clinical practice. There is little evidence of difference over AP or many other CLP surfaces, and there may be considerations in terms of patient positioning, and moving and

	handling.
Low air loss therapy	Basic mattress replacement versions often require user calibration (barrel test) which is very subjective. Tends to favour pressure relief at sacrum at expense of the head and heels. Requires constant power/pumped air supply (deflates if power supply removed) placing patient at risk while being transported. High-end systems have more sophisticated pressure monitoring but are often integrated into bed frames and are therefore expensive for general use.
Alternating pressure	Mechanical robustness is an artefact of old trials in early days of technology. Small cell systems are rarely used. AP is widely used in clinical practice. However more research is required to understand the ideal depth, inflation pressure and cycle time.

	Research recommendations.
	Independent, well-designed, multi-centre, randomised, controlled trials are needed to compare the clinical and cost-effectiveness of different types of pressure-relieving support surfaces to treat existing pressure ulcers for patients in a variety of settings. In particular, this research should aim to compare: • alternating pressure support surfaces with continous low pressure supports. Future research must address the methodological deficiencies associated with much of the research described in this review. Attention should be paid to: • description of inclusion and exclusion criteria used to derive the sample from the target population • evidence of an *a priori* sample size calculation • evidence of allocation concealment at randomisation • description of baseline comparability of treatment groups • evidence of blinded outcome assessment • clear description of main interventions • adequate description of associated care, and

	• withdrawals reported by treatment group with reasons. Patients should: • be truly randomised (with concealed allocation) • be of sufficient size to detect clinically important differences and have clear criteria for measuring outcomes • have blinded interventions and assessment • have adequate follow-up, and • appropriate statistical analysis. Measure patient experiences of pressure-relieving equipment: • comfort • pain • ease of use • appropriateness for users and settings, and • durability of equipment. The studies should also have evaluations of the cost-benefit trade off of pressure ulcer treatment alternatives undertaken.

6.4 Dressings and topical agents in the treatment of pressure ulcers

The methods described in this review were those used to update the following systematic review:

Bradley M, Cullum N, Nelson EA, Petticrew M, Sheldon T and Torgerson D (1999b) Systematic reviews of wound care management: (2) dressings and topical agents used in the healing of chronic wounds. *Health Technology Assessment*, 3(17) pt 2.

Bradley M, Cullum N and Sheldon T (1999a) The debridement of chronic wounds. *Health Technology Assessment*, 3(17) pt 1.

Background

Technological advances have extended the range and complexity of dressing products, making meaningful classification increasingly difficult.

For the purposes of this document dressings are divided into five basic categories:

1) Contact layers
The key features of a contact layer should be their ability to prevent adherence to the wound bed and allow free drainage of exudate. These materials tend to be used on superficial or lightly exuding wounds – for example paraffin gauze (tulle gras), knitted viscose, silicone-coated fabric dressings .

2) Passive dressings
Dressings that create a local wound environment conducive to healing by controlling the local wound environment but which do not change their physical state or directly modify or interfere with the physiology of the wound. Such dressings are commonly used to control exudate but they may also be used, for example to prevent contamination or control odour. Examples include films, foams and hydrogels.

3) Interactive dressings
Dressings that change their physical state in contact with wound exudate. Such products commonly form a gel-like covering on the wound surface that is claimed to promote healing. Examples include hydrocolloids, alginates and products containing carboxymethylcellulose fibre.

4) Active dressings

Products that aim to directly influence the physiology or biochemistry of the wound healing process. They include:

- Products containing physiologically active components that act at a biochemical level in the wound bed. Typically influencing cell growth or correcting chemical deficits – for example growth factors, collagen and hyaluronic acid.
- Skin grafts – the transplanting of human or animal skin onto a wound bed. May be patient's own (autograft), donated (allograft) or animal – usually pig (Xenograft).
- Tissue-engineered products.
- Also known as skin substitutes or skin replacements. Products that replicate a layer (or layers) of human skin.

5) Antimicrobial dressings

Dressings containing antimicrobials agents – for example iodine, chorhexidine silver and honey.

A number of characteristics of the ideal dressing have been described by pharmacists (see box, *Functions of an ideal dressing*). Many manufacturers refer to these characteristics when marketing their products. However, as this is an ideal list, none of the dressings in current use fulfil all of the criteria.

Gauze Woven or non-woven fabric produced from cotton, viscose, polyester, or other suitable fibres formed into a swab. Should not be used as a primary dressing as it adheres strongly to wound bed due to capillary looping into the structure.

Contact layers Includes simple products such as paraffin gauze (tulle gras) (cotton or cotton and viscose woven fabric, which has been impregnated with white soft paraffin) and knitted viscose dressings. More advanced products such as silicone-coated net dressings and hydrocolloid or gel-impregnated viscose nets are now generally preferred. Contact layers have no absorbent properties and generally require a secondary absorbent layer.

Wound dressing pads

The basic wound dressing pad consists of an absorbent layer such as cellulose fibre enclosed in a sleeve of a nonwoven fabric. Some pads have a perforated plastic film layer to reduce adherence to the wound surface – e.g. Melolin, Smith & Nephew Healthcare Ltd.

Semi-permeable film dressings

Consist of a transparent polyurethane film coated with a thin layer of adhesive to enable the dressing to adhere to intact skin but not the wound surface. These dressings are permeable to moisture vapour and gases but impermeable to water and microorganisms.

Hydrocolloid dressings

These dressings comprise an absorbent gel-forming mass, commonly consisting of carboxymethylcellulose, which is contained within their structure together with elastomers and adhesives. The dressings are usually presented in the form of a self-adhesive wafer that absorbs wound exudate and traps it in the form of a gel. Hydrocolloid colloid dressings are generally occlusive in their intact state but become semipermeable once in contact with wound fluid.

Hydrogels

These consist of hydrophilic polymer commonly made from carboxymethylcellulose or modified starch dissolved or dispersed in water or a mixture of water (80%) and propylene glycol (20%) as a humectant and preservative. They have the ability to absorb exudate or rehydrate slough or necrotic tissue in a wound depending on whether the wound is exuding heavily or dry and necrotic – for example Intrasite®, Smith & Nephew Healthcare Ltd.

Alginate dressings

These are derived from seaweed, usually prepared as the calcium salt of alginic acid. When in contact with serum, wound exudate or

solutions containing sodium ions, the insoluble calcium alginate is partially converted to the soluble sodium salt, and a hydrophilic gel is produced.

Foam dressings Most foam dressings are designed to absorb and retain fluid. Modern foams are available in a variety of formats (shaped, adhesive, non-adhesive, bordered, cavity) with varying levels of absorbency and permeability.

CMC fibrous dressing A primary wound dressing made from sodium carboxymethylcellulose fibres woven into a fleece similar in appearance to the alginates.

Capillary dressing A three-layer, non-woven/woven, low-adherent dressing, which comprises 100% polyester filament outer layers and 65%/35% poly/cotton fibres.

The functions of an ideal dressing

- Allows excess exudate to be removed from the wound surface.
- Provides a moist micro-environment.
- Is sterile/contaminant free.
- Does not shed dressing material in the wound.
- Reduces wound pain.
- Is easy to remove and apply.
- Does not cause allergic reactions.
- Causes no trauma when removed.
- Is impermeable to micro-organisms.
- Provides thermal insulation.

Topical preparations

Topical preparations eligible for inclusion in the present review include growth factors, oxygen-free radical scavengers, zinc oxide paste, tri-peptide copper complex, and silver sulphadiazine cream. Topical antiseptics and antibiotics are not covered here

but have been reviewed elsewhere.

Several of these preparations are applied to the wound to compensate for a deficiency in a particular element considered important for wound healing. An example of such a topical agent is zinc oxide; zinc deficiency has been associated with poor wound healing. Other preparations are thought to modify the wound environment by killing harmful bacteria – for example silver sulphadiazine.

Debridement

Debridement involves the removal of dead or necrotic tissue, or other debris, from the wound to reduce the wound's biological burden. A number of terms are used to describe dead tissue in wounds:

- necrosis
- slough, and
- eschar.

There are six main methods of debridement:

- autolytic
- enzymatic
- sharp (or surgical)
- chemical
- mechanical
- larval therapy, the use of sterile maggots

Debridement agents

All non-mechanical debridement agents, including the use of dressings and larval therapy, were included in this review. These include:

- dextranomer polysaccharide beads or paste
- cadexomer iodine polysaccharide beads or paste
- hydrogels
- enzymatic agents, and
- adhesive zinc oxide tape.

Mechanical debriding agent wet-to-dry dressings (saline gauze) were also included in this review. Other types of mechanical debriding agents, such as surgery or sharp debridement, were excluded from this review and will be examined separately.

Non-mechanical debridement techniques

Numerous non-mechanical techniques are available for wound debridement. Many

are easy to apply and may have additional properties that are beneficial for wound healing. Such interventions include hydrogels and hydrocolloids. These materials have largely replaced enzymatic agents and dextranomer beads.

Several different enzyme preparations are available that digest slough and necrotic tissue. In the UK, only the formulation containing streptokinase and streptodornase (Varidase Topical®, Wyeth Laboratories) is licensed for use. This enzyme breaks down the proteins fibrin and pus cells but is ineffective against collagen and elastin, the main structural components of skin and by extension necrotic eschar/slough. Other enzymatic debriding agents are available and used internationally; these include trypsin and collagenase.

Dextranomer polysaccharide is supplied as anhydrous, porous beads with a diameter of 0.1-0.3 mm or as a paste. The beads are highly hydrophilic and rapidly absorb exudate from a necrotic sloughy mass. Prostaglandins, hormones and other relatively small molecules enter the matrix of the beads, while larger particles such as bacteria and wound debris become concentrated at the surface of the dextranomer layer. When the beads are changed by washing with saline, the absorbed and trapped necrotic material is removed.

Cadexomer iodine is similar to dextranomer, consisting of small spherical beads that are hydrophilic in nature. The beads are made from a modified starch infused with iodine at a concentration of 0.9%. Absorption of fluid from the wound results in a slow controlled displacement of iodine from the matrix, which acts as a bactericidal agent. The slow and consistent release of iodine overcomes the problem of iodine inactivation by protein absorption in the wound. The antibacterial property, biodegradability and high rate of fluid absorption distinguish cadexomer iodine from dextranomer. Bead dressings are difficult to apply and remove, and are for this reason now generally used in the form of pastes.

Hydrogels are a group of agents that were primarily developed as debriding agents. These gels are biologically inert and have a significant water content. They complement the body's natural debriding process by providing an advantageous environment for autolysis, while still acting to preserve living healthy tissue. The hydrogel is usually applied directly into the wound bed and held in place by a non-adherent dressing. Once the gel is fully hydrated it is unable to absorb the copious quantities of exudate that are released by some wounds. For this reason hydrogels are often used in conjunction with a highly absorbent dressing. In addition to the amorphous gel, hydrogels are also available in a sheet form. Several types of hydrogel are available manufactured under different trade names (Intrasite® Gel,

Smith & Nephew Healthcare Ltd; Sterigel®, Seton Healthcare Group plc; Granugel®, CovaTec UK Ltd).

Larval therapy, also known as maggot therapy or biosurgery, exploits the natural feeding behavior of maggots of Lucilia sericata, the common green bottle, for the benefit of the patient. When placed in a wound maggots have the ability to selectively and rapidly remove slough and necrotic tissue leaving healthy tissue intact. They also ingest living bacteria from within the wound which are killed as they pass through the insect's gut.

In clinical practice there is wide variation in the use of debriding agents and no consensus on which agent is most appropriate for use in pressure ulcers.

Mechanical debriding agents

These involve the use of physical force to remove necrotic tissue and debris from the wound surface. Simple methods include the use of wet-to-dry dressings which remove tissue, although unselectively – i.e. healthy and unhealthy tissue. Other methods include wound irrigation – cleansing and pressure irrigation, whirlpool therapy, ultrasonic therapy and laser therapy.

Objectives

To systematically assess the evidence for the effectiveness of dressings and topical agents in the treatment of existing pressure ulcers.

Selection criteria

Types of studies

Only randomised controlled trials (RCTs) were included in this review. Studies that did not use true random allocation of participants to treatment groups, such as quasi-experimental designs, were excluded. The units of allocation had to be patients or lesions. Studies in which wards, clinics or physicians were the units of allocation were excluded because of the possibility of non-comparability of standard care. Both published and unpublished studies were included.

Types of participants

Studies that recruited people with existing pressure ulcers, of any grade or severity, were eligible for inclusion in the review. The study could be in any setting including

hospital, clinic, community facilities or home.

Types of interventions

Trials in which a dressing or topical agent was compared with another dressing or topical agent(s), or were compared with a placebo, usual care, or no treatment were eligible for inclusion in the review. All types of dressings or topical agents were eligible for inclusion with the exception of topical antimicrobial agents (in a separate review). Non-dressing mechanical debriding agents, sharp and surgical debridement were excluded.

Types of outcome measures

The primary outcome was wound healing.

Search strategy

Clinical effectiveness searching – debridement

Main literature search

Searches were undertaken to update the following Health Technology Assessment reviews for the aspects which were relevant to pressure ulcers:

Bradley M, Cullum N and Sheldon T (1999a) The debridement of chronic wounds. *Health Technology Assessment*, 3(17) pt 1.

Lewis R, Whiting P, Ter Riet G, O'Meara S and Glanville J (2001) A rapid and systematic review of the clinical effectiveness and cost-effectiveness of debriding agents in treating surgical wounds by secondary intention. *Health Technology Assessment*, 5(14).

Clinical effectiveness searching – dressings

Main literature search

Searches were undertaken to update the following Cochrane review:

Bradley M, Cullum N, Nelson EA, Petticrew M, Sheldon T and Torgerson D (1999b) Systematic reviews of wound care management: (2) dressings and topical agents used in the healing of chronic wounds. *Health Technology Assessment*, 3(17) pt 2.

Searches were limited by study design to retrieve randomised controlled trials. Searches were also limited to retrieve literature published in English, and to omit animal studies and letters, comments and editorial publication types.

Databases were searched in April 2004 and searches were updated in August 2004.

The strategies are listed in Appendix B.

Description of included studies

Sixty eligible randomised trials, involving 3,230 participants, were identified for inclusion in the review.

Most of the trials were conducted in either hospital or an aged-care facility, hence most of the enrolled patients were elderly, around 70–80 years old. There was a range of pressure ulcer severity included in the trials with baseline area at enrolment from 1-200cm^2. This reflects the differing ulcer stages for participants in the trials. On average, ulcers would be at grade 3-4 at the start of treatment. Thus, many of the ulcers treated within the included trials had persisted for between three and 12 months without resolution.

In studies of pressure ulcer treatment it is important for trialists to report on the baseline comparability of the treatment groups for important variables such as baseline ulcer size. A change in wound area is often expressed as the percentage change which, unlike the absolute change in area, takes into account the initial size of the wound. For two wounds healing at the same linear rate (as measured by diameter reduction) percentage area calculations will show a larger change for a small wound than for a big wound. The converse is true when the absolute change in area is measured, as for any unit reduction in wound radius, a bigger area reduction will occur for a large wound.

This has important consequences for the validity of trial results where there is poor comparability in initial wound size at baseline between the treatment groups. In large trials, randomised allocation should ensure that the mean wound size and variance in each group is similar. In a small trial random allocation is unlikely to result in an even distribution of wound sizes. This problem will persist in small trials, even when the average wound size appears to be comparable between groups, because the distribution of wound sizes about the mean is likely to differ. In a trial where there is poor comparability between groups for wound size at baseline, and the outcome is

based on the change in area, the result can only be considered valid if it is obtained either against the anticipated direction of the bias for wound size, or where percentage area change and absolute area change are in the same direction. If baseline data are not given then it is not possible to determine the direction of bias and the validity of the result cannot be determined. Twenty-eight of the 60 trials included in this review presented data on baseline ulcer size.

In some studies there were concurrent intervention and follow-up periods, ranging from two to 25 weeks. Other studies delivered the intervention for less than the full follow-up period. Twenty-two of the 61 included studies used photographic techniques as part of their objective measurement of wound healing. Others used planimetry (n=22), observer opinion of improvement (n=5), and other methods (n=13) such as water displacement techniques and rating scales. Many trials used a combination of these methods, while others failed to describe their assessment techniques in any detail.

Topical interventions were assessed in 31 studies. One trial (n=14) compared a topical agent against no treatment, nine trials (n=405) assessed a topical agent against a placebo, seven trials (n=548) compared one topical agent versus another, seven trials (n=197) examined topical agents compared with traditional dressings, and a further seven trials (n=444) compared topical agents with modern dressings. Modern dressings were compared with traditional dressings in 12 trials (n=573), with other modern dressings in 16 trials (n=994), and against a placebo in one trial (n=49). The Table of Comparisons details the individual comparisons examined under these broad groupings.

There were 22 studies that were excluded from the review. The citations and reasons for exclusion are detailed in the Table of Excluded Studies (Appendix D). The most common reasons for exclusion were non-randomised study design or lack of objective outcome measures reported.

Methodological quality of included studies

Details of the quality assessment of each study are outlined in the Table of Included Studies (see Appendix A). The key components of quality that were assessed included: *a priori* sample size calculations, allocation concealment, masking of outcome assessment and reporting of withdrawals by treatment group.

Sample size ranged from 14 to 168 patients per trial, with only six of the 60 trials recruiting more than 100 patients (Rees, 1999; Pullen, 2002; Colin, 1996; Brown-Etris, 1996; Belmin, 2002; Honde, 1994). *A priori* power calculations were reported in

only six trials. In 40 of the 61 included trials, the method of random sequence generation was not stated. Only six trials (Sayag, 1996; Thomas, 1997; Banks, 1994c; Graumlich, 2003; Meaume, 2003; Price, 2000) described the method of randomisation in enough detail that the reader could be sure of adequate allocation concealment.

Of the 10 trials that used a placebo comparator, only three described the placebo in sufficient detail to be confident that treatment allocation was masked to patients and caregivers (Robson, 2000; Ritz, 2002; Landi, 2003). Thirteen trials reported masked assessment of outcomes (Mustoe, 1994; Robson, 1992a,b; Robson, 2000; Landi, 2003; Pullen, 2002; Nasar, 1982; Moberg, 1983; Brown-Etris, 1996; Alm, 1989; Graumlich, 2003; Bale, 1998b; Ritz, 2002).

Thirty-six of the 60 included studies reported their withdrawal rates and reasons by treatment group. Withdrawals were common, and 34 studies reported withdrawals by treatment group and gave reasons for these withdrawals. There were sufficient data reported in 35 studies to enable results to be extracted and analysed on an intention-to-treat basis.

No attempt was made to weight the studies in the analysis using any statistical technique. However methodological quality was drawn upon in the narrative interpretation of the results.

Results

Many of the comparisons included in this review include only one eligible trial and many of these are of poor methodological quality. Hence, robust conclusions cannot be drawn from such results.

Topical agents versus no treatment

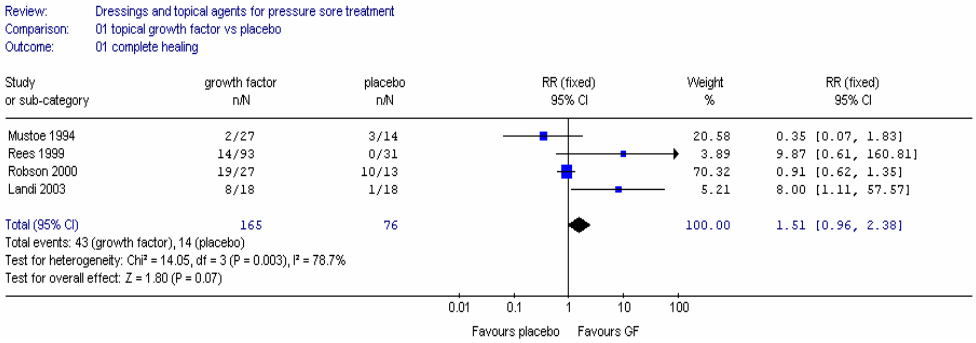
There was only one trial that was included in this comparison category. The incremental benefit of topical insulin (twice a day for five days) in addition to routine supportive nursing care was assessed in a single small trial (van Ort, 1976). The statistical analysis suggested that the addition of insulin resulted in a significant improvement in both the healing rate and the number of days that treatment was required. However, this trial was small (n=14) and no primary data or findings were presented, so firm conclusions cannot be drawn from these results.

Topical agents versus placebo

Nine trials compared a topical agent with a placebo. One assessed an active cream, referred to as F1400140 (formulation not stated but contained a barley plant extract) (Le Vassueur, 1991), one assessed collagenase (Lee, 1975), and a further seven trials assessed topical growth factors (rhPDGF-BB, rbFGF, interleukin I-beta, GM-CSF) compared to placebo (Rees, 1999; Mustoe, 1994; Robson, 1992a,b; Robson, 1994; Robson, 2000; Landi, 2003).

A meta-analysis of available data on complete ulcer healing from four of these seven trials (n=241) showed that overall, compared to placebo, there was no evidence that topical growth factors significantly improved healing rates (relative risk for complete healing with growth factor treatment 1.51; 95% confidence interval 0.96 to 2.38) (see Figure 17).

Figure 17:



However, as there is considerably heterogeneity in these results, both statistical (I^2 statistic 78.7%) and clinical, an assessment was made of the two trials (Mustoe, 1994; Rees, 1999) that used the same growth factor (rhBDGF-BB) in the same dosages (100μg/ml, 300μg/ml) compared with placebos. Both dosages of this topical agent showed evidence of improvement in ulcer healing (relative risk for ulcer healing with 100μg/ml rhBDGF-BB 7.17; 95% confidence interval 1.40 to 36.69) (see Figure 18); (relative risk for ulcer healing with 300μg/ml rhBDGF-BB 6.23; 95% confidence interval 1.17 to 33.34 (see Figure 19). It should be noted that, although these are statistically significant differences, the confidence intervals are wide, suggesting the results should be interpreted with caution.

No other data from this category of studies was suitable for pooling using meta-analysis.

Overall, topical growth factors did appear to reduce mean ulcer size. Robson and colleagues (Robson, 1992a,b; Robson, 1994; Robson, 2000) found increased reduction in wound size or volume with increasing concentrations of various growth factors (see Table of Included Studies for individual results, Appendix A).

Figure 18:

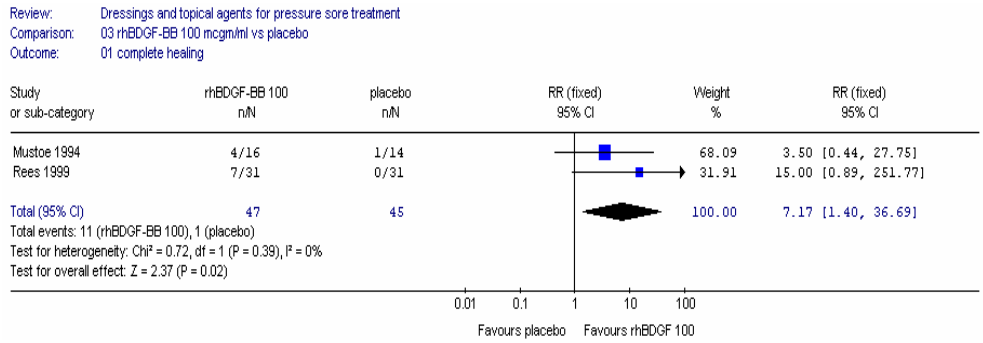
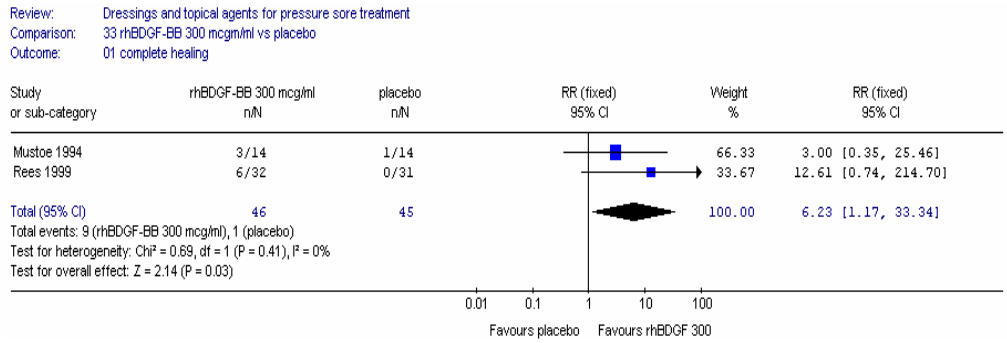


Figure 19:



A recent trial that assessed the effect of 2.5S murine nerve growth factor compared with placebo (Landi, 2003) found that this treatment reduced ulcer area by 74cm^2 in the treatment group compared to 49cm^2 for those receiving placebo. This topical agent also improved the rate of complete ulcer healing from one in 18 in the placebo group to eight of 18 in the treatment group (see Figure 17).

Topical agents versus topical agents

One trial compared topical collagenase with a topical fibrinolysis agent (Pullen, 2002). It reported no significant change in wound area, healing or depth, but primary data for these results were not given. The one small trial (n=28) that compared topical collagenase papain-urea ointment (Alvarez, 2002) showed that the percentage of non-viable tissue after four weeks of treatment was only 1% in the collagenase group compared with 75% in the group that received papin-urea ointment (weighted mean difference -74.00; 95% confidence interval -121.17 to -26.83).

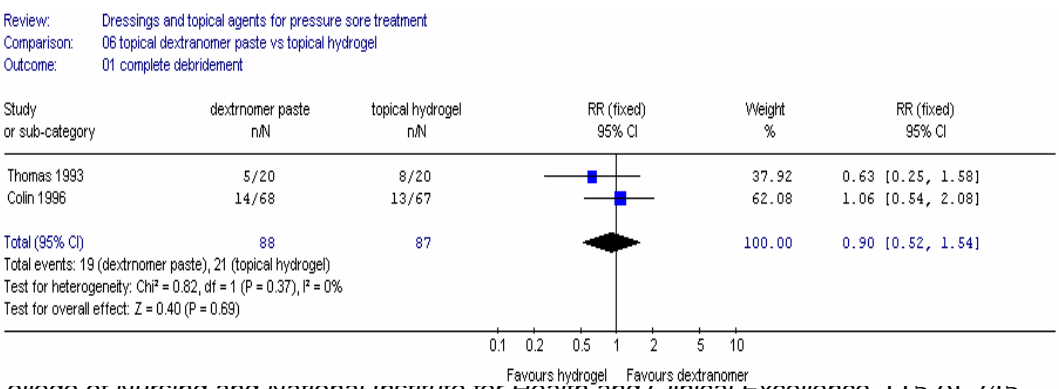
Another trial which compared collagenase paste (Santyl) with dextranomer polysaccharide paste (Debrisan) (Parish, 1979) showed no difference in ulcer healing rates (relative risk for ulcer healing for dextranomer paste 4.71; 95% confidence interval 0.66 to 33.61).

One larger trial which compared collagenase ointment in two dosing regimes (Burgos, 2000a) (24 versus 48 hours) showed no difference in healing rates (relative risk of ulcer healing 1.33; 95% confidence interval 0.63 to 2.830).

Although evidence in the form of RCTs is lacking, many clinicians believe that debridement facilitates wound closure by removing necrotic tissue that acts as a barrier to new tissue growth. This suggests that if debridement really does aid wound closure, then the effectiveness of a debriding agent should be measured by an outcome based on wound healing. Even though the debriding agent is not necessarily used throughout the entire healing process, an outcome measure based on healing remains valid as long as both comparison groups follow a similar schedule of nursing care after the debridement period. In this way, any difference in healing rates between groups can be attributed to the debriding agent used. Some researchers, however, have attempted to estimate the effectiveness of these agents by measuring the degree of debridement expressed as the percentage area of wound covered in necrotic material. This measurement may not be a reliable indication of treatment effect as the extent of debridement does not appear to have been scientifically validated as a surrogate or proxy measure of wound healing.

Dextranomer polysaccharide paste (Debrisan) was compared with a hydrogel (Intrasite) in two well designed trials (Colin, 1996; Thomas, 1993). The resulting meta-analysis of data from these trials showed no evidence of a significant difference in the rate of complete debridement (relative risk of complete debridement 0.90; 95% confidence interval 0.52 to 1.54) (see Figure 20). However, as neither of these trials reported complete ulcer healing, these results should be interpreted in light of the aforementioned comments.

Figure 20:

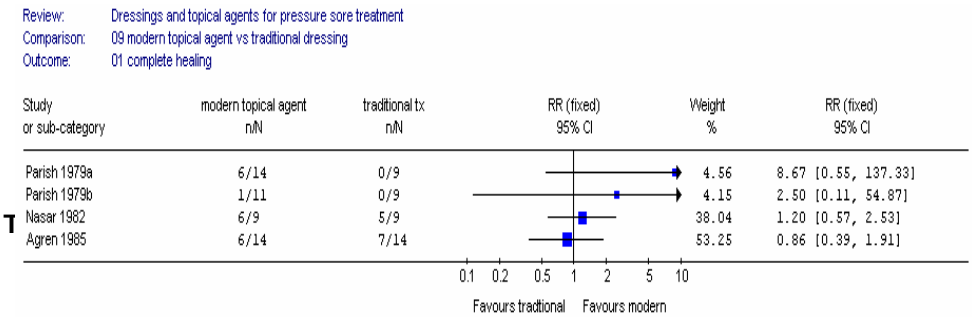


Topical agents versus traditional dressings

Modern topical agents – such as dextranomer polysaccharide paste (Debrisan), collagenase (Santyl), cadexomer iodine polysaccharide powder (Iodosorb), streptokinase preparation (Varidase) and hydrogel (Clearsite) – were compared with traditional dressings such as saline-soaked gauze, zinc oxide gauze, eusol and paraffin packs, and sugar and egg white in six trials (Ljungberg, 1998; Nasar, 1982; Parish, 1979; Moberg, 1983; Agren, 1985; Mulder, 1993).

As these agents all had different pharmacology and modes of action, it was inappropriate to combine the results from these trials in a meta-analysis. None of the three trials that reported complete wound healing found a significant improvement in ulcer healing rates with the use of either Debrisan (Parish, 1979; Nasar, 1982), Santyl (Parish, 1979) or Varidase (Agren, 1985) compared to traditional dressings (see Figure 21). Again, however, all these trials were small (ranging from 18 to 28 participants) and of only fair methodological quality.

Figure 21:



Seven trials that met the inclusion criteria compared a topical agent with a modern dressing. Three trials compared a hydrocolloid with a hydrogel (Brown-Etris, 1996; Darkovitch, 1990; Mulder, 1993), two studies compared polysaccharide beads with either a calcium alginate dressing (Sayag, 1996) or a collagen sponge dressing (Palmieri, 1992), and two compared a hydrocolloid dressing with either collagenase ointment (Burgos, 2000b) or a polyhydroxyethyl methacrylate paste (Brod, 1990).

One trial (Darkovitch, 1990) reported twice the rate of wound ulcer healing with the use of a hydrogel compared to a hydrocolloid dressing (relative risk for ulcer healing with hydrogel 2.23; 95% confidence interval 1.23 to 4.07). However a smaller, more recent trial, which compared a hydrogel with a modified version of the previous hydrocolloid (Mulder, 1993), found no significant difference in mean percent ulcer area reduction (weighted mean difference -4.70; 95% confidence interval -20.12 to

10.72) with the use of a hydrogel. A further comparison of a hydrogel with the same modified hydrocolloid (Brown-Etris, 1996) reported insufficient data to estimate a measure of statistical precision and hence meta-analysis of these results was not possible.

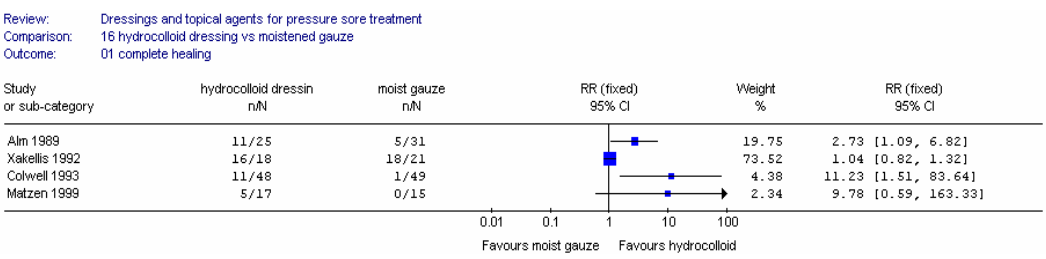
In both comparisons between polysaccharide beads and an alternative dressing (Palmieri, 1992; Sayag, 1996), the results indicated a benefit for the alternative treatment. However, this only reached statistical significance in the comparison with calcium alginate dressings, which showed a mean difference of 2.12cm^2/week in ulcer area reduction in favour of the alginate dressing (weighted mean difference 2.12; 95% confidence interval 0.74 to 3.50). Unfortunately neither of these authors reported ulcer healing rates, hence the significance of these findings should be interpreted with caution.

Modern dressings versus traditional dressings

Six trials (n=296) that met the inclusion criteria compared a hydrocolloid with the traditional treatment of saline-soaked gauze (Mulder, 1993; Alm, 1989; Colwell, 1993; Xakellis, 1992; Chang, 1998; Matzen, 1999). Due to significant clinical and statistical heterogeneity and missing outcome data for some trials, meta-analysis of results was deemed inappropriate.

Four of these trials reported wound healing results (Alm, 1989; Xakellis, 1992; Colwell, 1993; Matzen, 1999) (see Figure 22). The results are varied – some trials found large improvements in ulcer healing (Alm, 1989), others found little difference between the modern hydrocolloid dressing and traditional saline-soaked gauze (Xakellis, 1992). As these trials had quite different patterns of ulcer severity at enrolment, such differences might be expected.

Figure 22:

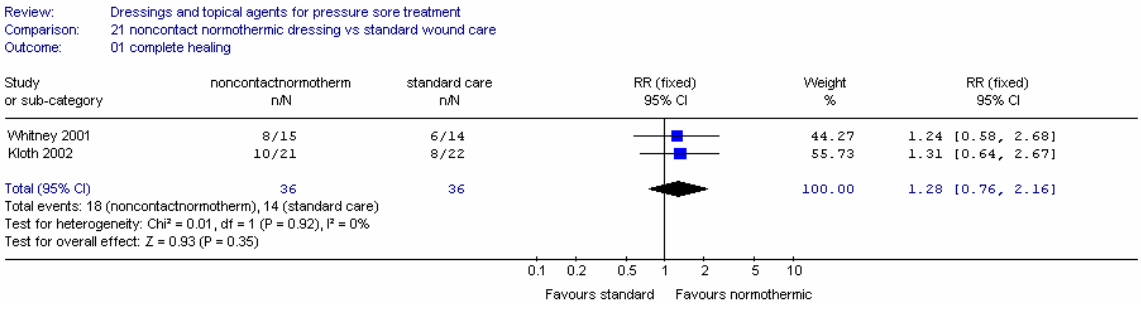


The comparisons of saline-soaked gauze and other modern dressings (semi

occlusive dressings, polyurethane dressings or hydrogel dressings) were only undertaken in small, single trials. They either had insufficient power to detect differences or showed no statistically significant differences between the groups for measures of ulcer healing. A trial of hydrocolloid dressing compared with povidone iodine gauze (Barrois, 1992) showed no statistically significant difference between the two groups for ulcer healing (relative risk for ulcer improvement with hydrocolloid 1.11; 95% confidence interval 0.51 to 2.42). Similarly, a semi-occlusive dressing was compared in one small trial (n=28) with saline-moistened gauze (Kraft, 1993) and no evidence of a difference between the two treatments was found (relative risk of ulcer healing with semi occlusive dressing 2.92; 95% confidence interval 0.74 to 11.45). A trial of 48 patients with 77 ulcers (Sebern, 1986) compared a polyurethane sterile dressing with saline gauze and found a large improvement in ulcer healing with the modern dressing (relative risk for ulcer healing with polyurethane dressing 16.39; 95% confidence interval 1.06 to 252.82). However the extremely wide confidence intervals for this result would suggest it was not a robust finding. One trial compared a hydrogel dressing with saline-soaked gauze (Thomas, 1998) and also found no evidence of improved ulcer healing rates (relative risk for ulcer healing with hydrogel 0.97; 95% confidence interval 0.56 to 1.68).

A newer dressing type, noncontact normothermic dressing, was compared with standard wound care in two trials (Kloth, 2002; Whitney, 2001). Wound healing results for these two trials showed no evidence of improved healing with the modern dressing (relative risk for ulcer healing with noncontact normothermic dressing 1.28; 95% confidence interval 0.76 to 2.16, see Figure 23).

Figure 23:

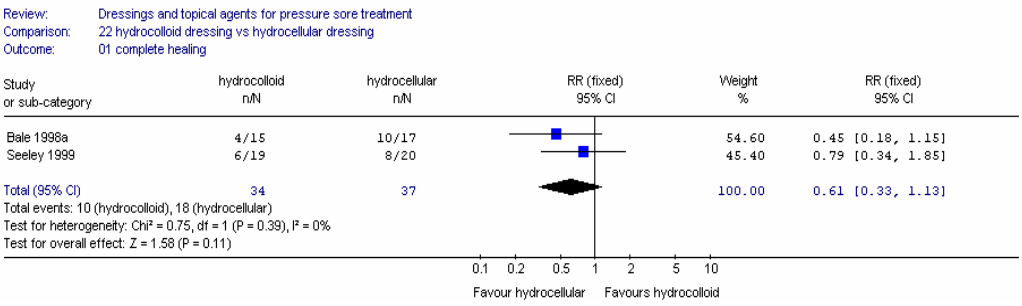


Modern dressings versus modern dressings

There were 16 trials that compared different types of modern dressings (Belmin, 2002; Seeley, 1999; Bale, 1997,1998a,b; Thomas, 1997; Banks, 1994a,b,c,1996,1997; Seaman, 2000; Graumlich, 2003; Honde, 1994; Meaume, 2003; Price, 2000).

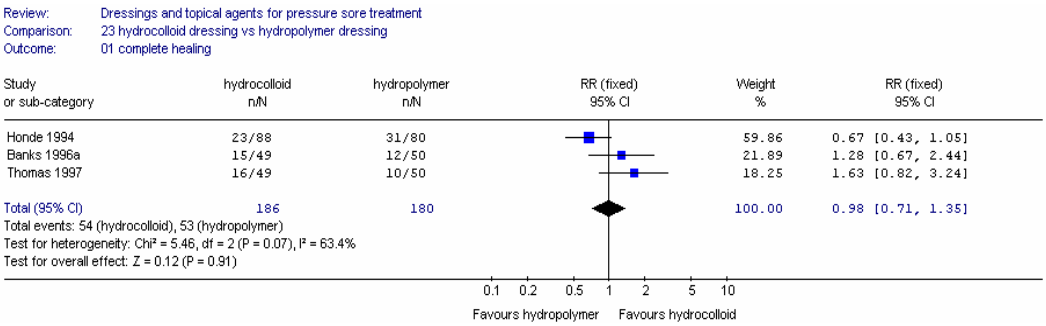
Hydrocellular dressings were assessed against hydrocolloid dressings in two trials (Seeley, 1999; Bale, 1998a). A meta-analysis of the results from these two trials did not show a significant difference in ulcer healing rates (relative risk for ulcer healing with hydrocolloid 0.61; 95% confidence interval 0.33 to 1.13 (see Figure 24). However, again these trials were small and it is likely there was insufficient power to detect real differences in treatment groups.

Figure 24:



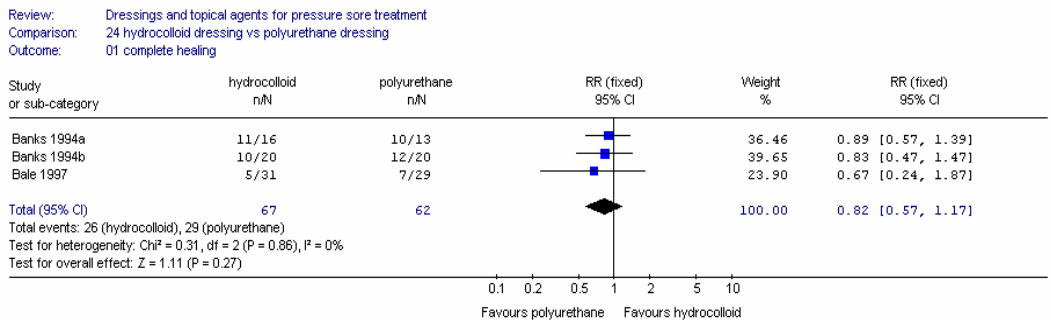
Meta-analysis of results from the three trials that examined hydropolymer versus hydrocolloid dressings (Banks, 1996; Thomas, 1997; Honde, 1994) showed no evidence of a significant difference in rates of wound healing (relative risk for ulcer healing with hydrocolloid 0.98; 95% confidence interval 0.71 to 1.35) (see Figure 25). As there was a moderate level of statistical heterogeneity (I^2 statistic = 63.4%), the meta-analysis was also run using a random effects model, but this made little difference to the results (relative risk for ulcer healing with hydrocolloid 1.07; 95% confidence interval 0.61 to 1.87, random effects).

Figure 25:



Three trials assessed hydrocolloid versus polyurethane foam dressings (Banks, 1994a,b; Bale, 1997). A meta-analysis showed no evidence of a significant difference in wound healing between these two types of dressings (relative risk for ulcer healing with hydrocolloid 0.82; 95% confidence interval 0.57 to 1.170 (see Figure 26).

Figure 26:



Several other comparisons between hydrocolloid dressings and other dressing types have been studied in randomised trials. A trial comparing hydrocolloid dressings with collagen dressings (Graumlich, 2003) found no evidence of a difference in wound healing (relative risk for ulcer healing with hydrocolloid 0.97; 95% confidence interval 0.60 to 1.57). The use of a calcium alginate dressing (UrgoSorb) for four weeks followed by a hydrocolloid dressing (Algoplaque) was compared with a standard hydrocolloid dressing (Duoderm E) for eight weeks in 100 patients (Belmin, 2002). A significant change in wound surface area at eight weeks was found for the sequential group with a reduction in mean surface area of 9.7cm^2 compared with the regular hydrocolloid dressing group whose mean surface area reduction was 5.2cm^2 (weighted mean difference 4.50; 95% confidence interval 1.83 to 7.17). A small (n=35) trial that compared a change indicator dressing (SIG) with a hydrocolloid dressing (Comfeel) (Seaman, 2000) saw an increase in wound healing with the change indicator dressings, but this was not statistically significant (relative risk for ulcer healing with hydrocolloid 0.16; 95% confidence interval 0.02 to 1.18). As most of these studies were small and have not been replicated, conclusive findings cannot been drawn from their results.

Similarly, there were a variety of single trial comparisons between several other dressing types. Hydrocellular and polyurethane dressings were compared in a trial of 20 patients (Banks, 1997) but although wound healing data were given for all patients, data were not presented for pressure ulcer patients alone. A recent trial of

38 patients compared the effect of hydropolymer and silicone dressings on wound healing (Meaume, 2003). This trial reported no evidence of a significant difference in ulcer healing rates between the two treatments (relative risk for ulcer healing with the hydropolymer dressing 1.13; 95% confidence interval 0.57 to 2.21). Polyurethane foam dressings (Lyofoam A) and low adherence dressings (Tegaderm) were compared in 50 patients (Banks, 1994c). Again, there was no evidence of a significant difference in wound healing between the two treatments (relative risk for ulcer healing with polyurethane 1.17; 95% confidence interval 0.79 to 1.72). When a radiant heat dressing was compared with an alginate dressing (Price, 2000), no evidence of a significant difference between the two groups was seen (relative risk for ulcer healing with radiant heat dressing 1.50; 95% confidence interval 0.27 to 8.22). Another study compared two types of hydrogel dressings (Sterigel and Intrasite) (Bale 1998b). This trial did not report wound healing data, only results for wound debridement. There was no evidence of a significant difference in this outcome between the two types of hydrogel (relative risk for wound debridement with Sterigel 1.44; 95% confidence interval 0.77 to 2.69). None of these fairly small trials showed significant or conclusive results favouring any of the new treatments, suggesting the need for further studies.

Modern dressings versus placebo

One small trial (n=49) compared a wound closure system (Provant) with a placebo (Provant support surface transparently modified so that no treatment was given) (Ritz, 2002) and found no evidence of significant difference in wound closure rates for grade 2 pressure ulcers at six weeks (relative risk for ulcer healing with wound closure system 3.50; 95% confidence interval 0.50 to 24.41).

Discussion

Quality of the studies

Quality assessment suggests that methodological flaws are an issue affecting the validity of studies in chronic wound care. In general, the studies were too small to ensure that wounds of different sizes (and other prognostic variables) were evenly distributed across trial arms, resulting in a bias at baseline in most trials. The majority of studies also had a short follow-up and did not analyse the data by survival analysis, which would account for both whether and when a wound healed, and which would be a more efficient method for estimating the rate of healing. If future trials perpetuate many of the methodological flaws highlighted in this review, they are unlikely to

provide the necessary evidence to determine an effective wound management strategy. The variability between wounds at baseline for prognostic variables, including size, indicates that recruitment numbers need to be large and that trials should probably be multi-centred. If small single-centred trials are to be continued they could be improved by the use of matched or stratified randomisation to ensure a similar distribution of wound sizes between treatment groups at baseline, and the data should be analysed by matched pairs analysis where appropriate. However, even with this improved design a trial still needs to be large enough to ensure comparability for both unknown and known confounding factors.

Dressings and topical agents as treatments for pressure ulcers

Studies that compare treatment with no treatment are very rare in the wound care literature because of concern over ethical issues associated with withholding treatment from a patient. In this review only a single trial was included that assessed the incremental benefit of topical insulin when given in addition to routine supportive care (not including direct management of the wound) for the treatment of pressure ulcers. This trial suggested that application of topical insulin did have a statistically significant benefit on wound healing. However, this requires further exploration and replication.

The alternative to withholding treatment from a patient is to use a placebo. Eleven trials were included in this review which assessed topical agents versus placebo or dressings versus placebo. In wound care trials such placebo treatments are unlikely to be inert as the application of the placebo or vehicle is likely to change the local environment of the wound, thereby modifying the biological processes associated with healing. A placebo is therefore not a substitute for withholding treatment in studies to determine the rationale for active treatment. The possible interaction between the vehicle and the healing process, together with small sample size, may provide some explanation for why trials do not show a statistically significant difference between an active treatment and a placebo.

Studies directly comparing topical agents for the treatment of pressure ulcers focused primarily on biologically active agents. Most of these trials were too small to provide conclusive results and their heterogeneity prevented pooling. At present the results are highly inconsistent both within and between trials, and further, better-designed studies with larger numbers are required.

6.4.1 Cost-effectiveness evaluation of dressings in the treatment of pressure ulcers

Table 5: Overview of economic evaluations to assess dressings and topical agents

Full or partial economic evaluation	Author	Country where study was conducted	Interventions compared
Partial	Aguilo Sanchez et al. (2001)	Spain	Hydrocolloid dressing vs. saline-moistened gauze dressing
Partial	Bale et al. (1998)	UK	Hydrocellular dressing vs. hydrocolloid dressing
Partial	Bergemann et al. (1999)	Germany	Gauze vs. impregnated gauze vs. calcium alginate vs. hydroactive wound dressing in combination with enzymatic wound cleaning collagenese vs. hydroactive wound dressing in combination with enzymatic wound cleaning collagenese during the first seven days of treatment
Full	Burgos et al. (2000)	Spain	Collagenese ointment vs. hydrocolloid occlusive dressing
Full	Capillas Perez et al. (2000)	Spain	Hydrocolloid dressing vs. saline gauze dressing
Partial	Colwell et al. (1993)	US	Hydrocolloid wafer dressing vs. sterile moist gauze dressing
Partial	Gorse et al. (1987)	US	Hydrocolloid dressing vs. Dakin's solution (chloramines-T) soaked wet-to-dry dressing

Partial	Graumlich et al. (2003)	US	Topical collagen vs. hydrocolloid dressing
Full	Harding et al. (2000/1)	UK	Saline-moistened gauze vs. hydrocolloid 1, hydrocolloid 2
Full	Kerstein et al. (2001)	US	Saline-moistened gauze vs. hydrocolloid 1, hydrocolloid 2
Partial	Kim et al. (1996)	Korea	Hydrocolloid occlusive dressing vs. wet-to-dry gauze dressing
Partial	Kraft et al. (1993)	US	Semi-permeable polyurethane foam dressing vs. moist saline gauze dressing
Partial	Mosher et al. (1999)	US	Autolysis vs. wet-to-dry saline vs. collagenese vs. fibrinolysin
Partial	Motta et al. (1999)	US	Synthetic polymer vs. hydrocolloid dressing
Full	Muller et al. (2001)	The Netherlands	Collagense containing ointment vs. hydrocolloid dressing
Full	Nasar et al. (1982)	UK	Debrisan vs. Eusol and paraffin dressings
Full	Ohura et al. (2004)	Japan	Hydrocolloid vs. traditional care with ointment and gauze with a standardised wound management algorithm vs. traditional care with ointment and gauze without a standardised wound management algorithm
Partial	Robson et al. (1999)	US	Recombinant human platelet-derived growth factor-BB: 100 µg rhPDGF-BB per day vs. 300 µg rhPDGF-BB per day vs. 100 µg grhPDGF-BB twice daily, vs.

			placebo
Partial	Robson et al. (2000)	US	Cytokine growth factors (2.0 μg/cm^2 GM-CSF) therapy topically applied daily for 35 days vs. 5.0 μg/cm^2 bFGF therapy applied daily for 35 days vs. 2.0 μg/cm^2 GM-CSF applied for 10 days followed sequentially by 25 days of topically applied 5.0 μg/cm^2 bFGF vs. Placebo applied daily for 35 days.
Partial	Sebern et al. (1986/9)	US	Transparent moisture vapour permeable dressing vs. gauze and tape
Partial	Xakellis et al. (1992)	US	Hydrocolloid dressing vs. non-sterile saline gauze dressing

Dressing and topical agents including debridement

The majority (81%) of economic evaluations obtained for review assessed the costs and outcomes associated with dressings and topical agents. Table 5 (above) presents an overview of the treatments that were assessed in this area together with the country where the study was conducted.

Table 6: Treatment comparisons

	Treatment comparisons	**Number of studies**	**References**
1	Hydrocolloid dressing versus saline gauze dressing	9	Aguilo Sanchez et al. (2001) Capillas Perez et al. (2000) Colwell et al. (1993)

			Harding et al. (2000/1) Kerstein et al. (2001) Kim et al. (1996) Ohura et al. (2004) Xakellis et al. (1992)
2	Hydrocolloid dressing versus Dakin's solution (chloramines-T)-soaked wet-to-dry dressings	1	Gorse et al. (1987)
3	Hydrocolloid dressing versus hydrocellular dressing	1	Bale et al. (1982)
4	Gauze versus impregnated gauze versus calcium alginate versus hydroactive wound dressing in combination with enzymatic wound cleaning collagenese versus hydroactive wound dressing in combination with enzymatic wound cleaning collagenese during the first seven days of treatment	1	Bergemann et al. (1999)
5	Collagenese ointment versus hydrocolloid dressing	2	Burgos et al. (2000) Muller et al. (2001)
6	Semi-permeable polyurethane foam dressing vs. moist saline	1	Kraft et al. (1993)

	gauze dressing		
7	Autolysis vs. wet-to-dry saline vs. collagenese vs. fibrinolysin	1	Mosher et al. (1999)
8	Synthetic polymer vs. hydrocolloid dressing	1	Motta et al. (1999)
9	Collagen vs. hydrocolloid dressing	1	Graumlich et al. (2003)
10	Debrisan vs. Eusol and paraffin dressings	1	Nasar et al., 1982
11	Growth factors versus placebo	2	Robson et al. (1999) Robson et al. (2000)
12	Transparent moisture vapour permeable dressing versus gauze tape	1	Sebern et al. (1986/9)

Seven (33%) full economic evaluations were reviewed together with 14 (67%) partial economic evaluations. Eleven studies (52%) were conducted in the US, three in the UK and three in Spain (14% each), and one in Germany, Korea, Japan and the Netherlands (5% each). Twelve different treatment comparisons were made and may be grouped as presented in Table 6. Companies who supply pressure ulcer treatments funded most studies. Reviews of the groups of different treatment comparisons follow.

Hydrocolloid dressings versus moist gauze dressings

Eight economic evaluations comparing hydrocolloid dressings to saline gauze dressings were reviewed including three full economic evaluations (Harding et al., 2000/1; Kerstein et al., 2001; Ohura et al., 2004) and six partial economic evaluations (Aguilo Sanchez, 2001; Capillas Perez et al., 2000; Colwell et al., 1993; Gorse et al., 1987; Kim et al., 1996; Xakellis et al., 1992).

Aguilo Sanchez et al. (2001)[iii] conducted a cost-consequence analysis based on data obtained from an RCT conducted in a hospital in Spain (see data extraction table 1, Appendix A). It is not clear from the abstract how long patient follow-up was. The effectiveness measure reported was the number of patients whose pressure ulcers were completely healed. Twenty (57%) pressure ulcers were completely healed in the hydrocolloid dressing compared to ten (29%) in the saline-moistened gauze group.

The daily cost of treatment, based on the cost of materials and nursing time, was Pta 180.50 (price year not stated) and Pta 209.36 for the hydrocolloid dressing compared to the saline-moistened gauze treatment. It is not clear how the daily cost of treatment was calculated since this could be the cost per day or the cost per day until complete heal of the ulcer. It appears that the hydrocolloid dressing is more effective and associated with lower costs (if indeed the daily cost of treatment takes length of time to heal into account). However, this needs verification before asserting that the hydrocolloid dressing was found to be more cost-effective. No statistical analyses or sensitivity analyses were conducted to assess uncertainty associated with the cost and effect estimates across the two groups.

Capillas Perez et al. (2000) also conducted a cost-effectiveness analysis based on an RCT conducted from the perspective of the district health authority in Spain (see data extraction table 5, Appendix A). The two effectiveness measures assessed were time to cicatrise an initial 1cm^2 wound and proportion of surface healed daily. The median nurse time to cicatrise an initial 1cm^2 pressure ulcer was 7.12 (first quartile 5.33 to third quartile 11.0) days compared to 12.18 (5.85 to 39.38) days for the hydrocolloid and saline gauze groups respectively. The median proportion of surface area healed daily was 1.42% (0.56% to 2.5%) versus 1.19% (0.59% to 1.55) for the hydrocolloid and saline gauze groups respectively. Neither difference was statistically significant.

Costs were calculated based on use of materials and nursing time. The median cost (1st and 3rd percentiles) of the cicatrisation of an initial 1cm^2 pressure ulcer was Pta 4,388 (1,808 to 7,539) (no price data available) compared to Pta 17,983 (6,521 to 87,798) and this difference was found to be statistically significant. Average cost-effectiveness rather than incremental cost-effectiveness was presented. However, it

[iii] *This review is based on an NHS EED abstract (NHS CRD, 2001). The original paper was written in Spanish.*

appears that hydrocolloid is cost-saving and is associated with better outcomes, dominating the saline gauze intervention.

It is worth noting that patients were allocated to intervention sequentially, which is not a truly random method of allocation. The effectiveness estimates were based on intermediate outcomes rather than final outcomes (pressure ulcer healed). Median costs were reported whereas, from the economics perspective, mean costs are the most appropriate and informative type of costs to report. The advantage of reporting the mean is the ability of parametric tests to make inferences about the arithmetic mean that is useful for budgetary purposes (Barber and Thompson, 1998)

Colwell et al. (1993) conducted a cost-consequence analysis based on an RCT conducted from the hospital perspective in the US (see data extraction table 6, Appendix A). Patients were followed up between six and 56 days (mean 17) and the outcome assessed was the proportion of pressure ulcers healed. Twenty-two percent (n=11) of pressure ulcers healed in the hydrocolloid group compared to two percent (n=1) in the moist gauze group. The total average cost (including cost of materials and nurse time) per patient was $53.68 (no price date) versus $176.90 for the hydrocolloid versus the gauze group. It appears that the hydrocolloid dressing costs less and is associated with better outcomes, dominating the moist gauze intervention.

A few caveats should be mentioned alongside the study results. The authors randomised by pressure ulcer rather than by patient and some patients had more than one pressure ulcer, both of which were included in the study. This method can introduce bias, for instance if the ulcers are allocated to different treatments then it may be difficult to remember to treat each differently. Also there may be something particular about the patient which impacts on the findings and this undermines the randomisation process. There were statistically significantly more grade 2 pressure ulcers allocated to the hydrocolloid treatment and these types of ulcers tend to have better healing characteristics than grade 3 pressure ulcers, potentially advantaging the hydrocolloid treatment.

Harding et al. (2000/1) conducted a cost-effectiveness analysis of saline-moistened gauze compared to two hydrocolloid dressings (Comfeel and Granuflex) (see data extraction table 9, Appendix A). The analysis was based on a probability based decision model, utilising data from the published literature and informed by expert opinion. The perspective of the analysis was the UK NHS. The effectiveness estimate was the proportion of pressure ulcers healed in 12 weeks and a meta-analysis was undertaken to pool data from 15 studies for use in the model. The proportion of pressure ulcers healed at 12 weeks in the saline-moistened gauze group was 51% compared to 48% in the hydrocolloid Comfeel group and 61% in the hydrocolloid Granuflex group. The average cost per patient healed (with costs including materials,

ancillary supplies, nursing and doctor debridement) was £2,663, £642 and £422 (1999 prices) for saline-moistened gauze, hydrocolloid Comfeel and hydrocolloid Granuflex respectively. Thus hydrocolloid Granuflex appears to be the most cost-effective option.

Although the unit cost of gauze treatment was lower than the unit cost of either hydrocolloid dressing, the total cost associated with the gauze treatment was highest due to higher nurse input. As the authors state, nurse time is the single most expensive cost for each treatment. The use of cost per wound healed does not take the length of time to healing into consideration. The assumptions and use of expert opinion on resource use and effectiveness were not described in a very transparent way. Incremental cost-effectiveness analysis was not undertaken.

Kerstein et al. (2001) also conducted a cost-effectiveness analysis, using a similar approach to Harding et al. (2000/1)[iv], comparing saline-moistened gauze to two hydrocolloid dressings (Comfeel and DuoDERM[v]). It was based on a probability based decision model, utilising data from the published literature and informed by expert opinion. However, the perspective of the analysis was different since the Kerstein et al. (2001) study was based on a US hypothetical managed care plan setting. The effectiveness results were identical but the cost estimates were estimated using US resource use and costs. In terms of results, the average cost per patient healed (with costs including materials, ancillary supplies, nursing and doctor debridement) was $2,179 (2000 prices), $1,267 and $910 for saline-moistened gauze, hydrocolloid Comfeel and hydrocolloid Granuflex respectively. The hydrocolloid DuoDerm dressing appeared to be the most cost-effective option. The same limitations as the Harding et al. (2000/1) study apply.

Kim et al. (1996) conducted a cost-consequence analysis based on an RCT undertaken in Japan (see data extraction table 11, Appendix A). The length of follow-up was not stated. Effectiveness measures included in the study were proportion of pressure ulcers completely healed, time to complete heal and rate of pressure ulcer heal. A total of 80.8% of pressure ulcers in the hydrocolloid group and 77.8% of pressure ulcers in the gauze group healed completely, and the difference between the two groups was not statistically significant. The time to complete heal was 18.9 days versus 24.3 days for the two comparators and the pressure ulcer healing speed was 9.1mm^2 per day and 7.9 mm^2/day for the hydrocolloid and the gauze group respectively.

[iv] *Based on the results it appears the Harding and the Kerstein study may be using the same data, however the perspective of the analysis differs.*
[v] *DuoDerm is the US brand name equivalent of the Granuflex UK brand name*

The average cost of the interventions was Won 8,204 (+/-2,664) and Won 14,571 (+/-6,700) (no price date) for the two comparators respectively (P<0.05). It appears that the hydrocolloid dressing is more cost-effective than the gauze dressing with lower associated costs and better effects. However, in general, little detail was provided on methods used to conduct the evaluation so it is not clear as to the validity and reliability of the results. The costs calculated did not take the cost of staff into account, which seems an important omission based on results from the evaluations above.

Ohura et al. (2004) undertook a cost-effectiveness analysis of hydrocolloid DuoDERM dressing with a standardised wound management algorithm, traditional care of ointment and gauze with a standardised wound management algorithm and traditional care of ointment and gauze without a standardised wound management algorithm (see data extraction table 17, Appendix A). The study was based on a multi-centre, non-randomised trial in Japan and considered grade 2 and 3 pressure ulcers over a follow-up period of 12 weeks maximum. Effects were measured in terms of the Pressure Ulcer Status Tool (PSST), with greater reductions in PSST being associated with greater health benefits achieved, and costs were based on use of materials and labour time.

The hydrocolloid dressing was associated with a 11.1 point reduction in PSST compared to a 6.9 point reduction for gauze with standard management and a 9.0 reduction in PSST for the gauze without standard management comparator. The reduction was statistically different when comparing the first two of these interventions. In terms of costs across the three treatments, the average total cost was Yen 87,715, Yen 131,283 and Yen 200,584 (2001 prices). The difference in the cost of the hydrocolloid treatment compared to the gauze without the standardised wound management strategy was as statistically significantly different as when materials and total labour costs were analysed separately.

Across all pressure ulcers, the PSST unit difference per Yen was 0.127 for the hydrocolloid dressing compared to 0.045 for gauze without standardised wound management and 0.052 for gauze with standardised wound management. In terms of cost-effectiveness, based on these results the hydrocolloid dressing dominates with lower associated costs and higher associated outcomes.

The Ohura et al. study (2004) was based on a multi-centre clinical trial. No tests were undertaken to assess variation across study centres. Patient allocation to groups was non-random. Limited statistical testing was undertaken to explore uncertainty with no sensitivity analysis being conducted to assess the robustness of findings to variables included in the analysis. The generalisability of these results is unclear. Unlike the

large majority of other studies, the cost of doctors' time was included which was a high-cost input. Costs were not reported separately from resource use.

Xakellis et al. (1992) conducted a cost-consequence analysis of hydrocolloid dressings compared to non-sterile saline gauze dressings, based on an RCT in a long-term care setting in the US (see data extraction table 21, Appendix A). The study period was 21 months and study endpoints included pressure ulcer heal, progression to stage 4 pressure ulcer, doubling in pressure ulcer area, systemic infection from the pressure ulcer, no decrease in size of the pressure ulcer at two months and six months of treatment, patient discharge from the long-term care facility and death.

Effectiveness was measured in terms of proportions of pressure ulcers completely healed, time to healing and healing rates. Eighty-nine percent (n=16) of pressure ulcers were completely healed in the hydrocolloid group compared to 86% in the comparator group. The median time to healing after randomisation was nine days for hydrocolloid group and 11 days for the gauze group and this finding was not statistically significantly different. Seventy-five percent of pressure ulcers healed within 14 days in the hydrocolloid group compared to the 26 days in the gauze group. After adjusting for exudates present at baseline, healing rates were not statistically significantly different across groups although the trend was towards slower healing in the gauze group.

The cost of use of materials and nurse time was assessed and the median total cost per patient was $15.58 (1990 prices) for the hydrocolloid group and $22.65 for the gauze group if local nurse wages were used, and the difference was not statistically significant. If national nurse wages were used, the median total cost was $15.90 and $25.31 respectively (p=0.04). Overall, the hydrocolloid was less costly and associated with greater health effects, hence it appears to be the more cost-effective option.

The authors reported median costs and conducted statistical tests based on non-parametric techniques, rather than mean costs and, as mentioned above (see review of Capillas Perez et al. (2000)), this makes findings difficult to interpret.

Overview of hydrocolloid dressings versus moist gauze dressings

Although there were a number of limitations associated with all the economic evaluations comparing hydrocolloid dressings to moist gauze dressings, typically hydrocolloid dressings were found to be the more cost-effective option.

Hydrocolloid dressings versus Dakin's solution (chloramines-T)-soaked wet-to-dry dressings

Gorse et al. (1987) (see data extraction table 7, Appendix A) conducted a cost-consequence analysis comparing hydrocolloid dressing with Dakin's solution (chloramines-T)-soaked wet-to-dry dressings in a hospital in the US. Patient follow-up was from initiation of conservative treatment until healing, hospital discharge or failure of the initial intervention. However, the time in days was not stated.

Effectiveness was measured in terms of the rate of healing for each pressure ulcer healed: that is the initial surface area divided by the number of days until complete healing. If patients died or were discharged before complete healing, the surface area at the last examination was subtracted from the initial surface area, and the results divided by the number of treatment days. In the hydrocolloid dressing group, 86.8% of pressure ulcers improved compared to 69.2% in the wet-to-dry dressing group. The number of days to complete heal for pressure ulcers that healed was 10.0 (+/-10.5) in the hydrocolloid group compared to 8.7 (+/-6.2) for the wet-to-dry dressing group. The rate of decrease (cm^2 per day) for pressure ulcers that healed was 0.72 (+/-1.22) compared to 0.55 (+/-0.59) for these groups respectively and this result was not statistically significantly different. Among the incompletely healed pressure ulcer group, the duration of follow-up was significantly longer for the wet-to-dry group but the rate of decrease in surface area was not significantly different. Among the pressure ulcers that worsened, a higher rate of increase in surface area was found in pressure ulcers treated in the hydrocolloid group compared to the wet-to-dry group.

Based on treatment costs alone, a cost of $6.20 per week was estimated for treating each pressure ulcer in the hydrocolloid group compared to $52.50 per week in the wet-to-dry dressing group. Costs associated with the hydrocolloid dressings were lower and more pressure ulcers healed in this group compared to those treated with wet-to-dry dressings, and on this basis the former appears to be the more cost-effective option, dominating wet-to-dry dressings.

The cost analysis undertaken as part of this study was particularly weak. As noted above, the cost of nursing time can be substantial but these costs were omitted. Also, the cost was not examined until time to heal or according to any other effectiveness measure. Some patients had more than one pressure ulcer that was entered into the trial and this could bias the results. The allocation of patients to interventions was not random. The uncertainty associated with the estimates was only assessed statistically for the effectiveness dimension of the study.

Hydrocolloid dressings versus hydrocellular dressings

Bale et al. (1998) conducted a cost-consequence analysis comparing hydrocolloid dressings to hydrocellular dressings (see data extraction table 2, Appendix A). The study was based on an RCT and the perspective of the analysis was the NHS. Patient follow-up was for a maximum of eight weeks. The effectiveness measure reported was the proportion of pressure ulcers healed completely at eight weeks. In this time, 59% of pressure ulcers healed in the hydrocolloid dressing group compared to 27% of the pressure ulcers in the hydrocellular dressing group.

Costs were based on materials and nursing time. The total cost of treatment per patient, whether their pressure ulcer had healed or not, was £50 in the hydrocolloid group and £76 in the hydrocellular group. A number of one-way sensitivity analyses were undertaken, including varying the costs applied if withdrawn before eight weeks, but did not alter the findings. Since more pressure ulcers healed in the hydrocolloid group and the daily cost of treatment was lower, it appears that hydrocolloid dressings may be the more cost-effective option.

There are a few study limitations that should be considered when interpreting the results. The cost of labour time, typically an important contributor to overall cost, was omitted. Some patients were withdrawn from the study (the authors do not say in which wound group they were). More patients were withdrawn from the hydrocellular group and this could bias results in favour of this group. Across all wounds, at seven weeks the numbers of wounds healed was very similar across groups but comparative data was not presented on pressure ulcers at seven weeks.

Gauze versus impregnated gauze versus calcium alginate versus hydroactive wound dressing in combination with enzymatic wound cleaning collagenese versus hydroactive wound dressing in combination with enzymatic wound cleaning collagenese during the first seven days of treatment

Bergemann et al. (1999) conducted a cost-consequence analysis to compare five different interventions used in four hospitals in Germany (see data extraction table 3, Appendix A). A spreadsheet model was constructed, informed by an expert panel, and data to populate it were obtained using the hospital databases. The treatment of four sizes of pressure ulcers were considered: (i) 5cm x 8cm (ii) 8cm x 12cm (iii) 10cm x 15cm and (iv) 12cm x 20cm. It was assumed that the bigger the wound, the longer the treatment duration required. Equal efficacy was assumed or a decrease in the length of hospital stay of 10% for the two hydroactive treatments.

Resource use estimates were assumed to vary across wound surface areas, as informed by the expert panel. Costs were based on materials used and nurse time to

provide pressure ulcer care. Cost savings of between DM1,138 (DM538 to 1739) for the first hydroactive treatment compared to the impregnated gauze treatment and DM8,234 (DM4610 to DM 11,858) for the first hydroactive treatment compared to gauze only were found. Two-way sensitivity analysis was undertaken on the total costs associated with each intervention as well as the following parameters used to calculate costs (personnel costs per minute, time required to change a dressing, total number of wound dressing changes) and results remained fairly robust. Monte Carlo simulation was used to estimate the variation in inputs into the model (95% CI). The main finding was that, despite the higher material costs of the two hydroactive therapies, the reduced labour costs, due to quicker time to heal and reduced duration of treatment or time to inpatient discharge that were assumed, resulted in lower total costs relative to the three comparators.

The model assumed that use of the hydroactive treatments reduced inpatient stays by 10% but the evidence on this is not strong. Pressure ulcers were followed in the model not only until they had healed but sometimes, instead, until inpatient discharge: hence the pressure ulcer may remain unhealed and this does not fully take into account effectiveness. It is unlikely that all treatments are equally efficacious. Length of hospital stay was considered to be a proxy for health effect, however; this was incorporated within the cost estimates.

Collagenese ointment versus hydrocolloid dressings

Burgos et al. (2000) conducted a cost-effectiveness analysis of collagenese ointment compared to hydrocolloid occlusive dressings (see data extraction table 4, Appendix A). The study was a multi-centre RCT conducted in Spanish hospitals. Patients were followed up for 12 weeks or until complete pressure ulcer heal, whichever occurred first. Reduction in pressure ulcer area was used as the measure of effect. The mean (standard deviation) reduction in pressure ulcer area in the collagenese group was 9.1 (1.2) cm^2 compared to 6.2 (9.8) cm^2 in the hydrocolloid group, an area reduction of 44% and 28% respectively. The pressure ulcer area decreased in 83% of cases in the collagenese group compared to 74% in the hydrocolloid group after twelve weeks of follow-up and these differences were not statistically significant. Pressure ulcers were completely healed for three patients in each group.

Resource use assessed were treatment supply, including ancillary supplies, and nurse time. Collagenese group pressure ulcers cost Pta 41,488 (95%CI: Pta 26,191-Pta 56,784) (price year 1998) compared to Pta 32,963 (95%CI: Pta 23,389-Pta 42,538) for the hydrocolloid dressing group and the difference was not statistically significant. The total cost per 1cm^2 reduction in pressure ulcer was Pta 4,559 for the collagenese group and Pta 5,310 for the hydrocolloid group. The cost per reduction in

pressure ulcer area was lower for the collagenese group, and on this basis it appears to be the more cost-effective option. Material costs were very similar but the total cost of collagenese tended to be higher than hydrocolloid dressings due to greater staff input. There was no allowance for across site differences.

Muller et al. (2001) also conducted a cost-effectiveness analysis comparing collagenese with hydrocolloid dressings (see data extraction table 15, Appendix A). The analysis was based on an RCT conducted in a hospital in the Netherlands. Effectiveness measures used included whether or not the ulcer was successfully treated (that is if the pressure ulcer was completely healed), the rate of complete wound healing and the average number of weeks required until pressure ulcer healing was achieved. In the collagenese group, 91.7% (11/12) patients were successfully treated compared to 63.6% (7/11) patients in the hydrocolloid group and this finding was statistically significant ($p<0.005$). The time to pressure ulcer heal was shorter for the collagenese group at, on average, 10 weeks compared to 14 weeks ($P<0.005$).

Resource use measured use of materials used and labour time, including doctor and nurse time. The average cost per patient of collagenese was NLG1,615.8 compared to NLG1,692.7 for the hydrocolloid dressings (price year 1998). The cost per successfully treated patient was NLG1,762.0 for collagenese compared to NLG2,661.4 for hydrocolloids, therefore the former appears to be more cost-effective with lower associated costs and better effects. A deterministic model and one-way sensitivity analysis and a probabilistic model using Monte Carlo simulation were conducted to explore uncertainty associated with the estimates. In all scenarios, collagenese remained the more cost-effective treatment. The assumption of the independency of model inputs is questionable. Average cost-effectiveness rather than incremental cost-effectiveness was reported. Two patients, one in each group, had two pressure ulcers (on the heel) but it was not mentioned which pressure ulcer (the pressure ulcers would be likely to differ) was included in the study.

Overview of collagenese ointment versus hydrocolloid dressings

The two studies comparing collagenese ointment with hydrocolloid dressings were full economic evaluations based on RCTs and were of moderate quality. Both economic evaluations suggested that collagenese is more cost-effective than hydrocolloid dressings. Neither study was conducted in the UK and currently, collagenese is not licensed for use in the UK.

Semi-permeable polyurethane foam dressings versus moist saline gauze dressings

Kraft et al. (1993) conducted a cost-consequence analysis comparing the use of semi-permeable polyurethane foam dressings to moist saline gauze dressings in stage 2 and 3 pressure ulcers (see data extraction table 12, Appendix A). The study was conducted in the US and was based on an RCT conducted in a long-term hospital care spinal cord injury centre. The effectiveness measure chosen was the proportion of patients with completely healed pressure ulcers. At 24 weeks, the follow-up duration, 42% (n=10) of pressure ulcers were healed in the semi-permeable polyurethane foam dressing group compared to 21% (n=3) in the gauze group. However this difference was not statistically significant. Treatment supply and nurse time was costed and the average total cost per week was $20.48 for the foam dressing group and $74.97 for the gauze dressing group.

Although costs and outcomes were not synthesised in the study more pressure ulcers were healed in the foam dressing group and the daily cost of treatment was lower, therefore this appears to be the more cost-effective option, dominating the gauze treatment option. The methods used to conduct the study were not written up in much detail so critical appraisal is a challenge. Some patients withdrew from treatment (two in the foam dressing group) but no reason for their withdrawal was provided. The cost analysis was not strong because only weekly costs per pressure ulcer treated were provided. The total cost of treatment to, say, time to complete heal, was not calculated. The length of time that the treatment is received can make a difference to the total cost of treatment.

Autolysis compared to either wet-to-dry saline, collagenese or fibrinolysin

Mosher et al. (1999) conducted a cost-consequence analysis from the third party payer (Medicare) perspective in the US (see data extraction table 13, Appendix A). A decision analytic model was used and effectiveness data was obtained from the literature and expert opinion. Median values of experts gained were used as probabilities in the decision model.

The patient being studied was a hypothetical 78-year-old female in a long-term care facility who had not been hospitalised in the prior 12 months. She has a new full-thickness pressure ulcer on her trochanter with 50% necrotic tissue (eschar) covering the ulcer, mild odour, minimal draining, no undermining and intact peri-ulcer skin. A modified Delphi approach was used to reach consensus on critical treatment choices and possible outcomes. The effectiveness measure chosen was the probability of obtaining a clean wound bed for each 28-day treatment of the hypothetical treatment. Resource use measured included drugs, dressing and irrigation supply, doctor visits,

ancillary services (for example outpatient laboratory tests), hospitalisation and associated resource use.

The probability of a clean wound bed was estimated to be 0.887 (87%) for collagenese, 0.641 for autolysis, 0.376 for wet-to-dry saline and 0.449 for fibrinolysin. The total cost per patient for 28 days was $610.96 (1995 prices) for collagenese, $920.73 for autolysis, $986.38 for fibrinolysin and $1008.72 for wet-to-dry saline. Probabilistic sensitivity analysis was conducted to investigate parameter uncertainty and when all parameter inputs were varied by –10% and +10% the results remained robust. It appears that collagenese was the most cost-effective option for the management of pressure ulcers in long-term care based on the study findings.

The quality of the literature review process and the elicitation of expert opinion was not clear. The authors note that the probability data was non-normally distributed and non-random.

Synthetic polymer versus hydrocolloid dressings

Motta et al. (1999) conducted a cost-consequence analysis based on pilot, RCT undertaken in the US and hence the sample size was small (n=10, 5 in each group) (see data extraction table 14, Appendix A). They compared a synthetic polymer dressing with a hydrocolloid dressing in home health care patients who were followed up for eight weeks.

Effectiveness measures included healing rates, adverse reactions and product performance (based on exudate performance, whether the dressing maintains a moist environment, promotes autolytic debridement and its overall clinical performance marked out of 1 to 5 with 1 being most favourable and 5 being least favourable). Two pressure ulcers in each group completely healed and all other pressure ulcers demonstrated substantial reductions in size. The overall healing rates were not statistically significantly different. No adverse reactions occurred and the overall performance of the interventions was assessed based on the average score obtained during dressing change for each parameter. No statistically significant differences were found.

Dressings and ancillary supplies and nurse time was costed. The total cost of treatment over eight weeks was $57.76 (no price date was given) for the synthetic polymer group and $9l.48 for the hydrocolloid dressing group. Since the same number of pressure ulcers healed across groups, if this was taken as the measure of effect, then it appears that the synthetic polymer may be cost saving compared to the

hydrocolloid dressing. The sample size was small and it is questionable as to whether the results are generalisable to other settings.

Collagen versus hydrocolloid dressings

Graumlich et al. (2003) conducted a cost-consequence analysis to compare topical collagen with hydrocolloid dressings (see data extraction table 8, Appendix A). The study was based on a multi-centre RCT of patients with grade 2 or 3 pressure ulcers in nursing homes in the US and the patients were followed up for eight weeks maximum (median of five weeks). Effects measured included the proportion of pressure ulcers completely healed within eight weeks and secondary outcomes including time to heal, ulcer area healed per day and linear healing of wound edge. Fifty-one percent of pressure ulcers were healed within eight weeks in the collagen group compared to 50% in the hydrocolloid group (95% CI: - 26% to 29%). The mean healing time in the topical collagen group was five weeks (95% CI: 4 to 6 weeks), and for the hydrocolloid group it was six weeks (95% CI: 5 to 7 weeks). The mean area healed per day was 6mm^2 in both groups and the mean linear healing of the wound edge was 3mm for both groups.

Treatment supply, including ancillary supplies and nurse time, was measured in order to calculate costs. The average cost per patient pressure ulcer over eight weeks was $627.56 (no price date) for topical collagen and $222.36 for the comparator. Statistical tests to compare findings across groups were undertaken. There were no statistically significant differences in the healing outcome across groups. Topical collagen was considerably more expensive and offered no major benefits to patients otherwise eligible for hydrocolloid dressings. As the authors state, no analysis was undertaken to adjust for the heterogeneity in healing outcomes identified across nursing homes. The cost analysis was not strong and quantities of resources used was not reported separately from unit costs.

Debrisan versus Eusol and paraffin dressings

Nasar et al. (1982) conducted a cost-effectiveness analysis based on an RCT in a hospital in the UK (see data extraction table 16, Appendix A). Patients were followed up until the pressure ulcer was clear and granulating, and appeared to be less than 25% of its original surface area. For the Debrisan group six out of eight pressure ulcers healed in approximately 39.3 days. One other patient died and one patient withdrew from treatment. For the Eusol group, five out of eight pressure ulcers healed in approximately 62 days. Three patients were switched to Debrisan. Resources measured to calculate costs included use of materials and ancillary supplies and hospital stay. The average cost of a pressure ulcer that healed was £1053.05 (price year not stated) for the Debrisan group and £1667.00 for Eusol group. Overall the

Debrisan cost less and was associated with a higher number of pressure ulcers healed compared to Eusol.

In summary, Debrisan appears to be more cost-effective than Eusol, costing less and being associated with a faster time to heal, for those pressure ulcers that healed. It is worth noting that some patients had more than one pressure ulcer entered into the trial, the actual length of patient follow-up was not stated and costs only related to those patients whose pressure ulcers had healed.

Growth factors versus placebo

Robson et al. (1999) conducted a cost-consequence analysis, based on a 16-week long RCT in a hospital in the US (see data extraction table 18, Appendix A). They compared Recombinant human platelet-derived growth factor-BB. (1) 100 µ g rhPDGF-BB per day with (2) 300 µ g rhPDGF-BB per day, (3) 100 µ grhPDGF-BB twice daily and (4) placebo.

The effectiveness measure used to compare treatments was wound volume decrease over time. Four surgeons, who were blind to patients, assessed changes in the ease of surgical closure of pressure ulcers on a scale from 0 (no need to close, healed) to 13 (not possible to close) based on photographs of pressure ulcers which were taken from a set focal distance and which were obtained weekly. Ninety-four percent of the maximum number of photographs possible were available for rating. At the end of the trial, the pressure ulcers of patients in group one were rated to have improved by six points (mean) on the scale from beginning to end of treatment. For group 2 and 3 patients, the mean pressure score assigned was five points compared to four points assigned to pressure ulcers in the placebo group. All outcomes were statistically significantly improved from their respective starting ease of closure scores of 10 ($p<0.0001$).

In terms of cost, the change in difficulty of wound closure was studied in relation to the composite cost including surgeon's fee, anaesthesia fee and operating room cost. Costs were arrived at from charges to patients at two university centres. The range of costs was $100 (no price date was stated) for a single-buttressed suture placed at the patient's bedside to $12,000 for a difficult musculocutaneous or free flap. At the beginning of the trial, the mean and median cost of closure was estimated at $8,000 per pressure ulcer as they were rated as requiring a somewhat easy pedicle flap procedure to close the wound. At the end of the trial, according to the raters, group 1 required a difficult direct wound application costing $800 to $1,000 (a cost saving of $7,000 to $7,200), compared to an easy skin graft for pressure ulcers in group 2 and 3 costing $1,200 (a cost saving of $6,800). For the placebo group a slightly more

difficult procedure was recommended costing $1,700 (a cost saving of $6,300). The cost savings were statistically significantly different even though 100% wound closure was not routinely achieved.

Based on the results, it appears that the growth factor received by group 1 was more cost-effective than that recommended to patients with pressure ulcers in groups 2 and 3 that, in turn, were more cost-effective than placebo. Statistical tests on effectiveness and costs were undertaken but the results of the latter were not reported. It is worth noting that the analysis assumes that pressure ulcers would have otherwise been closed via surgical techniques, a very costly intervention. The costs of the surgical interventions were given but no further details were provided. In an attempt to explore uncertainty, the authors tested the correlation between the ease of closure scale and the wound area, as photographs are only two-dimensional. Results of the clinical trial are provided in another paper.

Robson et al. (2000) also conducted another study using cost-consequence analysis (see data extraction table 19, Appendix A). The study was based on an RCT in a hospital in the US (see data extraction table 18, Appendix A). The interventions compared were cytokine growth factors: (1) 2.0 μg/cm^2 GM-CSF therapy topically applied daily for 35 days (2) 5.0 μg/cm^2 bFGF therapy applied daily for 35 days (3) 2.0 μg/cm^2 GM-CSF applied for 10 days followed sequentially by 25 days of topically applied 5.0 μg/cm^2 bFGF and (4) placebo applied daily for 35 days. Patients with grade 3 or 4 pressure ulcers were followed up for 35 days (five weeks). Effectiveness measures included the wound volume decrease over time. Surgeons rated changes in ease of surgical closure on a scale from (0) (no need to close, healed) to (13) (not possible to close) based on photographs of pressure ulcers at a set focal distance. An arbitrary response rate of at least 85% wound closure during 35 days of follow-up was chosen as indicative of a responder.

In terms of effectiveness, there were no differences in mean proportion of initial pressure ulcer volume remaining on day 36 across all interventions. However (2) had a trend toward greater pressure ulcer closure. The proportion of patients responding was statistically significantly higher for all cytokine therapies compared to placebo (4) ($p=0.03$), with (2) patients doing best. The median ease of closure for all four groups was 11 on day 0. Group (2) patients' pressure ulcers had improved seven points on the ease of closure scale. Group (3) patients improved five points, group (1) patients improved four points and group (4) patients improved three points.

Resource use on the amount of topical substance each week of treatment was based on volumetrically-determined surface area at baseline and on study days 7, 14, 21,

28. The change in difficulty of pressure ulcer closure in relation to total cost (surgeon's fee, anaesthesia fee and operating room cost) was calculated. At the beginning of the trial, the median cost of closure was estimated at $10,000 (no price date) per pressure ulcer. At the end of the trial, patients' pressure ulcers in group (2) were recommended to be healed by a difficult wound approximation costing $800 to $1,000 (a cost saving of $9,000 to $9,200). For patients' pressure ulcers in group (3), the rates recommended patients would require a somewhat easy skin graft costing $1,700 (cost saving of 8,300). For group (1) a somewhat difficult procedure was required costing $2,200 (cost saving of $7,800). For group (4) pressure ulcers could be closed for $3,000 (cost-saving of $7,000). It appears that cytokine (1) was the most cost-effective strategy.

The cost analysis was not strong and the uncertainty around cost estimates for surgical procedures was not explored. A major assumption on which the analysis was based is the assumption that pressure ulcers would have otherwise been closed via surgical techniques. Assessment of inter-rater reliability, using the ease of closure scale, was not undertaken.

Transparent moisture vapour permeable dressing versus gauze and tape

Sebern et al. (1986/9) conducted a cost-consequence analysis to compare transparent moisture vapour permeable (TMVP) dressing to gauze and tape (see data extraction table 20). An RCT was conducted using a sample of patients using home care that was served by a metropolitan visiting nurse association in the US. Patients were followed up for eight weeks and effect measures used included their healing status at eight weeks (whether their pressure ulcer had healed, was progressing towards healing, was unchanged, they discontinued treatment or their ulcer deteriorated). Additionally, healing rates and patient comfort was considered. Of the grade 2 pressure ulcers in the TMVP group 64% (n=14) healed compared to none in the gauze and tape group. For grade 3 pressure ulcers there was no significant difference between the two groups and no further details were provided. In terms of healing rates, grade 2 pressure ulcers in the TMVP group had a 52% median decrease in area of the wound compared to 100% median decrease in the gauze group ($P<0.01$, Wilcoxon). For grade 3 pressure ulcers, in the TMVP group, there was a 67% median decrease in pressure ulcer size compared to a 44% decrease in the gauze group but this finding was not statistically significant. Patients who had intact sensory input from their pressure ulcers reported less pain when the TMVP treatment was used.

Resource use assessed included treatments and nurse time. The mean eight-week treatment costs per grade 3 pressure ulcer was $1470 for the TMVP group and $1412 for the gauze group and this difference was not statistically significant. It appears that

TMVP was slightly more costly per pressure ulcer for the TMVP strategy; however, effects across the two interventions differed depending on the grade of the pressure ulcer and the effectiveness measure considered. There was no difference in outcome for grade 3 pressure ulcers; however, this may be due to type 2 error[vi]. Authors incorrectly re-graded pressure ulcers at the end of the study. The authors randomised by pressure ulcer rather than by patient and that can introduce bias. The variance associated with cost estimates was not reported and the statistical tests applied to costs were non-parametric when they should be parametric.

Level of evidence	Evidence statement
1++	There is insufficient evidence to indicate which dressing/s are the most effective in the treatment of pressure ulcers.
2-	**Economics evidence** Although there were a number of limitations associated with all the economic evaluations comparing hydrocolloid dressings to moist gauze dressings, typically hydrocolloid dressings were found to be the more cost-effective option.

Recommendations: dressings and topical agents

Decisions about choice of dressing or topical agent for those with pressure ulcers should be made by registered health care professionals. **[D]**

[vi] *The probability of failing to reject the null hypothesis when the latter is false. This probability becomes smaller with increasing sample size. The greater the probability of type 2 error, the weaker the power of the study to detect differences as statistically significant when such differences exist.*

Choice of dressings or topical agents for the treatment of pressure ulcers should be based on: **[D]**

- ulcer assessment (condition of wound)
- general skin assessment
- treatment objective
- dressing characteristics
- previous positive effect of particular dressing
- manufacturer's indications for use and contraindications
- risk of adverse events, and
- patient preference (lifestyle, abilities and comfort).

There is insufficient research evidence to guide clinicians' decision making about which dressings are most effective in pressure ulcer management**. [A]** However professional consensus recommends:

Create the optimum wound healing environment by using modern dressings – e.g. hydrocolloids, hydrogels, hydrofibres, foams, films, alginates, soft silicones) in preference to basic dressing types – e.g. gauze, paraffin gauze and simple dressing pads. **[D]**

Debridement

Clinicians should recognise the positive potential benefit of debridement in the management of pressure ulcers. Decisions about the method of debridement should be based on: **[D]**

- ulcer assessment (condition of wound)
- general skin assessment
- previous positive effect of debridement techniques
- manufacturer's indications for use and contraindications
- risk of adverse events
- patient preference (lifestyle, abilities and comfort)
- characteristic of dressing/technique, and
- treatment objective.

Decisions about debridement methods for patients with pressure ulcers should be made by registered health care professionals. **[D]**

	Research recommendations
	The research concerning wound dressings and topical agents is of varied quality. In those trials reviewed, sample sizes were often not sufficient to detect clinically important effects, and poor baseline comparability of the groups introduced bias. Several important messages can be identified for future studies. • Recruitment numbers should be based on an *a priori* sample size calculation. In most trials the sample size is too small to find a statistically significant difference between treatment groups. Multi-centre trials should be considered to recruit sufficient patient numbers. These large trials have been undertaken in other areas of health care and, although the field of wound care presents its own difficulties, there is no reason why such trials should not be successful. If these trials are to be commissioned they will require a strong infrastructure to provide support, promote collaboration and establish a common knowledge base. • A truly objective outcome measure should be used – for example time to complete healing of the wound or wound healing should be expressed as both percentage and absolute change in area. • For each patient a single reference wound should be selected. Multiple wounds on a patient should not be included in the analysis as they are not independent unless specialised statistical analysis is performed to separate out the effects of the intervention – that is matched-pairs analysis. • Experimental groups should be comparable at baseline. In small RCTs, randomisation alone will not achieve comparability; in such situations patients should be paired

	by prognostically important baseline characteristics and then the individuals of each pair randomised to treatment. Such randomisation is particularly important if ulcers of different aetiologies are to be assessed in the same trial. • Head-to-head comparisons of modern wound dressings are required and should use agents that are recommended for wounds of a similar nature. • A complete and thorough description of concurrent treatments including secondary dressings should be given in trial reports. • Assessment of outcomes should be blind to treatment. • Survival rate analysis should be adopted for all studies that assess wound healing. • Studies to determine the biological mechanisms involved in wound healing are needed. A better understanding of the healing process may lead to the development of validated outcome measures. • All trials should be published where possible. Those involved in primary research should make their data available to those undertaking systematic reviews. • Future trials should include cost-effectiveness and quality of life assessments, as well as objective measures of dressing performance. These measures would encapsulate those aspects of patient quality of life on which wounds most impact and would be sensitive to meaningful changes in quality of life generated by a change in the wound, including post healing of the wound.

6.5 Antimicrobial agents in the treatment of pressure ulcers

The methods described are those used to update the following systematic review:

O'Meara (2001) Systematic reviews of wound care management: (3) antimicrobial agents for chronic wounds; (4) diabetic foot ulceration, Volume 4, number 21.

The role of antimicrobial agents in the treatment of pressure ulcers remains unclear. The lack of clarity is due in part to uncertainty around the issues of whether bacterial presence in an important factor in wound healing. While the results from some studies indicate a positive association between higher bacterial counts and delayed wound healing (Lookingbill, 1978; Halbert, 1992), others show no such association (Eriksson, 1984; Gilchrist, 1989). Clinicians may use systemic antibiotics as a last resort when topical interventions have failed to produce healing (Huovinen, 1994).

Moist chronic pressure ulcers are an ideal medium for bacterial growth. Pressure ulcers may have a varied bacterial flora, with aerobic organisms cultured more frequently than anaerobes. *Staph. aureus*, *Streptococcus* species, *Proteus* species, *Escherichia coli*, *Pseudomonas*, *Klebsiella* and *Citrobacter* species are the most common isolates (Yarkony, 1994; Parish, 1983; Alvarez, 1991). In serious cases, infected pressure ulcers can lead to osteomyelitis and septicaemia (Yarkony, 1994).

Antimicrobials in current use

Systemic agents

Systemic agents fall into four main groups: penicillins, cephalosporins, aminoglycosides and quinolines. There are also several other drugs in use, including clindamycin, metronidazole and trimethoprim.

The penicillins work by interfering with the development of bacterial cell walls and cross-linkages. Broad spectrum agents such as ampicillin and amoxycillin are active against certain Gram-positive and Gram-negative organisms, but are inactivated by penicillinases produced by *Staph. aureus* and *E. coli* (BMA, 1999). Amoxycillin is sometimes used in combination with clavulanic acid (Chantelau, 1996). This combination produces an increased range of activity and is effective against both *Staph. aureus* and *E. coli* (BMA, 1999).

The cephalosporins have a similar action to the penicillins and have a wide range of

activity against both Gram-negative and Gram-positive organisms (BMA, 1999).

The aminoglycosides, such as gentamycin, act by interfering with normal protein synthesis. They have a wide range of action, but are potentially nephrotoxic and ototoxic, and serum levels should be monitored. They are active against the more resilient Gram-negative organisms. They are not absorbed from the gut and systemic administration is therefore by injection (BMA, 1999).

The quinolones, such as ciprofloxacin, prevent the formation of DNA within the cell nucleus. They are active against both Gram-positive and Gram-negative organisms. Ciprofloxacin is licensed for skin and soft-tissue infections, but there is a high incidence of staphylococcal resistance and it is recommended that its use is avoided in methicillin-resistant *Staph. aureus* (MRSA) infections (BMA, 1999).

Clindamycin is active against Gram-positive cocci, including penicillin-resistant staphylococci, and also against many anaerobes. It has an uncommon but serious and potentially fatal side effect, namely antibiotic-associated colitis. Current prescribing guidelines state that therapy should be withdrawn immediately in any patient developing diarrhoea (BMA, 1999). Metronidazole is active against anaerobic organisms (BMA, 1999), and has sometimes been used in combination with other agents, such as ampicillin (Lundhus, 1989). Trimethoprim is commonly used to treat urinary and respiratory tract infections (BMA, 1999), and has been shown to be active against *E. coli* when used to treat these conditions (Minassian, 1998).

Topical agents

Topical agents include antibiotics, antiseptics and disinfectants. Although various definitions exist for these terms, there appears to be a lack of consensus within the literature as to the characteristics of each type of preparation. It has been suggested that both antiseptics and disinfectants destroy micro-organisms or limit their growth in the non-sporing or vegetative state. However, antiseptics are usually applied solely to living tissues, while disinfectants may also be applied to equipment and surfaces (Morgan, 1993).

Topical preparations may be divided into two categories, according to their function. One group consists of lotions with antimicrobial properties, used to irrigate or cleanse wounds. These usually have only a brief contact time with the wound surface, unless they are used as a pack or soak. They include the hypochlorites (e.g. Eusol®), hexachlorophene (a constituent of some soaps and other skin cleansers), and substances such as potassium permanganate and gentian violet (both used in solution for skin cleansing).

The second group consists of preparations designed to stay in contact with the wound surface for a longer period of time, ideally until the next dressing change. These include creams, ointments and impregnated dressings. Most topical antibiotics come into this category, and include mupirocin (available as 2% ointment) which has a wide variety of activity, and fusicidic acid (available as an impregnated dressing, or ointment, cream or gel, all 2%) for staphylococcal infections. Neomycin sulphate, available as a cream (0.5%) or ointment (0.25%), is used to treat bacterial skin infections. If large areas of skin are treated, ototoxicity is a possible adverse effect. Silver-based products, such as silver sulphadiazine (1% cream and impregnated dressing), have a broad-spectrum action against both Gram-positive and Gram-negative organisms, and also yeasts and fungi (Morison, 1997).

Some products that are available in different forms fall into both categories. These include povidone iodine (available as 10% solution, 10% ointment, 5% cream, 2.5% dry powder spray and impregnated dressing), chlorhexidine (available as 0.05% solution, 5% ointment and medicated tulle dressing; it is also a constituent of skin cleansers), benzoyl peroxide (available as lotions, creams and gels in various strengths) and hydrogen peroxide (available as 3% and 6% solutions and 1% cream) (BMA ,1999).

Objectives

To systematically assess the evidence for the clinical effectiveness of systemic and topical antimicrobial agents in the treatment of existing pressure ulcers.

Selection criteria

Types of studies

Both randomised controlled trials (RCTs) and prospective controlled clinical trials (CCTs) with concurrent controls were eligible for inclusion in this review. For both RCTs and CCTs, the units of allocation had to be patients or lesions. Studies, in which wards or clinics were the units of allocation, were excluded because of the possibility of non-comparability of standard care.

Types of participants

Studies that recruited people with existing pressure ulcers, of any grade or severity,

were eligible for inclusion in the review. The study could be in any setting including hospital, clinic, community facilities or home.

Types of interventions

Trials in which an antimicrobial was compared with another antimicrobial agent, or in which antimicrobial agent(s) were compared with a placebo, usual care, or no treatment, were eligible for inclusion in the review. Trials of antibiotics, antifungal and antiviral agents were all considered. Reports of antibiotic cover used with skin grafting of pressure ulcers and antimicrobials used in conjunction with debriding agents were excluded.

Types of outcome measures

The primary outcome was wound healing. Since some measures of wound healing can be subjective, studies had to incorporate an objective assessment – such as change in ulcer size, rate of healing, frequency of complete healing or time to complete healing – to be included in the review.

Many evaluations of antimicrobial agents focus on microbiological outcomes such as wound cultures, sensitivities of micro-organisms, bacterial counts and bacterial eradication. Studies reporting only these types of results were excluded from this review since these intermediate (surrogate) outcomes have not been shown to be accurate and reliable indicators of healing. Where studies reported both wound healing and microbiological outcomes, only the former were incorporated in the review. Where available, data on adverse effects of interventions were to be included.

Search strategy

Searches were carried out in April 2004 and an update search performed in June 2004. Full details of the search strategies can be found in Appendix B.

Methods of the review

Full details are described in the methods section of this Guideline.

Description of studies

Five eligible randomised trials were identified. Two of the included trials assessed antimicrobial agents on patients with other types of chronic wounds (Della Marchina, 1997; Worsley, 1991) but data relevant to patients with pressure ulcers were able to

be extracted separately and were thus included.

Most of the trials were conducted in either a hospital or an aged-care facility, resulting in most of the enrolled patients being elderly. There was a range of pressure ulcer severity requiring treatment in the included trials.

The period of either the interventions and/or follow-up assessments ranged from about two to 14 weeks. Three of the five included studies used photographic techniques as part of their objective measurement of wound healing.

No eligible trials were identified that assessed the effects of systemic antimicrobial agents in the treatment of pressure ulcers.

A variety of topical interventions were assessed in the included studies. One trial tested the effectiveness of an antiseptic spray (Della Marchina, 1997). Two trials assessed the effects of ointments: Gerding (1992) tested an oxyquinoline-based ointment, while Toba (1997) compared a gentian violet-based ointment with a povidone iodine ointment. Two trials assessed the effects of hydrocolloid dressings (Huchon, 1992; Worsley, 1991).

Methodological quality of included studies

The studies included in this review were small and generally of poor methodological quality. Details of the quality of each individual study are included in the Table of Included Studies [see Appendix A?].

Sample size ranged from 14 to 137 patients per trial and *a priori* power calculations were not reported in any of the trials. In four of the five eligible trials, the method of random sequence generation was not stated. Only one trial (Toba, 1997) reported adequate allocation concealment. Blinding of treatment allocation and/or outcomes assessment was only reported in one trial (Gerding, 1992). Only one study reported withdrawal rates and reasons (Worsley, 1991).

In studies of pressure ulcer treatment it is extremely important for trialists to report on the baseline comparability of the treatment groups for important variables such as baseline risk. Risk of pressure ulcer development is usually reported as one of various risk scores such as Norton, Waterlow, Gosnell or Braden. Only one of the studies reviewed here (Huchon, 1992) presented such baseline data.

Even more importantly in pressure ulcer treatment trials it is essential to ensure baseline comparability for initial area of ulcers. A change in wound area is often

expressed as the percentage change which, unlike the absolute change in area, takes into account the initial size of the wound. For two wounds healing at the same linear rate (as measured by diameter reduction) percentage area calculations will show a larger change for a small wound than a big wound. The converse is true when the absolute change in area is measured, since for any unit reduction in wound radius a bigger area reduction will occur for a large wound.

This has important consequences for the validity of trial results where there is poor comparability in initial wound size at baseline between the treatment groups. In large trials, randomised allocation should ensure that the mean wound size and variance in each group is similar. In a small trial random allocation is unlikely to result in an even distribution of wound sizes. In a trial where there is poor comparability between groups for wound size at baseline, and the outcome is based on the change in area, the result can only be considered valid if it is obtained either: against the anticipated direction of the bias for wound size; or where percentage area change and absolute area change are in the same direction. If baseline data are not given then it is not possible to determine the direction of bias and the validity of the result cannot be determined. Three of the five trials included in this review presented data on baseline ulcer size (Gerding, 1992; Huchon, 1992; Toba, 1997).

Quality was not used to weight the studies in the analysis using any statistical technique. However methodological quality was drawn upon in the narrative interpretation of the results. Methodological flaws are discussed for each study in the Table of Included Studies (see Appendix A).

Results

Five eligible trials were identified that assessed the effectiveness of antimicrobial agents in the treatment of existing pressure ulcers. All used topical antimicrobial agents; no trials were identified that assessed the effects of systemic agents.

Two trials (Huchon, 1992; Worsley, 1991) compared the use of a hydrocolloid dressing with one impregnated with povidone iodine. Neither trial individually, or when their results were combined in a meta-analysis, demonstrated a significant difference between the two treatments in terms of the number of pressure ulcers assessed as completely or partially healed at follow up between eight and 12 weeks (RR 1.19, 95% CI 0.92, 1.54). Worsley (1991) drew attention to the fact that fewer dressing changes per week were needed in the hydrocolloid group compared with the povidone iodine group (mean $\pm$ SD: 3 $\pm$ 1.38 versus 4.9 $\pm$ 1.69, respectively, $p < 0.005$).

Two trials evaluated the effects of different ointments on the rate of pressure ulcer healing. A small trial (n=19) by Toba (1997) assessed the effects of GVcAMP ointment (gentian violet 0.1% blended with dibutyryl cAMP) in elderly women with pressure ulcers contaminated with MRSA. There was no statistically significant difference (mean difference –11.1%, 95% CI –27.86, 5.66) between the two groups in change in wound area at 14 weeks. The authors hypothesised that the lack of difference seen might be due to the fact that the two largest wounds (area greater than 50 cm^2) were in the experimental group. However, an absence of power calculations makes assessment of this comment difficult.

The results of the trial by Gerding and colleagues (1992) are difficult to assess as although the unit of allocation was said to be patients, the unit of analysis was the number of lesions. From the results presented it is not clear how many of the 74 patients were randomised to each group. It is likely that some patients had more than one lesion. The results were presented and divided according to stage of lesion at enrolment which demonstrates that although the result for all lesions combined showed a significant increase in the number of ulcers either partially or completely healed with the oxyquinoline ointment (90%) compared to the povidone iodine ointment (63%) (RR 1.41, 95% CI 1.01, 1.91), when assessed by lesion stage sub-group no significant benefit was observed for either stage 1 or 2 lesions. Hence, these results should be interpreted with caution.

In a small RCT (n=19) by Della Marchina and colleagues (1997) no difference was found (RR 2.22, 95% CI 0.24, 20.57) in the rate of complete healing of pressure ulcers between an antiseptic spray containing eosin 2% and chloroxylenol 0.3% and an alternative spray.

No reliable or objective measures of secondary outcomes such as cost-effectiveness, adverse events, comfort, durability, reliability and acceptability of topical antimicrobial interventions were reported in any of the studies.

Discussion

Despite the frequency of pressure ulcer incidence, the cost of the condition to the health care budget and the myriad of treatment modalities, this review demonstrates the paucity of good-quality evidence that guides current clinical practice on the use of antimicrobial agents in the treatment of existing pressure ulcers.

Oxyquinoline ointment may be more effective than a standard emollient for treating existing pressure ulcers (Gerding, 1992) , but no significant differences were seen

when a hydrocolloid dressing was compared with povidone iodine ointment (Huchon, 1992; Worsley, 1991), or when a preparation based on gentian violet 0.1% was compared with a povidone iodine and sugar ointment (Toba, 1997). The trial which compared an antiseptic spray with an alternate spray (Della Marchina, 1997) was small and of poor methodological quality, precluding a reliable assessment of the effectiveness of this intervention.

These few interventions, tested in small trials of generally poor quality, were the only studies identified that assessed the effectiveness of antimicrobials in the treatment of existing pressure ulcers. There were no trials identified that assessed the effects of systemic antimicrobial agents in pressure ulcer management. The confidence with which we can draw firm conclusions from the few studies detailed in this review is greatly tempered by (a) the poor quality of many of the trials and (b) the lack of replication of most comparisons. Hence, much of the research into this subject requires replication on a larger scale. Attention should be paid to detailed baseline data collection and reporting, blinding of outcome assessors, reporting of withdrawals and the use of the intention-to-treat protocol. Rigorous methods of blinding for wound assessors are essential to establish the relationship between different types of products and changes in nurse labour time required. Finally, concurrent interventions should be described in detail, in particular pressure-relieving support surfaces, debridement techniques and forms of topical dressing application.

There are very few data on the cost-effectiveness of antimicrobial agents in pressure ulcer healing. Cost-effectiveness studies should be carried out in conjunction with rigorous evaluations of clinical effectiveness to determine the relative difference between cost per unit of the clinical effects of two or more treatments. A cost-effectiveness or cost-utility analysis should include both a measure of the clinical benefit from a non-biased study, and a measure of the net resources used (Drummond, 1994). Data should be collected relating to both short- and long-term patterns of wound healing and recurrence.

Information from two of the studies included in this review (Huchon, 1992; Worsley, 1991) suggests that certain treatments may be associated with reduced nurse labour time, but further research is required to establish this more reliably. Hydrocolloid dressings require significantly fewer changes than do dressings using conventional antiseptics and wound coverings. For the two studies which assessed this intervention (Huchon, 1992; Worsley, 1991) the effects on nursing time need to be assessed in relation to the equivalent results seen in terms of clinical effectiveness (wound healing).

	Evidence summary
1++	There is insufficient evidence to indicate whether antimicrobials are effective in the treatment of pressure ulcers. No economic evaluations assessing antimicrobials for the treatment of pressure ulcers were found.

	Research recommendations
	The results summarised in this review are based on findings from small trials with methodological problems. Therefore, much of the required research needs replication in larger, well-designed studies using contemporary interventions for antimicrobial activity.

Recommendations: antimicrobial therapy

In the presence of systemic and clinical signs of infection in the patient with a pressure ulcer, systemic anti-microbial therapy should be considered. **D[GPP]**

6.6 Mobility and positioning in the treatment of pressure ulcers

Mobility, or more precisely immobility, is reported as a significant risk factor for both the development of pressure ulcers as well as a contributory factor in delayed healing (Guralnik et al., 1988; Berlowitz and Wilking, 1989; Ek et al., 1991; Allman et al., 1995; Bergstrom et al., 1996; Schue and Langemo, 1998; Nixon et al., 2000 and Bergquist, 2003). Clinicians and carers engage in a range of activities to reduce the effects of immobility on the healing of pressure ulcers. Mobilising, positioning and repositioning patients (turning) to best promote healing by reducing pressure on the wound, and maintaining muscle mass and general tissue integrity are all central to the aims of this activity.

The literature suggests that both seated and bed bound individuals are at risk of delayed healing and many methods have been postulated to reduce this risk. Much of the research around positioning and re-positioning reports interface pressures for different sitting and lying positions with and without support surfaces. The effects of these interventions on the healing of pressure ulcers is not clear.

Limited sitting and lying times are seen as one aspect of reducing the risks for those with pressure ulcers. Another is posture and combining the sitting and lying regimes with appropriate support surfaces. Re-positioning patients every two or three hours is generally accepted as an effective method to prevent pressure ulcers in both patients with and without existing pressure ulcers (Defloor, 2000). The research evidence to support these interventions is not clear and is therefore the aim of this review. The literature reports a range of re-positioning times from two hourly to six hourly (Defloor, 2001) and, despite the possible effects on patients and the impact on resources, this evidence is limited with suggestion that re-positioning patients has no preventative effect on the development of grade 1 pressure ulcers (Defloor and Grypdonck, 2000).

Clinical question

What is the evidence that mobility is effective in the treatment of pressure ulcers?

What is the evidence that re-positioning is effective in the treatment of pressure ulcers?

Objectives

The objective is to undertake a systematic review of the evidence of mobility and positioning in the treatment of pressure ulcers to determine:

- What are the key mobility interventions/techniques used in pressure ulcer treatment?
- What are the key positioning techniques used in pressure ulcer treatment?
- What is the significance of these in pressure ulcer treatment?
- What are the priorities in pressure ulcer treatment?
- What is the existing evidence base for their use in the treatment of pressure ulcers?
- What is the empirical evidence that these processes are effective in the management of pressure ulcers?

Selection criteria

Types of studies

RCTs evaluating the effectiveness of mobility and or positioning interventions/techniques in the treatment of pressure ulcers. In the absence of any RCTs, evidence-controlled studies evaluating the effectiveness of mobility and positioning interventions in the treatment of pressure ulcers. Studies reporting interface pressure will not be included in this review because it is not clear how such outcomes relate to delayed healing and complications.

Types of participants

All: adults and children, including those in primary and secondary care, residential homes, nursing homes, secure settings and the home.

Types of interventions

Mobilising (exercise interventions) compared to standard care. Different positioning/re-positioning interventions compared and compared to standard care.

Types of outcome

Healing rates, all objective measures of wound change over time.

Clinical evidence

A total of 33 studies were identified from the sifting process and subsequently full papers ordered. This number also included those studies referenced with relevant titles but where the abstract was absent in the citation. After sifting full papers for relevance and duplicates at this stage, 26 papers were opinion pieces, editorials, anecdotal reports or fell outside the inclusion criterion for this review. Out of the six selected studies, five were excluded and one was included.

Bates-Jensen et al.(2004)

Bates-Jensen et al. (2004) undertook a randomised controlled trial with blinded assessment of outcomes at three points. A total of 190 incontinent nursing home residents were randomised to receive standard care or exercise and incontinence care every two hours between 8am and 4.30pm five days per week for 32 weeks. Skin health outcomes were the outcome measures of interest which included pressure ulcers. Assessors were blind to treatment group. *A priori* was performed. Intervention subjects had significantly better skin health outcomes than controls. However this was limited to the sacral and trochanter regions (p = <.001).

Because this is a duel intervention trial it is not clear what proportion of the improved outcome is attributed to the exercise (mobilising) intervention. This trial included a range of skin conditions which included: maceration, papules, macules, blanching erythema, non blanching erythema, non pressure ulcers and pressure ulcers combined. The effects of the interventions on pressure ulcer healing are not clear from this study.

Due to the lack of evidence for mobility and positioning recommendations were sought from formal consensus methods.

Recommendations: mobility and positioning

Mobilising, positioning and repositioning interventions should be considered for *all* individuals with pressure ulcers (including those in beds, chairs and wheelchairs). **[D]**

All patients with pressure ulcers should actively mobilise, change their position or be re-positioned frequently. **[D]**

Avoid positioning individuals directly on pressure ulcers or bony prominences (commonly the sites of pressure ulcer development). **[D]**

Mobilising, positioning and re-positioning interventions should be determined by: **[D]**

- general health status
- location of ulcer
- general skin assessment
- acceptability (including comfort) to the patient, and
- the needs of the carer.

Frequency of re-positioning should be determined by the patient's individual needs and recorded – e.g. a turning chart. **[D]**

Passive movements should be considered for patients with pressure ulcers who have compromised mobility. **[D]**

	Research recommendations
	There needs to be rigorous research to evaluate the effects of mobility interventions on the healing of pressure ulcers.

6.7 Nutrition in the treatment of pressure ulcers

The methods described in this review are those used to update the following systematic review:

Langer G, Schloemer G, Knerr A, Kuss O, Behrens J (2004) Nutritional interventions for preventing and treating pressure ulcers (Cochrane Review) in: *The Cochrane Library,* Issue 3, Chichester, UK: John Wiley & Sons, Ltd.

The treatment of pressure ulcers involves a number of strategies designed to address both extrinsic factors – e.g. reducing the pressure duration or magnitude at the skin surface by repositioning or using pressure-relieving cushions or mattresses – and intrinsic factors, which are concerned with providing the optimum tissue environment for wound healing – i.e. optimum hydration, circulation and nutrition.

It has been reported that malnutrition is positively correlated with pressure ulcer incidence and severity (Berlowitz, 1989; Bergstrom, 1992). Also that decreased calorie intake, dehydration, and a drop in serum albumin may decrease the tolerance of skin and underlying tissue to pressure, friction and shearing force, increasing the risk of skin breakdown and reducing wound healing (Mueller, 2001). Serum albumin is commonly used as a measure of the amount of protein in the blood for healing. However the effect of serum albumin level on wound healing is not clear – there is difference of opinion as to the relevance of such levels in pressure ulcer healing and thus it has limited value as an inclusion/exclusion criterion in controlled clinical trials (Hill et al., 1994). Low energy and low protein intake feature in reports of nutrition and wound healing. The combination of low energy and low protein intake is often described as protein-calorie or protein-energy malnutrition.

The Prinz (prevalence and incidence) study, which collected data from more than 45,000 patients in Austria between 1995 and 1999, reported that malnutrition – defined as a serum albumin less than 3.5 g/dl – was identified as a risk factor in 25% of patients (van Steelandt, 2000). Further studies suggest a correlation between protein-calorie malnutrition and pressure ulcers (Breslow, 1991; Finucane, 1995; Strauss, 1996).

The effectiveness of special diets in preventing and treating pressure ulcers has not yet been examined sufficiently despite the fact that risk assessment tools (for example Braden, 1994; Gosnell, 1989) include nutritional status as a part of the assessment process in the prevention of pressure ulcers. Nevertheless, there is a consensus that nutrition is an important factor in both the prevention and treatment of pressure ulcers.

This has been reiterated by the incorporation of nutritional factors in various guidelines – e.g. the EPUAP Pressure Ulcer Prevention Guidelines ("*There should be clarification of a full risk assessment in patients to include: [...] nutrition [...]*") or the EPUAP Pressure Ulcer Treatment Guidelines ("*Ensure adequate dietary intake to prevent malnutrition [...]*") (EPUAP 1998, EPUAP 2003). A systematic review is therefore required to summarise the best available research evidence and enable evidence-based guidance on the role of nutritional interventions in pressure ulcer prevention and treatment.

Objectives

To evaluate the effect of nutritional support and supplementation in the treatment of pressure ulcers.

Selection criteria

Types of studies

Randomised controlled trials (RCTs) of parallel or crossover design evaluating the effect of enteral and/or parenteral nutrition in the treatment of pressure ulcers by measuring ulcer healing rates or changes in pressure ulcer severity. Controlled clinical trials (CCT) were only considered eligible for inclusion in the absence of RCTs.

Types of participants

People of any age and sex with existing pressure ulcers, in any care setting, irrespective of primary diagnosis. A pressure ulcer was defined as an area of localised damage to the skin and underlying tissue caused by pressure, shear, friction and/or a combination of these.

Types of interventions

Clearly described nutritional support (enteral or parenteral nutrition); supplementation or special diet. Comparisons between support or supplementary nutrition plus standard diet versus standard diet alone, and between different types of supplementary nutrition – e.g. enteral vs. parenteral – were eligible.

Types of outcome measures

The primary outcome was:

- time to complete healing.

The following secondary outcomes were summarised:

- acceptability of supplements
- side effects
- costs
- rate of complete healing
- rate in change of size of ulcer (absolute and relative), and
- quality of life.

Main literature search

Searches were undertaken to update the following Cochrane Review:
Langer G, Schloemer G, Knerr A, Kuss O, Behrens J (2004) Nutritional interventions for preventing and treating pressure ulcers (Cochrane Review) in: *The Cochrane Library,* Issue 3, Chichester, UK: John Wiley & Sons, Ltd.

Databases were searched in August 2004.

Full search strategies are listed in Appendix B.

Appraisal of methodological quality

Criteria for inclusion (methodological quality is reported in the evidence tables).

No economic evaluations assessing nutritional support in the treatment of pressure ulcers were found.

Clinical evidence

Ascorbic acid (Vitamin C), two trials

Taylor (1974) carried out a double-blind, RCT with 20 surgical patients with pressure ulcers. Patients in the treatment group received an additional 500mg ascorbic acid twice daily for four weeks.

ter Riet (1995) conducted a multi-centre blinded RCT with 88 patients with pressure ulcers in 11 nursing homes and one hospital. Patients in the intervention group received 500mg ascorbic acid twice daily with or without ultrasound for a period of 12 weeks. Patients in the control group received 10mg ascorbic acid twice daily with or without ultrasound. Most patients had nutritional deficiencies on admission.

Protein, one trial

Chernoff (1990) undertook a RCT with 12 institutionalised tube-fed patients with pressure ulcers. Patients were randomised to a high-protein or a very high-protein dietary formula and monitored for eight weeks to assess pressure ulcer healing.

Zinc, two trials

Norris (1971) performed a randomised, double-blind, crossover study with 14 patients with pressure ulcers. Patients received either 3 x 200mg zinc sulphate per day or placebo for a period of 24 weeks. After 12 weeks the patients switched groups.

Brewer (1967) conducted a randomised, double-blinded, placebo-controlled trial with 14 spinal cord injury patients. Patients received either zinc sulphate 220mg, or a placebo capsule, three times a day for two to three months.

Multinutrient supplementation, one trial

Ek (1991) performed a randomised, controlled trial of 501 patients newly admitted to a long-term medical ward. Patients in the standard care group received the standard hospital diet containing 2200 kcal/day. The intervention group received 200ml liquid supplement, twice daily for the duration of their hospital stay or for 26 weeks, whichever was the shorter. Each 100ml of the liquid supplement contained 4g protein, 4g fat, 11.8g carbohydrates, 419 kJ, and minerals and vitamins.

Methodological quality of included studies

The included studies were small (average sample size was 33, with a range from 12 to 88 patients) and of poor methodological quality. None of the included studies reported a power calculation.

Ascorbic acid (Vitamin C), two trials

The RCT by Taylor (1974) with 20 surgical patients was placebo-controlled, and patients were allocated to the treatment groups according to their year of birth, indicating that they were likely to be aware of the allocation. Patients were comparable at baseline, and no dropouts were reported. Outcome assessors were blinded to treatment.

ter Riet (1995) carried out a multi-centre RCT in 88 patients where investigators, nursing staff, physiotherapists and patients were blinded as to treatment allocation but allocation concealment was not described. They performed an intention-to-treat and a per-protocol analysis.

Protein, one trial

Chernoff (1990) undertook a RCT with 12 patients. Follow up was for eight weeks. They published no information about randomisation and allocation method, blinding, baseline characteristics or follow up.

Zinc, two trials

The trial by Norris (1971) was a randomised crossover study, which was described as double-blind but the method of allocation was not specified. Only three of 14 patients (21%) completed the study after 24 weeks. Pressure ulcer volumes have been measured in four-week intervals. No intention-to-treat analysis was given.

The trial by Brewer (1967) was a randomised, double-blinded, placebo-controlled trial, although the methods of random allocation and blinding are not described. Thirteen of the fourteen enrolled patients completed the trial after two to three months of treatment. Pressure ulcer healing was described as complete, definite improvement or no change, but the method of outcome assessment was not described.

Multinutrient supplementation, one trial

Ek (1991) was a randomised controlled trial but the method of allocation was not specified. The numbers of patients who completed the treatment (to discharge or 26 weeks, whichever was shorter) was not stated. Methods of assessing pressure ulcer

healing were not reported but methods of assessing several other outcome measures, such as serum protein analyses, anthropometry, skin testing, malnutrition and the modified Norton Scale score, were reported in detail.

Results

The included trials were heterogeneous in terms of patients – for example some surgical, some critically ill, some residents in nursing homes – and to interventions, including, for example, type, application form, timing, dose and duration of nutritional supplementation. Furthermore different primary outcomes have been evaluated in the studies; therefore it was considered inappropriate to perform a meta-analysis.

Ascorbic acid (Vitamin C)

Taylor (1974): 20 people in surgical wards were followed up and data reported at one month. In the group treated with ascorbic acid there was a statistically significant mean reduction in pressure ulcer area of 84% (SE 7.60) after one month compared with 42.7% (SE 7.41) in the placebo group WMD 41.30 (95% CI 34.72 to 47.88 $p<0.005$) (see Figure 27). Complete healing of pressure ulcers occurred in six patients in the nutritional intervention group versus three patients in the placebo group. Relative risk for healing with supplement was 2 (95% CI 0.68 to 5.85) (see Figure 28). The mean healing rate was 2.47cm^2/week in the intervention group compared with 1.45cm^2/week in the control group.

ter Riet (1995): The mean absolute healing rate in the intervention group (n=43) was 0.21cm^2/week and 0.27cm^2/week in the control group (n=45)(difference -0.06cm^2/week; no standard deviations were reported).The mean volume reduction was 0ml/week in the intervention group and 0.20ml/week in the control group (difference -0.20ml/week). The mean clinical change where improvements – i.e. surface reduction, healing velocity, volume reduction – were scored on a scale from -100 to +100% was 17.89%/week in the intervention group and 26.08%/week in the control group (difference -8.19%/week).

ter Reit displayed the healing survival curves for both groups and there was no difference in the hazard of healing. From Figure 28 the proportion healed at 84 days was 17/43 in the treatment group and 22/45 in the control group (RR 0.81 95%CI 0.50 to 1.30 – calculated by the reviewers).

Figure 27:

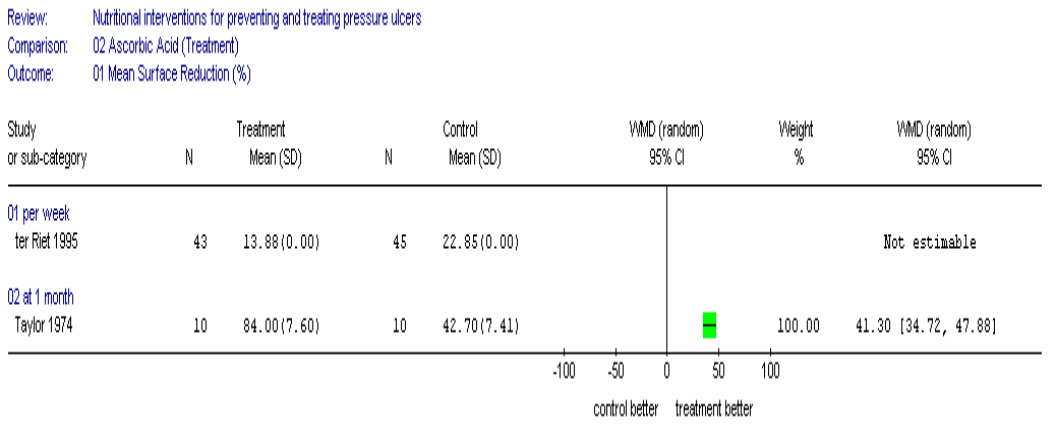
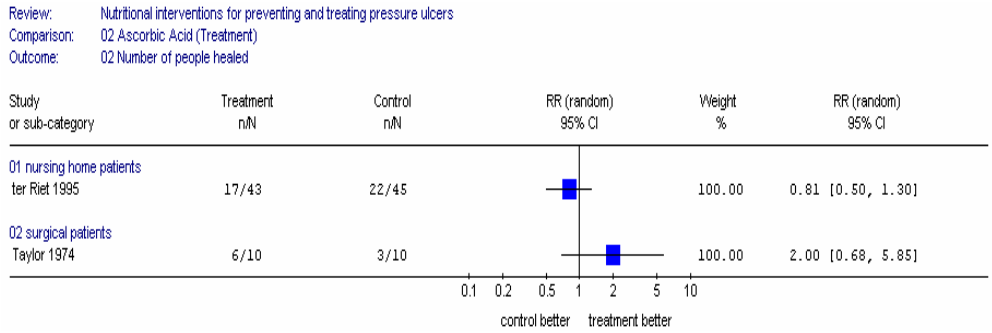


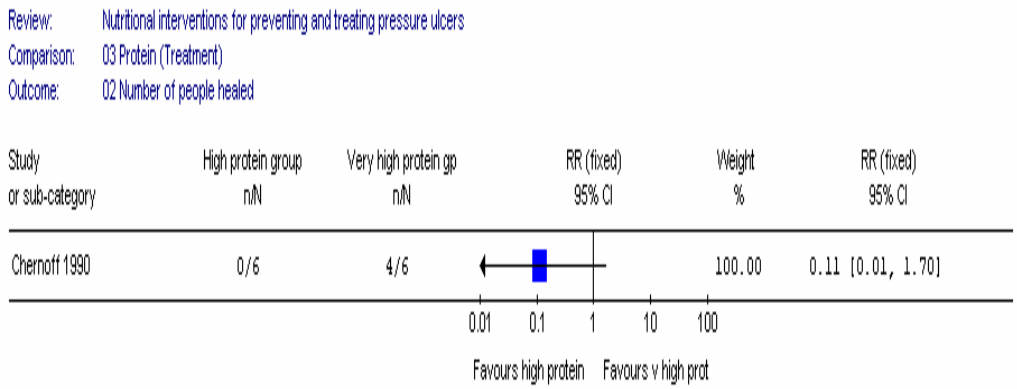
Figure 28:



Protein

Chernoff (1990): At the start of the study, pressure ulcers ranged in size from 1.6cm^2 to 63.8cm^2 in the high-protein group and from 1.0cm^2 to 46.4cm^2 in the very high-protein group. On both diets ulcer size decreased, but the improvement was greater in the very high-protein group. None of the patients in the high-protein group and four patients in the very high-protein group had complete healing of their ulcer. This gives a relative risk of healing of 0.11 (95%CI 0.01 to 1.70) which is not statistically significant (see Figure 29). The average decrease in ulcer size was 42% in the high-protein group compared with 73% in the very high-protein group.

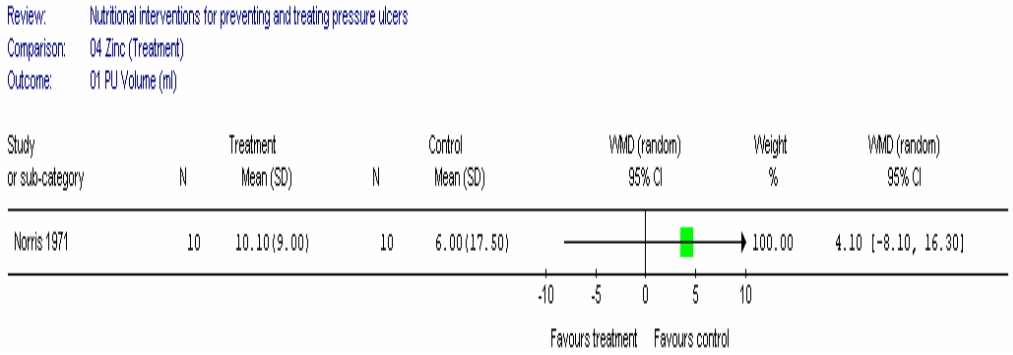
Figure 29:



Zinc

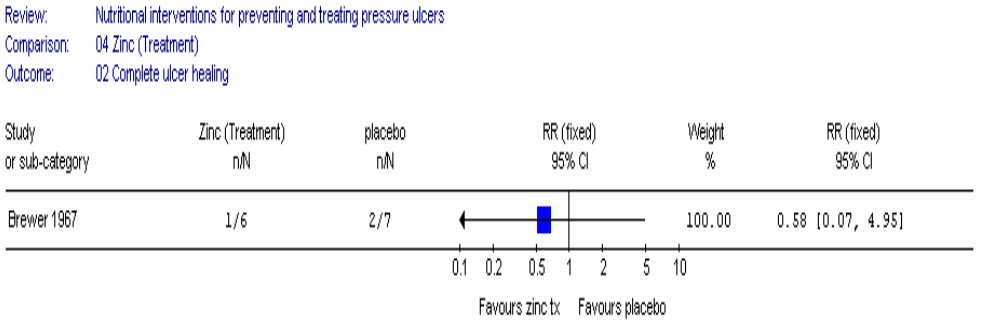
Norris (1971): 14 patients treated with zinc sulphate had pressure ulcers with a mean net change in volume of 10ml (SD 9ml), 14 patients receiving placebo had pressure ulcers with a mean net change in volume of 6.0ml (SD 17.5ml), which is not statistically significant (weighted mean difference (WMD 4.1ml; CI 95% -8.10 to 16.30; p=0.5).

Figure 30:



Brewer (1967): This early and small (n=14) trial reported no significant difference in the rate of pressure ulcer healing in spinal cord injury patients treated with zinc sulphate 220mg, three times a day for two to three months (one of six patients had complete ulcer healing), compared with patients receiving placebo capsules (two of seven patients).

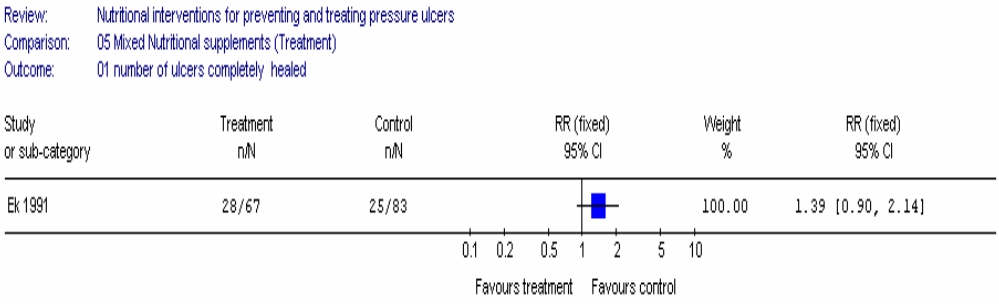
Figure 31:



Multinutrient supplementation

Ek (1991): The total number of sores that developed in the experimental group was 67 and in the control group 83. This was from a total of 495 patients on whom data was available (of the 501 patients randomised). However, it is not known how many patients were in each treatment group. Of the 67 sores that developed in the experimental group, 41.8% (28/67) healed completely compared with 30.3% (25) of the 83 pressure sores in the control group. These results were reported as not reaching statistical significance.

Figure 32:



Discussion

Studies of nutritional support/supplementation vary in terms of interventions, outcome measurements and follow up. Interpretation of these findings should be made with caution. Studies included too few patients and had a high drop-out rate. Furthermore, follow-up time was found to be very short. Hence trials are not likely to detect the true effects of the intervention. Some trialists reported that laboratory markers of malnutrition improved during treatment but the clinical effects of protein, calories, and vitamin or zinc supplementation on the healing of existing sores is unclear.

Ascorbic acid

The Taylor (1974) trial included a small number of participants (n=20). The method of randomisation (by year of birth) is open to the researchers, and there is the potential that people were recruited into the trial according to clinical judgment rather than truly randomly. They found significant effects on the reduction of pressure sore area with the intervention (500mg ascorbic acid twice daily up to 12 weeks for surgical patients) but the clinical relevance of a reduction in area (rather than complete healing) is not known.

In the trial by ter Riet (1995) most patients were based in nursing homes (n=88) and had nutritional deficiencies on admission. The control group received 10mg ascorbic acid, and the experimental group received 500mg. Patients in the control group had better clinical outcomes at 12 weeks. This study used a reasonable control intervention and a larger sample size, which would suggest that the effect of ascorbic acid on the treatment of pressure ulcers seems to be at least unclear.

Protein

Chernoff (1990) had a small number of institutionalised tube-fed patients (n=12), and the lack of information about randomisation and allocation method, blinding, baseline characteristics and follow up contribute to the poor trial quality. They reported an average decrease in ulcer size which was better in the very high-protein group (73% vs. 42%). There is only weak evidence on the effect of very high-protein supplementation rather than regular protein supplements for the treatment of pressure ulcers in tube-fed patients.

Zinc

The RCT of Norris (1971) is limited by the small number of patients (n=14). Only three patients completed the study after 12 weeks. They found no significant effects of zinc for pressure ulcers, but the trial is far too small to detect clinically important effects as statistically significant.

The trial by Brewer (1967) was also small (n=14) but had a good treatment completion rate (13 of the 14 patients). Again, although not significant, differences were not found in the effect of zinc on pressure ulcer healing. The small sample size did not permit the detection of statistically significant or clinically important treatment effects.

Multinutrient supplementation

The trial by Ek (1991) was poorly reported in terms of results by treatment group allocation. It is not known how many of the 501 patients randomised were allocated to each group, making an assessment of the effects of the treatment on either pressure sore prevention or healing difficult. Many secondary analyses were reported, including results on the patients' state of malnourishment, functional level of activity, mobility, food intake, albumin levels and other measures, but there were very limited data on pressure ulcer healing rates.

Most treatment studies have short trial periods. Therefore, improvement or healing of pressure ulcer wounds is unlikely to be detected.

Most patients in the studies described above seem to have laboratory defined and confirmed nutritional deficiencies, which improved throughout treatment with additional nutritional supplements. Whether this has an effect on clinically relevant outcomes, such as pressure ulcer healing, remains unclear.

	Evidence summaries
1++	There is no evidence to support the routine administration of nutritional support/supplementation included in this review to promote the healing of pressure ulcers.
1+	In patients who have detected deficiencies, supplementation to correct the deficiency according to the daily recommended amounts may be indicated following a nutritional evaluation.
1++	The effect of corrective nutritional supplementation on pressure ulcer healing remains unclear however.

Recommendations: nutritional support

† Nutritional support should be given to patients with an identified nutritional deficiency. **[C]**

Nutritional support/supplementation for the treatment of patients with pressure ulcers should be based on: **[D]**

† *The link between correcting this deficiency and its causal relationship with pressure ulcer healing has not been clearly established.*

- nutritional assessment (using a recognised tool, e.g. “MUST” Tool)
- general health status
- patient preference, and
- expert input supporting decision-making (dietician or specialists).

	Research recommendations
	Further research with larger numbers of patients and sound methodology is required to procure evidence on the impact of nutrition on pressure ulcers. Consideration should be given to the constituents of the supplement and method of administration, as studies have reported low tolerance of nasogastric tube feeding.

6.8 Surgery for the treatment of pressure ulcers

Surgery has been indicated for the treatment of pressure ulcers since the early part of the 20th century. As early as 1950, in a review of 59 ischial pressure ulcers, surgery was the method of treatment described, and an evaluation of complications and short-term outcomes reported (Cannon et al., 1950).

Surgery may be indicated:

- when conservative measures have failed to heal the pressure ulcer
- to accelerate debridement to expedite spontaneous healing
- to provide a quick by-pass to conservative measures for reasons of comfort, economy or achievement of a superior repair, and
- to achieve a more robust repair than could be achieved by conservative treatment.

Identifying candidates for surgical interventions is based on a thorough assessment of the individual including:

- aetiology of the pressure ulcer
- anatomical site, staging
- infection status
- any underlying medical condition
- nutritional status
- neurological status
- psychosocial status, and
- social factors.

(Foster et al., 1997; Margara et al., 2003).

Surgery is not usually indicated in patients who have grade 1 or 2 pressure ulcers (apart from minor debridement). It is usually used as an intervention in those with grade 3 or 4 pressure ulcers (Henderson, 2004).

The current surgical management of pressure ulcers broadly consists of debridement, which can be superficial and may or may not include the removal of bone tissue followed by flap coverage. There is a plethora of different techniques, which have been described in the literature. Pressure ulcers can be surgically debrided and left as an open wound to heal conservatively, surgically closed with or without debridement, or repaired using a range of myocutaneous flaps or skin

grafting.

Types of surgery

Surgery can be subdivided into:

- emergency (drainage or abscess)
- urgent (debridement of necrotic eschar), or
- elective (further debridement followed by closure).

Which techniques are currently considered to be the most effective is not clear. How clinicians reach decisions about which technique to use is also not clear. Indications about choice of technique from the available literature depends on the assessment of the patient and the site of the ulcer (a flap which is specifically indicated for the area involved and the ability of that chosen flap to be re-harvested if the ulcer reoccurs).

Methods of wound closure can be divided into:

- direct closure of the wound margins
- skin grafting
- preservation of the walls of the ulcer to conserve tissue, followed by direct closure or flap closure over this retained tissue, and
- radical excision of the walls of the pressure ulcer followed by flap closure.

This review aims to consider the contribution of surgery in the treatment of pressure ulcers and its effect on wound healing.

Clinical question

What is the evidence that surgery is effective in the treatment of pressure ulcers?

OBJECTIVES

The objective was to undertake a systematic review of the evidence of surgical interventions for individuals with pressure ulcers to determine:

- What are the surgical techniques and interventions used?
- In which populations are these techniques and interventions used?

- What are the safety implications?
- What is the empirical evidence that surgery is effective in the management of pressure ulcers?

Selection criteria

Types of studies

RCTs comparing surgery versus conservative treatment, surgical technique versus surgical technique, surgery versus other interventions (that do not come under the definition of conservative) for the treatment of pressure ulcers.

Types of participants

All: adults and children.

Types of outcome

Time to heal, time to wound closure, all objective healing measures. Mortality rates, safety information, quality of life measures.

Search strategy

Main literature search

This involved searching a range of medical, nursing, psychological and grey literature databases. All databases were searched from inception date and searches were not limited by study design. The searches were limited to retrieve literature published in English, and to omit animal studies and letters, comments and editorial publication types.

Databases were searched in February 2004 and an update search was performed in August 2004.

The strategies are listed in Appendix B.

DATA ABSTRACTION

Papers were screened for relevance and study design. The methodological quality of the papers was assessed using pre-defined principles as outlined in Appendix E. Data were extracted by a single reviewer and the evidence tables compiled.

Appraisal of methodological quality

No RCTs were identified from the search strategy and so the decision was taken to follow a narrative review with an open study design criteria. The body of evidence for this review was found to be case series.

Case series and case reports consist either of collections of reports on the treatment of individual patients, or of reports on a single patient. Case series and case reports have limited or no use in a review of an effectiveness of an intervention. However they have an important role in alerting to the potential rare harms or the benefits of an effective treatment (Vandenbrouke, 2001).

Case series and case reports have no control group with which to compare outcomes and therefore have no statistical validity.

Case series studies were assessed against eight quality variables to provide a guide of the extent to which the findings or reporting of each study could be relied upon, and to highlight any methodological flaws. The eight variables were:

- case series collected in more than one centre (multi-centre study)
- aims of case series clearly stated
- case definition clearly reported
- explicit statement that patients were recruited consecutively
- prospective data collection
- reporting of confidence intervals or other estimate of random variability
- reporting of mortality/recurrences/complications, and
- baseline data for ulcers.

Quality criteria for case reports and case series are not well established. This is an adaptation of criteria used in other systematic reviews of case series (Vardulaki et al., 2000)).

Search results

Initial search results	530
N screened for relevance following sift	53
N included	24
N excluded	11

Clinical evidence

A total of 53 studies were identified from the sifting process and subsequently full papers ordered. This number also included those studies referenced with relevant titles but where the abstract was absent in the citation. After sifting full papers for relevance and duplicates at this stage, 18 papers were opinion pieces, editorials, anecdotal reports or fell outside the inclusion criterion for this review. Out of the selected studies 11 were excluded, 24 included.

The majority of the included studies were case reports, case series and retrospective chart reviews of variable quality.

Total study population for this review is 1,085 cases represented in both individual case reports and case series. Case series number of participants ranged from two to 297. Less than 10 participants were included in this review. However a further 16 studies could have been excluded if this criterion was to have been used.

The reported locations of ulcers were:

- sacral area
- trochanteric area
- ischial area

- heel
- malleollar, and
- plantar.

The age range from reported studies was 5-83 years although not all studies reported full demographic details. The grade or stage of ulcer was only described in five studies (Aggarwal et al., 1996; Gusenoff, 2002; Higins et al., 2002; Margara et al., 2002; Tizian et al., 1986) and a range of grading systems was used. Grades ranged from grade 3 to 7 indicating that, despite the grade or staging system, it was the higher grades that were indicated for surgical interventions. However surgical intervention in lower grades cannot be ruled out due to the grading and staging systems not adequately being described. Baseline data for ulcer size was only given in seven studies (Aggarwal et al., 1996; Akan et al., 2001; Aydan et al., 2003; Benito; Forster et al., 1997; Gusenoff, 2002; Higins et al., 2002; Hiroyuki et al., 1995; Little et al., 1982; Margara et al., 2002; Tizian et al., 1986) either as a range, or largest and smallest ulcer.

Follow-up period varied greatly from less than one month to 60 months. Complications as a result of surgery were reported in 21 studies with rates of up to 60% reported on one study (Klien, 1988).

Reported complications were:

- wound dehiscence
- flap necrosis
- wound infection
- osteomyelitis
- sepsis
- seroma
- muscle atrophy
- blisters
- suture sinuses
- haematoma
- abscess
- recurrent ulcer
- death
- aspiration pneumonia
- intraoperative myocardial infarction, and

- deep venous thrombosis.

Generally co-interventions were poorly described in the included studies. Studies that did report on co-interventions were Bocchi et al. (2004), Margara et al. (2002), Rubayi (1999), Waiter et al. (1999), and Tizian et al. (1986).

Reported co-interventions were:

- two-hourly position changes
- water mattresses
- air mattresses
- vacuum-assisted closure
- oral fluids 30ml/kg/24 hours
- vitamins/minerals
- no smoking
- nutrition 30-35cal/kg/body weight
- protein of 1-2g/kg/24 hours
- physiotherapy
- compliance interventions, and
- sitting programme.

Conclusions

The lack of any randomised studies means that reporting on the effectiveness of surgical interventions is not possible given the available evidence.

There is no evidence to indicate whether surgery is effective in the treatment of pressure ulcers and consequently no evidence to indicate which technique is the most effective in the treatment of pressure ulcers. However surgery is clearly indicated as a treatment option. Its use is mainly indicated in those with spinal cord injury, the elderly and in children, although the latter is less frequently reported. Recurrence rates are variable in the limited evidence but reports indicate that they can be as high as 50%.

	Evidence summary
3	Surgical management of pressure ulcers should be based on an overall assessment of the individual with everyone involved in the patient's care. With high reported recurrence rates, risk factors for delayed healing and pressure ulcer development need to be minimised.
	No economic evaluations assessing surgical interventions for the treatment of pressure ulcers were found.

Recommendations for this area of the guideline have been made using formal consensus methods.

Recommendations: surgery

Referral for surgical interventions for patients with pressure ulcers should be based on: **[D]**

- level of risk (anaesthetic and surgical intervention; recurrence)
- patient preference (lifestyle, abilities and comfort)
- ulcer assessment
- general skin assessment
- general health status
- competing care needs
- assessment of psychosocial factors for the risk of recurrence
- practitioner's experience
- previous positive effect of surgical techniques, and
- failure of previous conservative management interventions.

6.9 Topical negative pressure, electrotherapy and electromagnetic therapy, and therapeutic ultrasound in the treatment of pressure ulcers

The methods described in this review are those used to update the following systematic review:

Cullum N, Nelson EA, Flemming K, Sheldon TA (2000) Systematic reviews of wound care management: (5) beds; (6) compression; (7) laser therapy, therapeutic ultrasound, electrotherapy and electromagnetic therapy. *Health Technology Assessment*, 4(21).

The treatment of pressure ulcers can be broken down into four main areas:

- local treatment of the wound using wound dressings and other topical applications
- pressure relief using beds, mattresses or cushions, and repositioning of the patient
- treatment of concurrent conditions which may be delaying healing – for example poor nutrition, infection, and
- the use of adjunct therapies such as electrical stimulation, ultrasound, laser therapy and negative pressure.

Adjunct therapies are being used increasingly to assist the healing of pressure ulcers (Lyder, 2003; Hess, 2003), usually when conventional therapy has failed to make significant improvements in wound healing. The clinical and cost-effectiveness of many of these treatments have not been rigorously assessed.

Description of adjunct therapies to be included in the review

Topical negative pressure

One way of manipulating the wound environment in order to promote healing is to apply a topical negative pressure (TNP) (measured in mmHg) across the wound surface via a dressing (Davydov, 1992; Davydov, 1994; Fleischmann, 1993; Fleischmann, 1995; Argenta, 1997). The concept of negative pressure to create a suction force, enabling the drainage of surgical wounds and the promotion of wound healing is well documented (Fox, 1976; Fay, 1987). It has been suggested that if excess fluid is not adequately removed from a wound following surgery, its components may serve as both physical and chemical deterrents to wound healing (Fay, 1987). The basic concept that mechanical forces influence the shape and growth of tissues is also well documented (Ovington, 1999).

TNP is reported to do both, that is remove excess interstitial fluid, and transmit mechanical forces to surrounding tissues with resultant deformation of the extracellular matrix and cells (Morykwas, 1998). Both factors are thought to result in increased wound healing through a variety of mechanisms (Banwell, 1999). The transparent adhesive used to secure the dressing may also help maintain a moist wound environment (Mendez-Eastman, 1998; Banwell, 1999).

There are a number of names to describe the treatment of a wound with TNP – including sub-atmospheric pressure therapy or dressing, vacuum sealing technique, vacuum-assisted wound closure, vacuum-assisted closure, negative pressure therapy or dressing, foam suction dressing, vacuum compression, vacuum pack, sealed surface wound suction (Banwell, 1999; Banwell, 2003), or sealing aspirative therapy. For the purposes of this review this intervention will be referred to as TNP.

TNP requires an open cell dressing (e.g. foam) to pack the wound, tubing to connect the dressing to a suction pump via a cannister which collects any exudate, and an air-tight seal around the dressing (Baxandall, 1997). All non-viable tissue is removed beforehand (Argenta, 1997). TNP is generally viewed as contraindicated if the wound or surrounding tissues are cancerous, if there are fistulas to organs or body cavities, there is necrotic tissue, or if there is untreated osteomyelitis (Mendez-Eastman, 1998).

Laboratory evidence of the effectiveness of TNP on the wound environment has been obtained from several animal studies (Morykwas, 1993; Morykwas, 1997; Fabian,

2000).

The use of TNP in chronic human wounds has been described by a number of clinicians (Morykwas, 1995; Das Gupta, 1996; Argenta, 1997; Mullner, 1997; Banwell, 1998; Holmich, 1998; Genecov, 1998; Deva, 2000; Ladin, 2000; Lange, 2000 ; Mooney, 2000; Wu, 2000; Thomas, 2001 ; Heath, 2002). The use of TNP for the in-home treatment of chronic wounds has been reviewed (Weinberg Group, 1999) by referring to trials using non concurrent/historical control groups. This review examines the impact of TNP on chronic human wounds by referring to trials where the patients have been randomised to concurrent control groups. In 2001, a group of Canadian wound care opinion leaders was convened (with the financial assistance of a TNP support surface manufacturer) to assess the potential role of TNP in the treatment of chronic wounds (Sibbald, 2003). They noted that there was a gap between the evidence base and current practice with regard to this form of adjunct therapy.

Theraputic ultrasound

The mechanisms by which ultrasound may affect wound healing have been reviewed by Dyson (1982). The cellular effects of ultrasound can be divided into thermal and non-thermal (Dyson, 1982); the lower intensities used therapeutically mean that any beneficial effects are likely to be due to non-thermal mechanisms (Dyson, 1987). Non-thermal effects include the production of standing waves, acoustic streaming, microstreaming and cavitation. Some of these effects may be beneficial while others are potentially harmful; standing waves may cause the arrest of blood flow, while cavitation may cause bubble formation within the blood stream (Dyson, 1987). Careful choice of exposure time, intensity, and continuous movement of the ultrasound applicator should minimise these effects. Therapeutic ultrasound has been evaluated in a number of different regimens: varying pulse duration, power output and frequency.

Electrotherapy and electromagnetic therapy

Electrical stimulation has been used for decades as a treatment for chronic wounds (Hewitt, 1956) and is often applied by physical therapists. However, its role in promoting pressure ulcer healing as an adjunct to or in the absence of other proven therapies is unclear.

Research into the role of electricity in wound healing has been undertaken since at least the 1940s (Burr, 1940). Experimental animal studies have shown that electrical potentials over the wound during healing are initially positive, becoming negative after

the fourth day of healing (Weiss, 1990). It has been concluded that the proliferative phase of healing is related to a negative electrical potential over the wound; however, some studies have experimented with positive wound electrodes, and others by reversing the electrode during healing. It is hypothesised that electrical stimulation influences the migratory, proliferative and synthetic functions of fibroblasts, and also results in increased expression of growth factors (Weiss, 1990). It seems likely that a moist wound environment is essential to maintain endogenous or applied current flow.

There are several types of electric treatment modalities including: low-voltage direct current (LVDC), high-voltage pulsed direct current (PDC), low-voltage alternating current (LVAC) and pulsed electromagnetic field (PEMF) (Sheffet, 2000; Unger, 2000). All have different administration regimes and equipment required. Electromagnetic therapy is distinct from most other forms of electrotherapy in that it is a field effect, and not a direct electrical effect or a form of radiation. The terminology Pulsed Electromagnetic Field (PEMF) is used to distinguish it from short-wave diathermy, which uses either capacitance or induction to produce indirect heating of tissues and can be thought of as a field effect (Stiller, 1992).

Objective

To systematically assess the evidence for the effectiveness of adjunct therapies in the treatment of existing pressure ulcers.

Selection criteria

Types of studies

Only randomised controlled trials (RCTs) were included in this review. Studies that did not employ true random allocation of participants to treatment groups, such as quasi-experimental designs, were excluded. The units of allocation had to be patients or lesions. Studies in which wards, clinics or physicians were the units of allocation were excluded because of the possibility of non-comparability of standard care. Both published and unpublished studies were included, with no restriction on date or language.

Types of participants

Studies that recruited people with existing pressure ulcers, of any grade or severity, were eligible for inclusion in the review. The study could be in any setting including hospital, clinic, community facilities, or home.

Types of interventions

Trials in which an adjunct therapy or therapies were compared with a placebo, usual care, or no treatment were eligible for inclusion in the review. All modes of delivery/administration/dose for the named adjunct therapies were considered for the review. It was anticipated that, where appropriate, similar regimens would be grouped and subjected to sub-group analyses.

Types of outcome measures

The primary outcome was wound healing. Since some measures of wound healing can be subjective, studies had to incorporate at least one objective assessment – such as change in ulcer size, rate of healing, frequency of complete healing or time to complete healing – to be included in the review. Change in ulcer size may have been presented as a percentage or absolute change over a period of time. Objective methods of measuring changes on wound size included tracing the ulcer outline followed by counting grids on graph paper, weighing uniform-density tracing paper, planimetry or computerised image analysis.

A single standard outcome measure for wound healing does not exist. Both objective and subjective measures are widely used by researchers, but little effort has been made to determine the validity of many of these measurements. Comfort, ease of application, ease of removal, exudate and handling are frequently-used measures of dressing performance, but they are not validated outcomes on which to base decisions of effectiveness. In this review the most commonly validated outcome measures encountered were based on wound healing. The non-ambiguity of complete healing, and its importance to clinicians and patients alike (because of its potential impact on quality of life and burden of care), make it the preferred outcome measure with which to compare studies of clinical effectiveness.

Objective measures of healing are usually based on wound area. Planimetry, often aided by computer analysis, is the most frequently used method of calculating wound area, though other methods, such as the measurement of wound diameter or weight of a tracing drawn around the area of the wound, are also used. Measurements of

wound volume are infrequently reported in the literature; these methods are often cumbersome and their accuracy has not been proven. Computerised image analysis may in the future, as the equipment becomes more affordable and portable, prove to be a useful technique for the assessment of wound volume.

Even though objective measures reduce or eliminate subjective biases and reduce random measurement errors, they have certain inherent biases if the patients being compared have wounds with different baseline size. A change in wound area is often expressed as the percentage change which, unlike the absolute change in area, takes into account the initial size of the wound. For two wounds healing at the same linear rate (as measured by diameter reduction) percentage area calculations will show a larger change for a small wound than for a big wound. The converse is true when the absolute change in area is measured, as for any unit reduction in wound radius, a bigger area reduction will occur for a large wound.

This has important consequences for the validity of trial results where there is poor comparability in initial wound size at baseline between the treatment groups. In large trials, randomised allocation should ensure that the mean wound size and variance in each group is similar. In a small trial random allocation is unlikely to result in an even distribution of wound sizes. In a trial where there is poor comparability between groups for wound size at baseline, and the outcome is based on the change in area, the result can only be considered valid if it is obtained either: against the anticipated direction of the bias for wound size; or where percentage area change and absolute area change are in the same direction. If baseline data are not given then it is not possible to determine the direction of bias and the validity of the results cannot be determined. Despite the potential for objective outcomes to be biased by differences in wound size at baseline, they remain the most reliable assessment of wound healing as, unlike subjective measures, they reduce the biases of the assessor which cannot be estimated.

Secondary outcomes such as costs, quality of life, pain and acceptability of the adjunct therapy were assessed where possible.

Search strategy

Clinical effectiveness searching

Main literature search

Searches were undertaken to update the following Cochrane review:

Cullum N, Nelson EA, Flemming K, Sheldon TA (2000) Systematic reviews of wound care management: (5) beds; (6) compression; (7) laser therapy, therapeutic ultrasound, electrotherapy and electromagnetic therapy. *Health Technology Assessment*,4(21).

Searches were limited by study design to retrieve randomised controlled trials. Searches were also limited to retrieve literature published in English, and to omit animal studies and letters, comments and editorial publication types.

Databases were searched in February 2004 and update searches were carried out in June 2004:

The strategies are listed in Appendix B.

Description of included studies

Ten eligible randomised trials were identified for inclusion in the review. One trial (Joseph, 2000) assessed the effect of topical negative pressure on a variety of chronic wounds including pressure ulcers. Three RCTs examined the effect of therapeutic ultrasound in the treatment of pressure ulcers (McDiarmid, 1985; ter Riet, 1995; Nussbaum, 1994). Four trials compared electrotherapy to sham therapy for the treatment of pressure ulcers (Gentzkow, 1991; Griffin, 1991; Wood, 1993; Ritz, 2002). A further two trials assessed the effect of electromagnetic therapy for the treatment of pressure ulcers (Comorosan, 1993 ; Salzburg, 1995).

Included studies for topical negative pressure

Joseph and colleagues (2000) assessed 24 patients with 36 chronic wounds (resulting from pressure, wound dehiscence, trauma, venous stasis or radiation), defined as present for greater than one month, in a randomised parallel group study. Eighteen wounds received TNP (open cell foam dressing with continuous suction (125 mmHg) changed every 48 hours. Eighteen wounds received normal saline wet-to-moist gauze dressings (with an occlusive dressing used to secure the gauze) changed three times a day. If patients had multiple wounds, it appears that the

individual wounds were treated during randomisation and data analysis as if they were independent from each other.

At three and six weeks the percent change in wound volume was measured by volume displacement of alginate impression moulds. Additional outcome measures were given by Joseph, such as histology and culture, but they did not fulfil the selection criteria of this review. The trial used a commercially available therapy unit and integral dressing (VAC Therapy, KCI, OXON, UK) to apply the negative pressure.

A total of twenty-one studies reporting the effects of TNP on pressure ulcer healing were excluded from the review (see Table of Excluded Studies, Appendix D). The main reason for exclusion was that they were not RCTs. Patients were either not randomly allocated to the two concurrent treatment groups, or the control group was non concurrent/historical, or, as in the majority of studies, there was no control or comparison group at all. Some of the studies were prospective RCTs, but on animals not humans, and some assessed the effect of TNP on types of chronic wounds other than pressure ulcers. Those prospective RCTs on humans were reporting the effects of TNP on acute wounds.

A further seven studies are still awaiting assessment. This is mainly due to publication as abstracts only without a subsequent full publication, and thus insufficient information to assess inclusion criteria or to extract results data, or the primary paper is yet to be sourced and assessed for inclusion. The citations and reasons for not yet being assessed are detailed in the Table of Studies Awaiting Assessment

Included studies for therapeutic ultrasound

Three RCTs were identified that examined the effectiveness of ultrasound treatment in the healing of pressure ulcers. The studies all contained small numbers of patients with group sizes varying from 20 patients in three arms to 88 patients in two arms. Two trials (McDiarmid, 1985; ter Riet, 1995) compared ultrasound therapy delivered at approximately 3MHz to sham therapy. A third (Nussbaum, 1994) compared a combination of ultrasound and ultraviolet with laser treatment (820nm laser diode) with standard wound care. McDiarmid (1985) and Nussbaum (1994) studied patients with superficial pressure ulcers. ter Riet (1995) studied patients with stage 2 pressure ulcers (partial skin thickness or worse).

The first of these studies (McDiarmid, 1985) compared 3MHz of ultrasound with sham treatment for patients with pressure ulcers. Treatment was for a minimum of five

minutes (timing dependent on wound size), three times per week. The duration of follow up for the study was unclear.

ter Riet (1995) randomised 88 nursing home patients with pressure ulcers to receive either ultrasound or sham treatment five times a week over a 12-week period. The ultrasound was at a frequency of 3.28MHz with a pulse duration of 2ms.

Nussbaum (1994) compared a combination of ultrasound and ultraviolet treatment (given alternately for five days a week) with laser treatment (820nm laser diode), and with standard wound care twice daily (cleansing with 0.05% chlorine solution, paraffin tulle dressing and pressure relief). Treatment continued until healing occurred.

Two trials were excluded from the review as they were not RCTs (see Table of Excluded Studies, Appendix D).

Included studies for electrotherapy and electromagnetic therapy

Four trials comparing electrotherapy to sham therapy for the treatment of pressure ulcers were suitable for inclusion in this review (Gentzkow, 1991; Griffin, 1991; Wood, 1993; Ritz, 2002). These four studies contained a total of 137 patients.

The first of these RCTs (Gentzkow, 1991) recruited both hospital and community patients with stage 2, 3 or 4 pressure ulcers who were randomised to receive either electrical stimulation twice daily for four weeks or sham stimulation. Patients with more than one pressure ulcer could have all ulcers randomised into the study. Both groups received standard treatment of cleansing with normal saline, a wound dressing (type not stated), and turning to relieve pressure on the affected area in addition to the electrotherapy or sham electrotherapy. The grading of ulcers was described by the authors as stage 2: full thickness skin defect to subcutaneous tissue; stage 3 to muscle; stage 4 to bone/joint.

The second study (Griffin, 1991) examined 17 male patients with spinal cord injury and a pressure ulcer graded between 2 and 4 on the Delisa system. Participants were randomised to receive electrotherapy and standard treatment or sham therapy plus standard treatment. The standard treatment consisted of wound cleansing and dressing – pressure ulcers were cleansed using Cara-Klenz application of Carrington gel (dermal wound cleanser) and dressed using a dry dressing. Mechanical debridement was as necessary. There was no change of mattress for any patient during the study.

The third study (Wood, 1993) compared electrotherapy with sham therapy for the treatment of chronic stage 2 or 3 pressure ulcers which had shown no improvement with standard nursing care over the proceeding five weeks. Both groups received standard treatment of wound cleansing, simple moist dressings and whirlpool baths. No hydrocolloids, films or foam dressings were used. There was no description of the system for grading pressure ulcers in the study.

The final study (Ritz, 2002) compared the Provant wound closure system (which uses radiofrequency stimuli to induce fibroblast and epithelial cell proliferation) twice daily with sham treatment in high-risk patients with grade 2 to 4 pressure ulcers. This treatment was in addition to standard care. Patients treated with concurrent adjunct therapy support surfaces – e.g. hyperbaric oxygenation, electrical stimulation – were excluded.

Two studies of electromagnetic therapy for the treatment of pressure ulcers were included in the review (Comorosan, 1993; Salzburg, 1995). These two studies contained a total of 60 patients. The first study (Comorosan, 1993) was a three-arm study comparing electromagnetic therapy, a combination of sham electromagnetic therapy and standard therapy, and standard therapy alone, over a two-week treatment and follow-up period. Treatment was given for 30 minutes, twice a day. The participants were all patients in an elderly care unit with grade 2 or 3 pressure ulcers. The grading system for the ulcers was not described.

The second study (Salzburg, 1995) compared electromagnetic therapy with sham electromagnetic therapy over a 12-week period. The patients included in the study were all male hospital inpatients with a spinal cord injury. This study also gave treatment for 30 minutes twice a day, although the electromagnetic therapy regimen differed from the Comorosan study.

The pressure ulcers were graded as 2 or 3 with an even distribution of each between the groups. A clear definition of the grading of the ulcers was provided by the authors. Grade 2 ulcers were defined as partial-thickness skin loss involving epidermis or dermis, superficial, and clinically presenting as a deep crater, abrasion, blister or shallow crater. Stage 3 was defined as full-thickness skin loss involving damage or necrosis of subcutaneous tissue extending down to, but not through, underlying fascia, clinically presenting as a deep crater with or without undermining of adjacent tissue.

Two trials that assessed either electrotherapy or electromagnetic therapy were excluded from the review as they were not RCTs (see Table of Excluded Studies, Appendix D)

Methodological quality of included studies

Details of the quality assessment of each study are outlined in the Table of Included Studies (Appendix, A). The key components of quality that were assessed included *a priori* sample size calculations, allocation concealment, masking of outcome assessment and reporting of withdrawals by treatment group. Quality was not used to weight the studies in the analysis using any statistical technique; however methodological quality was drawn upon in the narrative interpretation of the results.

Methodological quality of included topical negative pressure studies

In Joseph (2000), of the 24 patients recruited to the study, 12 patients had multiple wounds resulting in a total of 36 wounds. It is not clear how many patients in each arm of the study had multiple wounds and if these patients were evenly distributed across groups. This could potentially impact on baseline comparability of groups. Baseline comparability was reported for age, sex, initial wound volume, ethnicity, smoking status and wound duration. Each wound was randomised to either TNP or saline gauze dressings. Of the 12 patients with multiple wounds, three patients were randomised to both therapies.

It is inappropriate to randomise and analyse multiple wounds as if they were independent from each other unless using a within subjects design. The preferable way of dealing with multiple wounds using a between patients design is to have a single reference wound. Random assignment of wounds to treatments was achieved using files, marked with silver or black labels on the inside panel that were randomly organised in a locked cabinet. It is not clear if these files were sealed so the adequacy of allocation concealment is unclear.

Neither the patient nor the providers were blind to the treatment used. The outcome assessors were blinded as they were not involved in the daily care of the study patients and they only assessed the wounds once the dressings had been removed. Appropriate outcome measures were used, for example percent change in wound volume over time, but also extraneous ones which would be reflected in the change in volume. The authors stated that follow up beyond the six-week study period continued until complete wound closure was shown for each patient but unfortunately

this time to complete healing data was not reported. It was not reported if there were any withdrawals. It is unclear whether intention-to-treat analysis was performed.

Methodological quality of included therapeutic ultrasound studies

None of the three included trials that assessed therapeutic ultrasound (McDiarmid, 1985; Nussbaum, 1994; ter Riet, 1995) included information on the method of randomisation although ter Riet (1995) stated that the method of allocation was concealed – that is the person randomising the patient to the trial was unaware of which group they would enter before randomisation. The two trials that evaluated only ultrasound (McDiarmid, 1985; ter Riet, 1995) attempted to mask the patients to which group they were in by using a sham therapy group. All three trials used blinded outcome assessment. None of the trials used intention-to-treat analysis. Concurrent interventions, such as support surfaces, were described in two of the three studies (ter Riet, 1995; Nussbaum, 1994).

Methodological quality of included electrotherapy and electromagnetic therapy studies

It was difficult to extract some of the details on methodological quality due to poor reporting in the five studies that assessed either electrotherapy or electromagnetic therapy (Comoroson, 1993; Salzberg, 1995). Attempts to contact the authors for clarification were unsuccessful.

None of the studies that assessed electrotherapy (Gentzkow, 1991; Griffin, 1991; Wood, 1993; Ritz, 2002) provided information about the method of randomisation used for their trials, and none incorporated an intention-to-treat analysis. However all four studies did provide information about the baseline features of the pressure ulcer area which enables more accurate interpretation of the results. While all three studies reported the type of wound dressing used during the trials, none reported other concurrent interventions such as support surfaces (beds, mattresses and cushions) used.

Neither study that assessed electromagnetic therapy (Comoroson, 1993; Salzberg, 1995) stated the method of randomisation, nor conducted an intention-to-treat analysis. Both studies however used blinded outcome assessment. While both studies reported the types of wound dressings used during the study, neither reported other concurrent interventions such as support surfaces (bed, mattresses and cushions) used. The study by Comorosan (1993) did not provide information on the

strategies used for randomisation and so there is no rationale as to why the three arms in the study contain an uneven distribution of patients.

Results

Results for topical negative pressure studies

Synthesis of results using statistical pooling methods was not appropriate, as only one trial fulfilled the selection criteria.

Joseph (2000) reported a significantly greater reduction in wound volume (expressed as a percentage of the initial volume at six weeks) in favour of TNP dressings when compared with standard wet-to-moist saline gauze dressings (78% vs 30% p=0.038). It was not clear whether mean or median values were provided. No standard deviations, ranges or confidence intervals were provided. The trialists stated that follow up beyond the six-week study period continued until complete wound closure and that all patients were offered operative wound closure for any remaining open wounds. Unfortunately these time-to-healing data were not reported. Adverse outcomes were three out of eighteen wounds with TNP had osteomyelitis and/or calcaneal fractures. Two of the patients suffered calcaneal fractures while ambulating on the TNP dressing, which Joseph (2000) states is against the manufacturer's recommendations and medical advice. Both patients eventually required amputation. Eight out of eighteen wounds with control dressing had osteomyelitis, other wound infections or fistulas (p=0.0028).

There were no RCTs evaluating the effectiveness of TNP on cost, quality of life, pain or comfort and there were no RCTs evaluating the effectiveness of different TNP regimens.

Results for therapeutic ultrasound studies

Two trials compared therapeutic ultrasound with sham ultrasound (McDiarmid, 1985; ter Riet, 1995). The third trial compared a combination of ultrasound and ultraviolet light with laser therapy and standard treatment (Nussbaum, 1999).

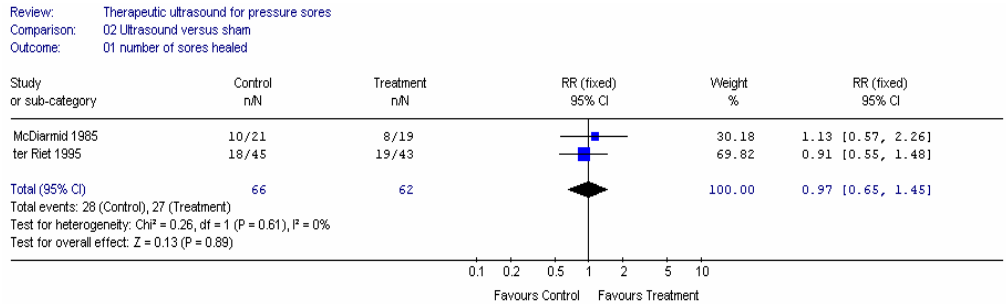
Ultrasound therapy versus sham therapy

McDiarmid (1985): 10/21 (48%) pressure ulcers healed in the ultrasound group compared with 8/19 (42%) in the sham group (RR 1.13, 95% CI 0.57, 2.26). Treatment was delivered three times a week for an unspecified period of time.

ter Riet (1995): 18/45 (40%) of pressure ulcers healed in the intervention group compared with 19/43 (44%) in the control group (RR 0.91, 95% CI 0.55, 1.48). Treatment was given five times a week for 12 weeks or until healing had occurred.

The trials by McDiarmid (1985) and ter Riet (1995) were considered sufficiently similar to pool (chi-squared = 0.26, I^2=0%), giving a pooled relative risk of 0.97 (95% CI 0.65, 1.45; p=0.89). Thus two studies involving only 128 patients in total found no evidence of a benefit of ultrasound on the healing rates of pressure ulcers (see Figure 33).

Figure 33:



Ultrasound and ultraviolet therapy versus laser therapy versus standard treatment

Ultrasound combined with ultraviolet (UV) therapy was compared with laser alone and standard therapy in 20 patients with spinal cord injury and pressure ulcers up to 1cm in depth (Nussbaum, 1994). Groups were broadly similar in terms of area and depth of ulcers. Four patients dropped out leaving 16 patients with 18 wounds. After 12 weeks all ulcers (6/6) had healed in the combined ultrasound/ultraviolet treatment group. In the laser treatment group 4/6 (66%) ulcers healed, and in the standard wound care group 5/6 (83%) ulcers healed. There was no statistically significant difference between the groups due to the extremely small sample size, and the consequent lack of power, as shown below:

- ultrasound/UV therapy versus laser therapy: RR 1.5,95% CI 0.85, 2.64
- ultrasound/UV therapy versus standard treatment: RR 1.2, 95% CI 0.84, 1.72
- laser therapy versus standard therapy: RR 0.8, 95% CI 0.41, 1.56

No secondary outcome measures, including costs, quality of life, pain and acceptability, were measured in any of the RCTs included.

Results for electrotherapy and electromagnetic therapy studies

Electrotherapy versus sham electrotherapy

Four trials compared electrotherapy with sham electrotherapy.

Gentzkow (1991): After four weeks there was a mean percentage ulcer healing of 49.8% (SD 30.9) in the electrotherapy group and a 23.4% (SD 47.4) mean percentage ulcer healing in the sham group (p=0.042). The baseline ulcer areas given demonstrated larger ulcers in the intervention group. Thus the result is against the direction of bias, as the outcome of percentage healing favoured the control group.

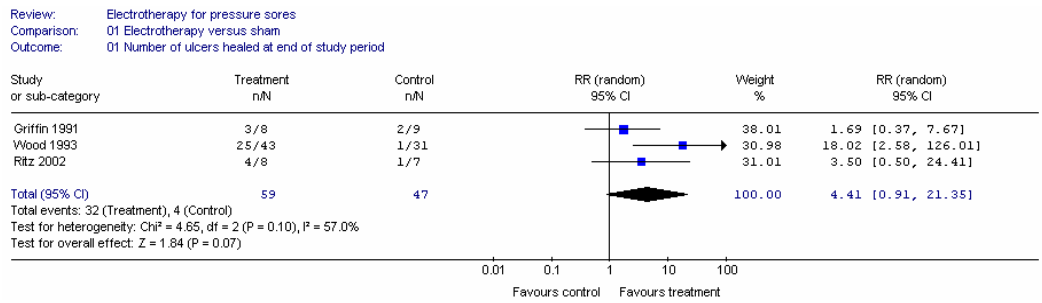
Griffin (1991): 3/8 (37.5%) ulcers healed in the electrotherapy group compared with 2/9 (22%) in the control group (RR 1.69, 95% CI 0.37-7.67).

Wood (1993): 25/43 (58%) of electrotherapy group ulcers healed, compared to only 1/31 (3%) in the sham therapy group (RR 18.02, 95% CI 2.58-126.01). As the ulcers were larger at baseline in the intervention group, this result is against the direction of bias.

Ritz (2002): 4/8 (50%) ulcers in the electrotherapy group healed completely, compared with only 1/7 (14%) in the sham therapy group (RR 3.50, 95% CI 0.50, 24.41). This was a very small, industry-sponsored study.

Three studies had outcomes on the numbers of ulcers healed and were considered sufficiently similar to pool (Griffin, 1991; Wood, 1993; Ritz 2002) (Chi-square 4.69, I^2=57%). This resulted in a pooled relative risk of 4.41 (95% CI 0.9-21.35; p=0.07) (see Figure 34). This shows no evidence of improved healing of pressure ulcers treated with electrotherapy compared with sham therapy. Again, however, as this result is drawn from three small studies with a total of 106 patients, the results should be interpreted with caution.

Figure 34:



Electromagnetic therapy versus sham therapy

Two trials compared electromagnetic therapy with sham therapy, although the trial by Comorosan included a third arm in which only standard therapy was applied.

Comorosan (1993): 17/20 (85%) ulcers healed in the electromagnetic therapy group within two weeks compared with no ulcers healing in either of the other two groups (0/5 and 0/5) (RR 10, 95% CI 0.7-143.7).

Salzburg (1995): For grade 3 pressure ulcers, 3/5 (60%) healed in the electromagnetic therapy group compared with no ulcers healing in the sham electrotherapy group (0/5) at 12 weeks (RR 7, 95% CI 0.45-108.26). For grade 2 pressure ulcers, there was a median of 84% healing in the electromagnetic therapy group at one week compared with 40% in the sham therapy group (p=0.01). Groups could not be combined due to the different timings and outcome measures between the grade 2 and grade 3 pressure ulcers.

Secondary outcome measures, such as financial costs, quality of life, pain and acceptability, were not measured in either of the RCTs included.

Discussion

Quality of the included studies

Quality assessment suggests that methodological flaws are an issue affecting the validity of most studies in chronic wound care. In general, the studies were too small to ensure that wounds of different sizes (and other prognostic variables) were evenly distributed across trial arms, resulting in a bias at baseline in most trials. The majority of studies also had a short follow-up and did not analyse the data by survival analysis, which would account for both whether and when a wound healed and which would be a more efficient method for estimating the rate of healing.

If future trials perpetuate many of the methodological flaws highlighted in this review, they are unlikely to provide the evidence needed to determine an effective wound management strategy. The variability between wounds at baseline for prognostic variables, including size, indicates that recruitment numbers need to be large and that trials should probably be multi-centred. If small single-centred trials are to be

continued they could be improved by the use of matched or stratified randomisation to ensure a similar distribution of wound sizes between treatment groups at baseline, and the data should be analysed by matched pairs analysis where appropriate. However, even with this improved design a trial still needs to be large enough to ensure comparability for both unknown and known confounding factors.

It is important to ensure, when conducting an RCT, that systematic differences in comparison groups (selection bias), care provided apart from the intervention being evaluated (performance bias), outcome assessment (detection bias), and withdrawals from the trial (attrition bias) are avoided (or made explicit) (Clarke, 2003). The logical basis for this being that any differences in group outcomes could be due to these systematic differences. Differences in group outcomes could then be wrongly attributed to the intervention being evaluated.

Selection bias can be eliminated by assembling comparison groups in such a way that the process is impervious to any subconscious influence by the individuals making the allocation. This is most securely achieved if an assignment schedule generated using true randomisation is concealed. Allocation concealment can always be implemented (Clarke, 2003). Performance and detection biases can occur if there are unintended differences in the way the treatment and placebo groups are treated, either while receiving the intervention or being assessed at follow up. The best way to avoid these potential biases is for those providing and receiving care, and those undertaking the outcome assessments, to be blinded so that they do not know the group to which the recipients of care have been allocated (Clarke, 2003). There is limited empirical evidence of a relationship between parameters thought to measure validity and actual trial outcomes. More research is needed to establish which criteria for assessing validity are important determinants of study results and when (Clarke, 2003).

When critically appraising the validity of the studies, the reviewers had to rely on adequate reporting of the trials. Assuming that if something was not reported it was not done is not necessarily correct. The reviewers relied on the good will of experts in the field to provide information on completed, or ongoing, published or unpublished studies.

The reviewers did attempt to obtain additional clarifying data from investigators; however no response was received.

The alternative to withholding treatment from a patient is to employ a placebo. In wound care trials such placebo treatments are unlikely to be inert, as the application of the placebo or vehicle is likely to change the local environment of the wound, thereby modifying the biological processes associated with healing. A placebo is therefore not a substitute for withholding treatment in studies to determine the rationale for active treatment. The possible interaction between the vehicle and the healing process, together with small sample size, may provide some explanation for why so few of the trials included in this review showed a statistically significant difference between an active treatment and a placebo.

Generally, the methodological quality and sample size of the trials included in this review was only fair. Very few trials reported their methods of randomisation or allocation concealment, and few calculated *a priori* sample size estimates. However, several studies used sham therapy in order to maintain blinding of treatment allocation to the patients, clinicians and outcomes assessors.

Topical negative pressure as an adjunct treatment for pressure ulcers

In the study by Joseph (Joseph 2000) the assignment schedule appeared to be generated using true randomisation but the adequacy of allocation concealment was unclear, hence risking selection bias. The study was also at risk of performance bias as the experimental group received TNP delivered via a foam dressing whereas the control groups had saline gauze dressings so it was impossible to blind those providing and receiving care. However, outcome assessors were blind on treatment allocation thereby reducing the risk of detection bias. It is uncertain whether the Joseph (2000) study was at risk of attrition bias. In this study it was not clear whether intention-to-treat analysis was used, if exclusions were made, and, if they were, the reasons for these (protocol deviations, withdrawals, dropouts and losses to follow up).

Due to the poor reporting of this study, precise effects measures cannot be calculated. This, coupled with the small sample size and methodological flaws, means that this trial does not provide any evidence of benefit on the use of topical negative pressure as an adjunct therapy for pressure ulcer treatment. Further controlled trials are needed to address this question.

Therapeutic ultrasound as an adjunct treatment for pressure ulcers

The results of the two included trials in this review (McDiarmid, 1985; ter Riet, 1995) do not suggest a benefit associated with therapeutic ultrasound in the healing of

pressure ulcers. Again however, as the numbers of randomised patients are small and methodological quality relatively poor, the results should be viewed with caution. Further randomised trials are warranted.

Electrotherapy or electromagnetic therapy as an adjunct treatment for pressure ulcers

The four trials identified that assessed these interventions (Getzkow, 1991; Griffin, 1991; Wood, 1993; Ritz, 2002) all suggested a trend toward benefit associated with using electrotherapy to treat pressure ulcers. However this suggestion is drawn from a total of only 186 patients.

The three studies whose results were pooled (Griffin, 1991; Wood, 1993; Ritz, 2002) all had unmatched groups for ulcer size at baseline. Griffin (1991) had larger ulcers in the control group. The result (RR 1.69, 95% CI 0.37-7.67), while not statistically significant, favours electrotherapy, and is therefore with the direction of bias. There were only small numbers of patients in each group in this study.

Wood (1993) included patients whose ulcers were larger in the intervention group. The result of this study (RR 18.02, 95% CI 2.58-126.01) is statistically significant while being against the direction of bias. Overall, there was no evidence of a statistically significant benefit in pressure ulcer healing with the use of electrotherapy. The extent to which electrotherapy contributes to healing in patients who are otherwise receiving pressure relief and moist wound-healing strategies needs to be explored further using rigorous methodology.

While the two trials (Comorosan, 1993; Salzburg, 1995) that assessed the effect of electromagnetic therapy are both suggest a benefit for the healing of pressure ulcers, neither reaches statistical significance and the evidence is rather unreliable. Both trials contained small numbers of patients, and had differing regimens of treatment over varying time scales. The extent to which electromagnetic therapy contributes to healing in patients who are otherwise receiving pressure relief and moist wound-healing strategies should be explored further. The trials do not adequately report the severity of pressure ulcers and baseline comparisons. As such the results should be viewed as unreliable and further research is needed involving larger numbers of patients.

6.9.1 Cost-effectiveness of adjunct therapies (topical negative pressure, therapeutic ultrasound, electrotherapy and electromagnetic therapy)

One full economic evaluation and one partial economic evaluation of adjunct therapies were identified for review (Macario et al., 2002; Philbeck et al., 1999 respectively).

Macario et al. (2002) conducted a cost-utility analysis comparing noncontact normothermic wound therapy to current standard care (see data extraction table 22, Appendix A). The study was conducted in a long-term care institution in the US. The authors reported that the perspective of the analysis was societal. The analysis included societal-based utilities, however the costing was undertaken from the perspective of the health care payer (see data extraction table 22, Appendix A). The study was based on a decision-analytic model. The base case analysis involved a hypothetical 72-year-old patient with a two-month old, ischial grade 3 pressure ulcer who was living in a nursing home. The secondary analysis involved a grade 4 pressure ulcer. Monte Carlo simulation was undertaken to resample from the data to estimate results for 10,000 hypothetical patients.

Data to populate the model were obtained from national statistics, the literature and author opinion. A Markov model was used which comprised of six mutually exclusive health states including: (i) grade 3 pressure ulcer, (ii) grade 4 pressure ulcer, (iii) healing wound, (iv) closed wound healed back to normal, (v) complications requiring hospitalisation, and (vi) death. Patient progression through the model was divided into eight-week cycles over 40 months.

Utility estimates were based on author assumption, informed by the literature. The quality of life of a patient with a pressure ulcer was determined by assigning levels of disability and distress to each health state. The authors used the Rosser-Kind index, which includes disability and distress dimensions to attach utilities to each of the six health states (above). The change in utility attached to patients' health status as they progressed through the model was combined with life expectancy to calculate QALY estimates. The resources measured and costed included nurse and doctor time, use of supplies and equipment, and the cost of complications.

Over the 40-month timeframe, it was estimated that for grade 3 pressure ulcers 0.10 (SE[vii] = 0.0005) QALYs were gained per patient using noncontact normothermic wound therapy over current standard care. For grade 4 pressure ulcers the gain in QALYs was 0.14 (SE = 0.0010) per patient. In terms of costs, for grade 3 pressure ulcers it was estimated that noncontact normothermic wound therapy cost $6,3340 (SE = $98) (price year 2000) less than current standard care and for grade 4 pressure ulcers the cost was estimated to be $15,216 (SE = $186) less. Thus noncontact normothermic wound therapy was identified as the dominant strategy in treating grade 3 and 4 pressure ulcers.

Probabilistic sensitivity analysis was undertaken to test the robustness of the results by simultaneously considering uncertainty associated with all probabilities, utilities and costs included in the model. Results were most sensitive to the following model inputs: daily treatment costs and the probability of healing to a normal closed wound with standard care; the cost of the complication state; and the acquisition cost of noncontact normothermic wound therapy. If the cost of the latter increased to $421 its use increased overall costs. The Monte Carlo simulations showed that noncontact normothermic wound therapy is likely to reduce costs and increase quality of life for at least 75% (SE=0.4%) of patients with stage 3 pressure ulcers and to reduce costs by around 81% (SE=0.4%) for patients with stage 4 pressure ulcers.

These results should be considered in the light of a number of assumptions that underpin the Macario et al. (2002) model. As the authors mention, their assumption that transition probabilities remain constant over time may be questioned. For instance, in practice the probability of healing after the first eight-week cycle may not be equal to the probability of healing after the fourth eight-week cycle. Utilities were attached to health states indirectly, that is the patients themselves did not value health states as this data was not available. The model assumed that reduction in wound size directly improved the probability of wound healing. Data to populate the model was obtained from numerous sources, based on controlled and randomised trials. There was much variability due to differences in the delivery of care across settings (standard care varies in particular), confounding comorbidities, variability in types, sizes and locations of pressure ulcers.

Philbeck et al. (1999) conducted a cost-consequence analysis comparing negative pressure wound therapy (TNP) to saline-soaked gauze dressing applied to patients

[vii] SE = Standard Error. This statistic indicates the degree of uncertainty in calculating an estimate from a sample

placed on either a low air loss mattress or a foam mattress bed for grade 3 or 4 pressure ulcers (see data extraction table 23, Appendix A). The analysis was conducted from the perspective of the health care payer although this was not stated.

For the negative pressure wound therapy group a Medicare observational dataset was used which covered a 180-day follow-up period. For the comparator, data from the Ferrell et al. study (1993) were used (see Appendix A data extraction table 25, which presents an economic evaluation by Ferrell et al. ((1995)) which was also based on this trial). The study was excluded from the clinical effectiveness review because it was based on retrospective, observational data for the negative pressure wound therapy and a historical control (Ferrell et al., 1993) for the comparator.

Effectiveness measures from both studies included healing rates as a reduction in wound area and volume over 30 days, and time to heal. The reduction in cm^2 per day of the wound was faster for negative pressure wound therapy at 0.230cm^2 per day compared to 0.090cm^2 for the comparator. Time to heal, based on wound healing rates, was expected to be 97 days for negative pressure wound therapy compared to 247 days for the comparator. The total cost of negative pressure wound therapy per day, including the cost of materials and nursing visits was $149.96 versus $95.00 (the price year was not stated). However, due to a faster expected healing rate, the expected total cost to complete heal was lower on average for each patient in the negative pressure wound therapy group ($14,546 versus $23,465).

It appears that negative pressure wound therapy dominates saline-soaked gauze dressings applied to patients placed on either a low air loss mattress or a foam mattress bed for grade 3 or 4 pressure ulcers. However, there are a number of substantial limitations associated with the study that cast doubts on the validity and reliability of the results. While the authors aimed to closely match patients from either study, the potential variability and uncertainty introduced into the study as a result of the study design was not explored. The authors state that the Medicare dataset did not contain data on the duration of previous interventions, medical history and laboratory values relevant to wound healing, and the homogeneity of the patients across the two groups, apart from the treatment received, is questionable. The initial surface area of the wounds was very different (22.2cm^2 versus 4.3cm^2 for the negative pressure and comparator treatments respectively). However this may be expected to favour the latter.

Overview of adjunct therapies

	Research evidence
1-	Topical negative pressure treatment was only assessed in one trial with a small sample size and methodological limitations. While the trial results suggested that topical negative pressure treatment may increase healing rates of pressure ulcers compared with saline gauze dressings, the findings must be viewed with extreme caution. Practitioners ought to make patients aware of the limited trial-based evidence for the effectiveness of topical negative pressure for pressure ulcer healing and that further research is required to validate the preliminary findings.
1+	There is no evidence of a benefit of using ultrasound therapy in the treatment of pressure ulcers. The possibility of a beneficial or a harmful effect cannot be ruled out, however, due to the small number of trials with methodological limitations and small numbers of participants.
1+	The meta-analysis of the results of three trials which assessed the effect of electrotherapy on pressure ulcer healing showed no evidence of benefit for this treatment. However this suggestion is drawn from three studies with a total of only 137 patients. Therefore the results should be viewed with caution as it is difficult to determine clinically important effects from such small samples. Further research is required into this potentially beneficial treatment before definitive recommendations for practice can be made.
1+	There is no reliable evidence of benefit of using electromagnetic therapy in the treatment of pressure ulcers. The possibility of benefit or harm cannot be ruled out due to the small number of trials with methodological limitations and small numbers of participants.

1++	Overall, while adjunct therapies are increasingly being used in clinical practice, there is currently little good-quality evidence to support their use. **Cost-effectiveness** The effectiveness evidence on which the two economic evaluations were based was moderate to low, primarily due to lack of data. The two studies compare different treatments so it was not appropriate to synthesise the data. The economic evaluation presented by Macario et al. is the stronger of the two studies and it appears that noncontact normothermic wound therapy may be more cost-effective than current standard care. Although the Philbeck et al. (1999) study suggests that negative pressure wound therapy might be a more cost-effective option than saline-soaked gauze dressings applied to patients placed on either a low air loss mattress or a foam mattress bed for grade 3 or 4 pressure ulcers, the internal validity and generalisability of the findings is questionable. One partial economic evaluation compared (TNP) to standard care and found that TNP was more cost-effective.

Recommendations: adjunct therapies

The use of adjunct therapies (electro-therapy technologies and topical negative pressure therapy) for the treatment of pressure ulcers should be based on: **[D]**

- ulcer assessment
- level of risk from holistic assessment
- general skin assessment
- general health status
- previous positive effects of the technology/therapy
- patient preference (lifestyle, abilities and comfort), and
- practitioner's competence.

	Research recommendations
	There is a need for well-designed, adequately powered, multi-centre RCTs to evaluate the contribution of adjunct therapies to the healing of pressure ulcers. Evidence for the relative effectiveness of adjunct therapies compared to other treatment modalities in pressure ulcer management is likely to be provided by trials in which the comparison is an adjunct therapy against a background of standard care (preferably treatments based on the best available evidence), or adjunct therapies compared with sham therapies. Well-designed, multi-centre RCTs evaluating the effectiveness of adjunct therapies on healing rates, healing times, cost, quality of life, pain and comfort, and whether there are optimal regimes for patients with existing pressure ulcers of varying degrees of severity, are thus required.

7. RECOMMENDATIONS FOR RESEARCH

The following research gaps were identified by the GDG. Following NICE requirements, the first five are those that were prioritised by the GDG using a group consensus process, in which every research recommendation was ranked by each group member.

Risk of delayed healing/complications to healing

Well designed, large-scale prospective cohort studies including those with pressure ulcers, and including relevant identified risk factors to show how the identified risk factors lead to more severe ulcers or delayed healing or complications.

Pressure ulcer assessment

Pressure ulcer assessment is a fundamental activity for both evaluating treatment interventions and communicating that information. Research needs to focus on which methods of measurement and which parameters are of use to clinicians to allow accurate wound evaluation.

Support surfaces for pressure support

Independent, well-designed, multi-centre, randomised, controlled trials are needed to compare the clinical and cost-effectiveness of different types of pressure-relieving support surfaces to treat existing pressure ulcers for patients in a variety of settings. In particular, this research should aim to compare, for example:

- different types of high-specification foam mattresses and other constant low-pressure devices, and
- alternating pressure, air fluidised and low air loss devices.

The studies should also evaluate the cost-benefit trade off of pressure ulcer treatment alternatives.

Positioning and repositioning should be investigated in those with existing pressure ulcers to determine:

- the need for repositioning with pressure-relieving devices
- methods of repositioning on different devices with frequency, and
- practitioner time involved in repositioning.

Future research must address the methodological deficiencies associated with much of the research described in the reviews. Particular attention should be paid to:

- description of inclusion and exclusion criteria used to derive the sample from the target population
- evidence of an a priori sample size calculation
- evidence of allocation concealment at randomisation
- description of baseline comparability of treatment groups
- evidence of blinded outcome assessment
- clear description of main interventions
- adequate description of associated care, and
- withdrawals reported by the treatment group with reasons.

Attention should also be paid to:

- true randomisation (with concealed allocation)
- a sample of sufficient size to detect clinically important differences, and clear criteria for measuring outcomes
- blinded interventions and assessment
- adequate follow up
- appropriate statistical analysis
- measuring patient experiences of pressure-relieving equipment
- comfort
- pain
- ease of use (for devices)
- appropriateness for users and settings, and
- durability of equipment.

Antimicrobials/nutrition

The results summarised in this review are based on findings from small trials with methodological problems. Therefore, much of the required research needs replication in larger, well-designed studies using contemporary interventions for antimicrobial activity, and nutritional support/supplementation.

Surgery

Research needs to focus on the effectiveness of different types of surgery, and surgery compared to conventional treatments, in those with pressure ulcers.

Combined Quick Reference Guide

8. AUDIT CRITERIA

The audit criteria below are to assist with implementation of the Guideline recommendations. The criteria presented are considered to be the key criteria associated with the Guideline recommendations. They are suitable for use in primary and secondary care, and for all patients with pressure ulcers.

Caveats for Guideline users

- Objectives for an audit.
- Individuals to be included in an audit.
- Data sources and documentation of audit.

Systems for recording the necessary information, which will provide data sources for audit, should be agreed by trusts.

Whatever method is used for documentation, it should be accessible to all members of the multidisciplinary team.

Documentation of the factors taken into consideration when deciding the most appropriate intervention should occur.

The fact that carers and patients have been informed about pressure ulcers should be documented. Patients and carers should be directly questioned about their satisfaction with, and the adequacy of, the information provided. This should be documented in either the patient's notes or in another source as agreed by the trust.

Trusts should establish a system of recording when staff have been educated in the management of pressure ulcers and should implement a process for reviewing pertinent education needs.

	Criterion	Exception	Definition of terms
1.	The individual's plan of care contains a classification/grade for all pressure ulcers using the European Pressure Ulcer Advisory Panel (EPUAP) classification system.	None	The grade of ulcers should be clearly documented in the plan of care to be available to the inter-disciplinary team. Pressure ulcers should be given a grade of 1-4. Pressure ulcers should not be reverse graded in that a healing grade 4 pressure ulcer should be described as such and not as a grade 3 pressure ulcer.
2.	A pressure ulcer that is identified as a grade 2 or above is documented as a clinical incident.	None	The reporting should follow trust procedure for reporting of clinical incidents.
3.	Individuals with pressure ulcers have their ulcer assessed initially (within six hours) and the assessment is ongoing. The assessment is supported by tracings and or a photograph of the ulcer.	None	The ulcer is assessed for cause, site/location, dimensions, stage/grade, exudates (amount and type), local signs of infection, pain, wound appearance, appearance of surrounding skin, undermining/tracking (sinus or fistula), and odour. Clinical experts are involved as appropriate – e.g. tissue viability nurse.
4.	Individuals with pressure ulcers have access to appropriate pressure-relieving support surfaces or strategies throughout a 24-hour period. This includes all surfaces used by the individual, including mattresses and cushions.	None	Support surfaces include all surfaces used by an individual, which will include mattresses for beds (including theatre trollies), and cushions for chairs and wheelchairs. Strategies include the use of repositioning to minimise prolonged pressure on the body.
5.	Individuals with grade 1-2 pressure ulcers have a high-specification foam mattress/cushion as a minimum and are very closely observed for deteriorations. Individuals have a documented repositioning regime.	Those in whom this is contraindicated. Those with perceived or further deterioration. *Need input from clinician.*	Repositioning is documented in the plan of care.
6.	Individuals with grade 3-4 pressure ulcers have alternating pressure	Those in whom this is contraindicated – i.e due to patient weight	Repositioning is documented in the plan of care.

	overlay or sophisticated low pressure support as a minimum and are closely observed.	or issues of safety. Where a replacement system or alternative support may be indicated.	
7.	Individuals with pressure ulcers have their ulcers dressed with modern wound dressings to create the optimum wound healing environment.	Those individuals in whom these dressings are contraindicated. Patient informed choice.	The dressing should be documented in the plan of care with rationale for its use. Choice of dressings should be based on the ulcer assessment, general skin assessment, treatment objective, risk of adverse events, patient preference, dressing characteristics, and manufacturer's indications for use. Decisions about choice should be made by registered health care professionals. Examples of modern dressings are: hydrocolloids, hydrogels, hydrofibres, foams, films, alginates and soft silicones.

9. DISSEMINATION OF GUIDELINES

The Guideline will be produced in a full and summary format, and a version for the public (*Information for the public*).

Full copies of the Guideline will be available through the NICE website (http://www.nice.org.uk) in PDF format and the summary through the National Electronic Library for Health (NeLH) (http://www.nelh.nhs.uk/) and National Guideline Clearinghouse (http://www.guidelines.gov).

10. VALIDATION

The Guideline has been validated through two stakeholder consultation processes. The first and second drafts were submitted in December 2004 and March 2005 to NICE, who obtained and collated stakeholders' comments for consideration by the GDG.

11. SCHEDULED REVIEW OF GUIDELINE

The process of reviewing the evidence is expected to begin four years after the date of issue of this Guideline. Reviewing may begin earlier than four years if significant evidence that affects the Guideline recommendations is identified sooner. The updated Guideline will be available within two years of the start of the review process.

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The management of pressure ulcers in primary and secondary care

Appendices

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This guideline has been developed by the Royal College of Nursing

Appendix A: Evidence tables for holistic assessment review.

Study	Objective	Design/ Method	Population/Setting	Measurements	Results/Findings	Authors' conclusions
Williams DF et al (2000) USA	To describe the characteristics of patients with pressure ulcers present on admission to the hospital, and predictors of pressure ulcer presence and severity.	Prospective cohort	267 adults admitted to a Pacific Basin military hospital who were expected to stay for more that 24 hours.	Instruments: Braden scale, portable vital sign machine and pulse oximeter. Demographic, physiological and laboratory data were obtained. Medical history and patient acuity were recorded.	12.8% (34) of the 267 had a pressure ulcer. The Braden scale was higher for those without a pressure ulcer (19.7) than for those with (15.9). Pressure ulcer group: Lower albumin levels, total lymphocyte count, haematocrit level, and haemoglobin levels. Significantly longer length of hospital stay and albumin $p < .001$ for ulcer severity.	Poorer nutritional status and decreased oxygen perfusion were predictors of pressure ulcers on admission. Nutrition and length of stay were predictors of ulcer severity.

Reviewer's comments.
Paper was found to be of medium quality.

- Patients are admitted to military hospital and may therefore be a specialised group of patients, and the results may not be generalisable to UK population.
- While the paper reports to some extent on the effectiveness of the Braden Scale to predict patients with ulcers it does not report the significance of the assessment process or data.
- Although factors associated with pressure ulcers ($p<.01$ on univariate analysis) were regressed and odds ratios calculated, they are not reported in this paper and the primary data is not available.

Appendix A: Evidence tables for ulcer assessment review.

Study	Objective	Design/ Method	Population/Setting	Measurements	Results/Findings	Authors' conclusions
Cutler NR et al. (1993) USA	To evaluate and compare various methodologies of measuring the characteristics of pressure ulcers namely area.	Prospective study	20 patients, 17 remained in the study on completion. Long term care facility. California. Inclusion criteria: Male or female with one or more ulcers. Ulcer judged as stage 3 or 4 and approximate size of 2-150cm^2 . Patients with clinical signs of infection in the ulcer, exposed bone or cellulitis were excluded.	• Baseline assessment. Weekly assessment thereafter. • All assessments performed by the same research nurse. • Duplicate measurements, tracings and photographs were obtained at each week. • Direct measurement of the ulcer at the bedside by longest length and longest width. • Depth measured as the deepest point of the ulcer. • All measurements rounded to the nearest millimeter. • Ulcer margins were traced onto a clear plastic bag placed directly over a ruler. • A photograph was taken of each ulcer. 35 mm (Minolta) with a macro lens view included a calibration ruler. • All measurements taken with patient in same position. • Surface area was calculated from ulcer dimensions. • Planimetric measurements were obtained using the tracings. • 3 measurements from each photograph and tracing. • Volume estimated using impression material.	Ulcer size range: 1.2- 61.6cm^2 All measurements detected a significant change in wound size at the week 4 assessment. Significant changes in stratified wound sizes were detected in all four measurements with all methodologies with the exception of photographic area measurement in the 10cm^2 group. Statistically significant change in wound size was detected earlier in <10cm^2 group than >10cm^2 group Wound volume (direct measurements) detected significant wound closure at 4 weeks in both groups (p=.05). Impression material estimations on significant (p=.05) in the >10cm^2 group.	Direct wound measurement, wound tracing and tracing planimetry were the most sensitive methodologies for detecting early changes in wound size.

Reviewer's comments

Paper was found to be of medium quality.

- This is a small study with only n= 17 patients. Interpretation of these results should be made with caution.
- All ulcer assessments were performed by the same research nurse.

Study	Objective	Design/ Method	Population/Setting	Measurements	Results/Findings	Authors' conclusions
Griffin W et al. (1993) USA	To compare test-retest reliability of measurements obtained by the use of a photographic methodology and those obtained by use of transparency methodology, and to compare wound surface area measurements obtained.	Prospective study	20 patients 18 male 2 female. Aged 31 +/- 16 years. Rehabilitation center Memphis. 22 ulcers identified. All pelvic region. Ulcer size 688mm +/- 228mm. Duration of ulcer 13+/- 26 weeks.	3 photographs taken at each assessment using 35mm color Olympus camera. Metric ruler was taped adjacent to the ulcer. Distance between ulcer and camera 29.9-30.5cm. Transparency placed over ulcer. 3 tracings made at each assessment. Tracings generated from both methods were digitalised. • Test- retest reliability obtained measuring 5 ulcers using both methods and repeating assessments after 1 hour. • To compare the 2 methodologies all 22 ulcers were measured on a single occasion. • To compare the 2 methodologies over time 16 ulcers were measured at 5-day intervals for 20 days.	Test-retest reliability obtained measuring 5 ulcers using both methods and repeating assessments after 1 hour. ICC=.99 Comparison of the 2 methodologies all 22 ulcers were measured on a single occasion. PCC=.99 Comparison of the 2 methodologies over time 16 ulcers were measured at 5 day intervals for 20 days. Significant correlation r=.996-.999. p=001	No evidence of superiority found. Methods found to provide equivalent information. Precision of measurements improved using the mean of 3 measurements as opposed to a single measurement.

Reviewer's comments
This study was found to of medium quality.
- Interrater reliability not investigated in this study.
- Location of wounds limited to pelvic area, results may not be representative for wounds in other locations.

Study	Objective	Design/ Method	Population/Setting	Intervention/ Measurements	Results/Findings	Authors' Conclusions
Houghton PE (2000) Canada	To examine the validity and reliability of using photographs of wounds to accurately assess wound status.	Prospective study	13 patients with pressure ulcers and 46 patients with leg and foot ulcers. Ulcers that had extensive tunneling or undermining, were too deep and could not be fully visualized, or were wrapped around the limb or bony prominence, were excluded from the study.	Measurements performed by trained health care professionals including a nurse reactionary, physician and a physical therapist. Photographs taken using an Olympus OM-2 or Nikon FM-2 camera. Photographs were taken in a range of light settings using a macro lens. 15cm rule was place next to wound with clear millimeter divisions. Patient identification was in the field of view. Blinded assessment. All patients received assessment using the pressure ulcer status tool. Six parameters using photographs. ▪ Wound edges ▪ Necrotic tissue – type/amount ▪ Skin colour ▪ Granulation tissue type ▪ Epithelialisation	Reliability Total scores assigned by one trained rater viewing 56 photographs of 13 pressure ulcers on 2 separate occasions ICC =0.96. Intrarater reliability for scores assigned on 2 occasions for 81 photographs of 34 leg ulcers ICC =0.86. Wound size estimates from photographs ICC = 0.96. Interrater reliability for pressure ulcers (from score assigned by several raters that evaluated the same set of photographs) ICC =0.75. Leg ulcers ICC = 0.83 Correlation for same observer for individual domain r .0.75 with exception of skin colour r =0.56. Between raters correlation for six domains r.0.75 with exception of wound edges r =0.68. Concurrent validity PSST & PWAT r =0.70 for PSST and r= 0.66 six domain PWAT. Agreement of surface area calcs from PWAT and wound tracings PSST ICC = 0.87.	Using the photographic wound assessment tool to assess the wound appearance provided interrater and intrarater reliability score considered to be excellent ICC>0.75. This was using the PSST as a reference standard which had ICC scores of 0.99 and 0.91 respectively in reported studies. Intrarater reliability was higher for pressure ulcers than other wounds within study.
Reviewer's comments This study was found to be of medium quality. Reference standard used is PSST, not a generally accepted standard. PSST designed for pressure ulcers, which may reflect positive results for pressure ulcers than other wounds within study.						

Study	Objective	Design/ Method	Population/Setting	Intervention/ Measurements	Results/Findings	Authors' conclusions
Shubert V (1997) Sweden.	To evaluate pressure ulcer surface area using four different methods of measurement.	Not clear	Division of geriatric medicine, University Hospital Huddinge, Sweden.	1. Direct measurement with digital planimeter 2. Measurement of length and width with millimeter ruler 3. Number of whole squares of 0.25cm^2 within the outline. 4. Number of squares whole(N) and partial (N_c) 0.25cm^2 within the outline. 5. Estimate the effective number of squares of 0.25cm^2 within the tracing. Planimeter was used as a reference standard.	373 different pressure ulcers Length/ width significantly higher 31%, p ,0.001 compared with reference standard. Largest error being +21.5cm^2 Counting number of whole squares significantly lower value –13%, p ,0.001 compared with reference standard. Largest error-7.3cm^2. Counting number of whole and partial squares inside the boundary line. Deviation much smaller than methods 2 & 3. +1% according to the formula (N + 0.50xN_c)x 0.25cm^2. After regression analysis the above formula was amended to (N + 0.45 xN_c)x 0.25cm^2 to give a more accurate estimate as each partial square was found to equal 0.45 cm^2 as opposed to the assumed 0.50cm^2.	Counting the number of whole squares (N0 and partial squares (Nc) within the tracing area gives the best estimate of wound size and can be easily used at the bedside.
Reviewer's comments This study was found to medium quality. Although 373 different ulcers assessed, no indication of number of participants. Study design not clear.						

Study	Objective	Design/Method	Population/Setting	Intervention/ Measurements	Results/Findings	Authors' conclusions
Plassmann P and Jones TD (1998) UK	Compare the performance of the MAVIS instrument to measure area and volume with three traditional wound measurement techniques.	Controlled trial.	50 patients Excluded patients: those with painful ulcers, undermining, extremely flexible and small ulcers, and very large ulcers.	MAVIS is based on colour coded structure light and is recorded by a camera. Measures area and volume. Measurement of length of wound using ruler, area using transparency tracing and alginate for wound volume. Plastercast made of several wound types and each measured 20 times using each technique to establish precision.	MAVIS gave overall better results than those of the other three methods.	MAVIS gave overall better results than those of the other three methods.
Reviewer's comments This study was found to be of medium quality. Few details of population. Results presented in graphical format as a percentage SD of the respective dimensions without clear precise axis.						

Table of included studies:

Study	Methods	Participants	Interventions	Outcome measures	Notes
Della Marchina (1997)	RCT. Method of allocation not stated. Trial duration: 15 days. Setting not noted, Italy.	Patients aged > 64 years with diabetic foot ulcers, venous leg ulcers or pressure ulcers. Wounds had to be classified as first or second degree (not defined). Excluded patients sensitive to test medication or receiving other treatment.	Intv (n=20): wounds were cleaned with normal saline and dried with gauze. 2% eosin and 0.3% chloroxylenol in hydroglycolic solution antiseptic spray was applied to the wound surface using gauze. The wound was then covered with gauze and changed 2-3 times/day. No details of co-interventions (e.g. pressure relief) given. During study period, treatment with other antiseptics, antibiotics, analgesics, antinflammatory or absorbing agents was discontinued. Ctrl (n=20): as intervention group, except an alternative spray (not described) was used.	Healing progress, assessed at 5, 10, 15 days. Wound gradings: 0 = <25% healed relative to baseline; 1 = 25-50% healed relative to baseline; 2 = > 50% relative to baseline; 3 = complete healing. No information about methods of measurement, or number of assessors involved.	Blinding procedures unclear. No power calcs reported.

Study	Methods	Participants	Interventions	Outcome measures	Notes
Gerding (1992)	Double blinded RCT. Random allocation lists used (unclear whether open or closed). Follow up at 28 days or until lesion resolution.	Geriatric residents of long-term care facilities (USA) with one or more newly diagnosed stage 1 or 2 pressure ulcers. Stage 1: area of erythema that persists for >30 mins after pressure relief, no skin breakdown, area does not blanch or fade. Stage 2: area of superficial breakdown involving epidermis and/or dermis, appears as an abrasion, blister or shallow crater.	Intv (n=55?): area washed with soap and water, DermaMend (oxyquinoline ointment) applied 3 times per day or whenever area cleansed. Ctrl (n=47?): area washed with soap and water, A&D ointment (a standard emollient) applied, 3 times per day or whenever area cleansed. No details re extent of ointment application, type of dressing or use of pressure-relieving support surfaces.	Complete healing, improvement, no change or worse. Lesions assessed daily by blinded assessor. Healing evaluated on basis of change in lesion size, intensity and extent of surrounding erythema, presence or absence of drainage or granulation. Time to complete healing. Nurses' preferences for two treatments (unblinded).	Approx. twice as many patients allocated to intervention than to control, not known if this was intentional. No details of withdrawals. No power calcs. Unit of allocation was patients, unit of analysis was lesions. Numbers allocated to each group unclear as possible overlap because some patients had both stage 1 and 2 lesions. No intention-to-treat analysis.

Study	Methods	Participants	Interventions	Outcome measures	Notes
Huchon (1992)	Multicentre, open RCT. Method of random allocation not stated. Study setting: France, six centres (1 surgical, 2 functional rehab, 3 elderly care). Trial duration 56 days or until healing.	Patients with pressure ulcers which were graded, after debridement, as either stage 2 (loss of epidermal tissue) or stage 3 (slough, or slough with loss of substance). Exclusions: diabetes, corticosteroid treatment. Mean age 81 years. Mean Norton score 14.1 and 13.8 for Intv and Ctrl groups respectively. Predominantly heel pressure ulcers.	Intv (n=38): lesions cleaned with saline, debrided with forceps if necessary, then hydrocolloid dressing applied (Granuflex, ConvaTec). No antiseptics used. Dressings changed weekly or more often in cases of excessive gel leak. Ctrl (n=38): cleaned as in intervention group, then dressed with gauze impregnated with povidone iodine ointment. Dressings changed daily or every other day.	Clinical assessment classified into 4 stages: 1 = healing or re-epithelialisation of wound area; 2 = improvement (reduction in wound area or ongoing granulation); 3 = no change; 4 = deterioration. Wound surface area (tracing onto acetate and photography).	No power calcs. Stated that baseline characteristics comparable but data not given. Withdrawals not reported.

Study	Methods	Participants	Interventions	Outcome measures	Notes
Toba (1997)	Single centre RCT with 14-week follow-up period. Study setting: inpatients, Japan. Random number tables used to generate sequence. Unit of allocation was pressure ulcers.	Elderly women who had suffered a stroke, with pressure areas contaminated with MRSA during the month preceding the trial. Exclusions: diabetes, malignant tumour, respiratory disease, liver or kidney disease, prostaglandin, anticoagulant or steroid therapy. Mean age 83.5 years. Stated similar prevalence of underlying disease and nutritional status, but no data given. Baseline pressure ulcer area: Intv 25.4 +/- 8.1 cm sq, Ctrl 12.8 +/- 4.2 cm sq.	Intv (n=8 pressure ulcers): ointment containing gentian violet 0.1% was blended with cAMP ointment in equal amounts, to produce preparation called GVcAMP, enough applied to cover pressure ulcer, every day. Ctrl (n=11 pressure ulcers): povidone iodine (concentration not stated) and sugar ointment applied to pressure ulcers every day. Both groups: other dressings and use of pressure-relieving support surfaces not described.	Change in wound area assessed fortnightly using photography; method for calculating percentage change in area relative to baseline not reported. Eradication of MRSA, assessed fortnightly using wound surface cultures.	No power calcs. No details of withdrawals or blinding measures used reported.

Study	Methods	Participants	Interventions	Outcome measures	Notes
Worsley (1991)	RCT. Method of allocation not stated. Trial duration: 12 weeks. Setting not noted, UK.	Patients with leg ulcers or pressure ulcers. Mean age 75 years (intv), 80 years (ctrl).	Intv (n=6): hydrocolloid dressing applied (Comfeel, Coloplast); no other details given. Ctrl (n=8): wounds covered with povidone iodine ointment, followed by non-adhering dressing and gauze.	Change in ulcer area (calculated using computerised photographic techniques).	No reporting of power calcs or blinding procedures. Large (56%) drop-out rate from study overall, unknown number of withdrawals from pressure ulcer patients.

Table of included studies: adjunct therapies

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Topical negative pressure (TNP)		**Placebo / standard care**						
Joseph (2000) Setting and length of treatment: hospital, nursing home or home patients with chronic wounds (associated with pressure, dehiscence, trauma, venous stasis or radiation); follow up at 3 and 6 weeks.	TNP (open cell foam dressing with continuous suction (125 mm Hg) changed every 48hours) (18 wounds). Standard care: both groups had necrotic tissue/debris mechanically debrided within 48 hours of initiation of therapy; both groups received standard nutritional supplements including zinc and a multivitamin; and a pressure-relieving surface.	Normal saline wet-to-moist gauze dressings with occlusive covering used to secure gauze changed 3x daily (18 wounds).	24 pts 36 ulcers	Inclusion criteria: any patient with an open wound that had failed to close or show signs of healing within 4 weeks or greater. Exclusion criteria: infection (urinary tract, pneumonia, wound infection); albumin <3.0g/dl; renal, pulmonary or other chronic disease requiring ongoing therapy for stabilisation; uncontrolled diabetes mellitus, thyroid disease or hypertension; systemic steroids, other immunosppressive therapy or anticoagulants; pregnant or breast feeding; osteomyelitis (determined by bone biopsy); considered	It is not clear how many patients in each arm had multiple wounds. There were no statistically significant differences with regard to age (56 vs 49), and the proportion of males (66% vs 44%). Initial wound volumes were different in the two groups (38cc in TNP group vs 24cc in control group). The authors reported that the two groups were comparable at baseline for ethnicity, smoking status and wound duration.	Primary: % change in wound volume over time (using volume displacement of alginate impression molds) 78% reduction with TNP vs 30% reduction with saline gauze dressings at 6 weeks (p=0.038). It was not clear whether mean or median values were provided. No standard deviations or ranges were provided to go with these figures. No confidence intervals were provided. The authors stated that follow up beyond the 6-week study period was	Files marked with silver or black labels on the inside panel were randomly organised in a locked cabinet. A file was randomly picked for each wound with the treatment determined by label colour. It is not clear if these files were sealed so the adequacy of allocation concealment is unclear. Neither the patient nor provider were	Partially funded with a grant from KCI, San Antonio, Texas. No a priori sample size calculation evident. The authors appeared to randomise and analyse multiple wounds as if they were independent from each other which is inappropriate when using a between patients design. It was not reported if there were any withdrawals. It was not made explicit whether intention-to-treat analysis was used. The alternative hypothesis was one tailed, so presumably so

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				uncooperative or unsuitable candidates for participating in dressing changes by investigators; malignant/neoplastic diseases in wound margin; fistulas (rectal, stomal or urethral fistulas to the wound).		done until complete wound closure was demonstrated for each patient - all were offered operative wound closure for any remaining open wounds. This time to complete healing data was not reported.	blind to the treatment used but outcome assessors were.	were the statistical tests. The author was contacted for missing information but no reply was received.
Theraputic ultrasound		**Placebo / standard care**						
McDiarmid (1985)	3 MHz of ultrasound for a minimum of five minutes for all pressure ulcers up to 3cm2. One additional minute was added for each additional 0.5cm2, up to a max of 10 minutes. Delivered 3x weekly.	Placebo ultrasound using same machine but no pulse. Same treatment frequency.	40	Patients with pressure ulcers limited to superficial tissues	*Awaiting original paper to assess*	Number of ulcers healed 1. 10/21 (48%) 2. 8/19 (42%) Not significant	Allocation concealment unclear. Method of randomisation described as "random allocation". No a priori sample size calcs. Blinding of treatment allocation.	
Nussbaum (1994) Setting and length of treatment: hospitalised spinal cord patients; treatment	1. Laser (800 cluster probe) 820nm laser diode 2. Ultrasound/ ultraviolet treatment alternated for 5 days a week	Standard wound care (cleansing with Hygeol (1:20), Jelonet dressing and avoidance of pressure on the area)	20 pts 18 ulcers	Patients with a diagnosis of spinal cord injury and skin wound	Some baseline data reported including age: mean 42 years (gp 1), 42 years (gp 2), 36 years (control gp); baseline wound area, depth, duration and aetiology reported. These differences reported as not	Number of ulcers healed at 12 weeks 1. 4/6 (66%) 2. 6/6 (100%) 3. 5/6 (83%) Significant difference between 1 and 2, p=0.032 Otherwise no	Allocation concealment unclear. Method of randomisation reported as "randomly assigned", no other details. No *a priori*	20 patients randomised (laser n=6, US/UV n=5, control n=9). 4 withdrawals: laser n=1 (transfer), US/UV n=0, control n=3 (1 transfer, 3 surgical repair of wound).

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
continued until wound healed. ter Riet (1995) Setting and length of treatment: nursing home patients; treatment for 12 weeks or until healing had occurred.	Ultrasound of frequency 3.28 MHz, pulse duration 2ms, pulse repetition frequency 100Hz, spatial average temporal average intensity 0.10 W/cm2, beam non uniformity ratio *4 effective radiating area 4cm2, given 5 times per week.	Detuned (sham) ultrasound 5 x week. All patients received standard nursing care including water beds, repositioning, wound care.	88	Patients with stage 2 pressure ulcers.	significant. Limited reporting of baseline characteristics. Noted that prognostic baseline covariates grouped in cogent clusters and used in the analysis to control for confounders.	significant difference. Number of ulcers healed at 12 weeks 1. 18/45 (40%) 2. 19/43 (44%) p=0.61	sample size calcs. Blinded outcome assessment. Adequate allocation concealment: ultrasound support surfaces had 20 codes randomly divided over two treatment groups. Randomisation was blocked and stratified. No *a priori* sample size calcs. Blinding of patients, clinicians and outcome assessors.	11 withdrawals (not reported by treatment group). Noted sensitivity analysis where trend of each drop out was extrapolated using the same group trend, and deletion (i.e. omitting such patients from the analysis), and found no difference in results.
Electrotherapy		**Placebo / standard care**						
Gentzkow (1991) Setting and length of treatment: length of treatment 4	Negative polarity until wound debrided and serosanguinous drainage appeared) then polarity alternated every 3 days. 128	Sham stimulation (n=24) Both groups: 100% received wound cleansing with normal saline and dressing, 10%	49	Inclusion criteria: stage 2, 3, or 4 pressure ulcer	Reported ulcers in the intervention group were larger at baseline.	After four weeks there was a mean percentage ulcer healing of 49.8% (SD 30.9) in the electrotherapy group and a 23.4% (SD 47.4) mean	Method of randomisation not stated. Double-blind. Adequate allocation concealment. *A priori* sample	

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
weeks.	pps, 35 mA, 0.89 coulombs per 30 min treatment. 2x daily for 4 weeks. When ulcer healed to stage 2, treatment at 64pps and polarity changed daily (n=25)	surgical or whirlpool debridement, 100% turning to relieve pressure, 55% bed rest and elevation of an extremity.				percentage ulcer healing in the sham group (p=0.042).	size calcs stated.	
Griffin (1991) Setting and length of treatment: 20 days.	Ultrasound at frequency 100pps, 200V, negative polarity, 1 hour day x 20 consecutive days (n=8). Plus routine dressings. Pressure ulcer cleansed using Cara-Klenz application of Carrington gel and a dry dressing. Mechanically debrided as necessary.	Sham stimulation plus routine dressing as above (n=9). All patients received two-hourly turning. No change of mattress during the study	17	Inclusion criteria: male, SCI, pressure ulcer grade 2-4 of Delisa system on sacral/coccygeal or gluteal/ischial region. Exclusion criteria: severe cardiac disease, cardiac arrhythmia, uncontrolled autonomic dysreflexia, cardiac pacemaker.	Mean ulcer size at day 0 (mm2) (range) I: 234.1 (126-1027) C: 271.8 (41-4067)	3/8 (37.5%) ulcers healed in the electrotherapy group compared with 2/9 (22%) in the control group (RR 1.69, 95% CI 0.37-7.67)	Method of randomisation not stated but stratified by grade of ulcer and smoking status. Adequate allocation concealment. No *a priori* sample size calcs. No blinding.	
Wood (1993) Setting and length of treatment:	Pulsed, low intensity direct current of 600 mA, pulse frequency 0.8Hz. 3 applications around each ulcer, alternate days 3x weekly. Larger ulcers had one or	Sham PLIDC, plus standard treatment, wound cleansing, simple moist dressing, whirlpool baths. No hydrocolloids, films or foam dressings were used (n=30 patients, 31 ulcers)	71 pts 74 ulcers	Inclusion criteria: stage 2 or 3 chronic pressure ulcers showing no improvement with standard nursing care over preceding 5 weeks. Exclusion criteria: patients receiving steroids, or other drugs	Mean ulcer area (cm2) I: 2.61 C: 1.91 p<0.05	25/ 43 (58%) electrotherapy group ulcers healed, compared to only 1/31 (3%) in the sham therapy group (RR 18.02, 95% CI 2.58-126.01)	Method of randomisation not stated. Double blind. Adequate allocation concealment. No *a priori* sample size calcs.	

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
	more additional placements of electrodes plus standard treatment (n=41 patients, 43 ulcers).			that influence wound healing.				
Ritz (2002) Setting and length of treatment: high-risk patients, setting not stated. Treatment was for 12 weeks or until ulcer closure or until discharge home, whichever occurred first.	Provant wound closure system (uses radiofrequency stimuli to induce fibroblast and epithelial cell proliferation), active, twice daily plus standard care, n=16.	Sham stimulation: standard care plus twice daily treatment with a Provant support surface transparently modified so that no treatment was given, n=18.	49	Inclusion criteria: stage 2 or 3 pressure ulcers, ≥18 years age. Exclusion criteria: change in Norton Risk Assessment score ≥7 within 30 days, osteomyelitis, immune dysfunction or repeated systemic infection, cancer, concurrent treatment with other wound-healing support surfaces (e.g. hyperbaric oxygenation, electrical stimulation).	?Mean wound area (cm2): Stage 2 ulcers: I: 3.0 C: 4.4 Stage 3 ulcers: I: 11.3 C: 4.4 ?Mean age (years): Stage 2 ulcers: I: 72 C: 69 Stage 3 ulcers: I: 75 C: 63	Wound closure at 6 weeks for stage 2 ulcers: I: 8/8 C: 4/11 Wound closure at 12 weeks for stage 3 ulcers: I: 4/8 C: 1/7 ?Mean (SD?) wound closure rates, stage 2 ulcers (cm2/day): I: 1.192 (0.20), n=8 C: 0.68 (0.17), n=11 ?Mean (SD?) wound closure rates, stage 3 ulcers (cm2/day): I: 1.29 (0.41), n=8 C: 0.36 (0.22), n=7 Not stated how measurements were assessed.	No *a priori* sample size calcs. Blinded outcome assessment. Randomisation procedure not stated.	No reporting of withdrawals.
Electromagnetic therapy		**Placebo / standard care**						

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Comorosan (1993) Setting and length of treatment:	1. Diapulse - local application - frequency 600pps, peak power 6 (117V, 27.12 MHz), for 30 minutes 2x daily. Hepatic application - 400 pps, peak power 4 (117V, 27.12 MHz), 20 minutes 1x daily, following initial treatment (n=20) 2. Conventional therapy - H2O2 cleansing, application of talcum powder, methylene blue in solution, tetracycline ointment, plus sham Diapulse (n=5)	Conventional therapy (n=5) No report of concurrent pressure relief.	30	Patients on an elderly care unit with either one grade two or grade three pressure ulcer. Grading system not defined.	Some elements reported. Patients were not matched at baseline for ulcer size. No report on patients' mobility status.	Number of ulcers healed at 2 weeks I1: 17/20 I2: 0/5 C: 0/5	Allocation concealment unclear. No *a priori* sample size calcs. Blinded outcome assessment. Randomisation procedure not stated.	
Salzberg (1995) Setting and length of treatment: 12 weeks	Electromagnetic therapy 27.12MHz, pulse repetition 80-600 pps, pulse width 65 microseconds, per pulse power range of 293 & 975 watts - delivered through wound dressing, 30 minutes treatment 2 x daily	Sham treatment as above (n=15) All ulcers dressed with moist saline gauze. No report of concurrent pressure relief.	30	Male inpatients with spinal cord compression and a grade 2 or grade 3 pressure ulcer. Grading defined by authors.	Reported that patients were not matched at baseline for ulcer size.	Number of grade 3 pressure ulcers healed at 12 weeks: I: 3/5 C: 0/5 Grade 2 pressure ulcers I: median of 84% healing C: median 40% healing	Adequate allocation concealment. No *a priori* sample size calcs. Blinded outcome assessment. Randomisation procedure unclear.	

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
	for 12 weeks (n=15)							

Table of included studies: support surfaces

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Allman (1987)	Surgical patients aged 18 or over with pressure ulcers. Patients expected to be limited to bed/chair and in hospital for a minimum of 1 week. Groups appear well matched at baseline including for baseline ulcer area.	1. Air-fluidised therapy (CLINITRON) (n=31) repositioned every 4 hours. 2. Conventional treatment (including two-hourly turns, heel and elbow protectors, alternating pressure mattresses) (n=34)	Mean 13 days (range 4-77)	Median change in total surface area of ulcers: 1. -1.20 2. 0.50 Proportion of patients improved: 1. 22/31 2. 16/34	A priori sample size calculation. 90% follow up. 4 patients withdrew because of difficulty transferring in and out of the air-fluidised bed.
Caley (1994)	Acute care patients with existing pressure ulcers and for whom an enterostomal therapy nurse had recommended low air loss therapy. 60% of participants were female; aged 42-98 (mean 76); average LOS 23.9 days; 87% Caucasian; average Norton Score of 10. Baseline ulcer areas *not* presented.	1. Low air loss bed (Monarch, Mediscus) (n=23) 2. Low air loss overlay (SPR Plus, Gaymar) (n=32)	Mean 24 days.	Median change in ulcer area measured by multiplying ulcer length by ulcer width: 1. 2.4 mm^2/day 2. 4.9 mm^2/day	Very little data provided; (median change in area and range). Unclear (and unlikely) that outcome assessment was blind to treatment group. No description of co-interventions except that routine skin care protocol applied to both groups. N.B. only 55/93 (59%) of patients randomised completed the study, reasons for which are not completely clear except that those discharged before the 3rd week of the study were not included in analysis (ie. those who improved quickest).
Clark (1999)	33 patients in elderly care wards within acute care hospitals, and nursing homes. Age >65 yrs. Established pressure ulcers over sacrum or ischial tuberosities. Moderate-high risk of developing further ulcers. Groups well matched for pressure ulcer risk status, mobility, nutritional status, continence at baseline.	1. 4 cell alternating air pressure cushion (Pro-active 2, Pegasus Airwave Ltd) (n=14). 2. Static air-filled dry flotation cushion (ROHO, Quadtro, Raymar Ltd) (n=11). All patients had an alternating pressure system (Pegasus Airwave) on their bed.	Not defined: "until ulcers healed": 1. Mean 58.6 days 2. Mean 43.7 days	Results reported for only 25 patients with final outcomes. Ulcers healed: 1. 3/14 (21.4%) 2. 5/11 (45.5%) Superficial ulcers: mean (SD) rate of change in surface area - cm sq / day: 1. 0.13 (0.37) 2. 0.27 (0.56) Deep ulcers: mean (SD) rate of change in volume - cm cubed / day: 1. 0.56 (0.86) 2. 0.49 (0.86)	No statistically significant differences found, but small sample size precludes ability to draw definitive results. 24% attrition; no intention-to-treat analysis.

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Day (1993)	Hospitalised, adult patients with existing stage 2-4 pressure ulcers.	1. Air suspension bed (Therapulse, Kinetic concepts). N=44. 2. Foam mattress overlay (Geomatt, SpanAmerica). N=33. Wound care standardised for two groups.	Minimum 7 days	Mean ulcer size (SD) Stage 2 (initial - end): 1. 12.7(3.2) - 7.3(3.2) 2. 10.0(3.9) - 5.3(2.1) Stage 3/4 (initial / end): 1. 51.8(11.9) - 37.1(8.1) 2. 13.7(2.9) -12.4(3.5) Mean comfort scores (SD): 1. 4.1 (1.3) 2. 3.7 (1.3)	No p values given, but all analyses reported as not statistically significantly different. Comfort score results only completed by half the subjects (Gp 1 n=20, Gp 2, n=21).
Devine (1995)	Elderly patients in hospital admitted with ulcers of grade 2 or above. Mean age 82.5 years (69-98 yrs). More people incontinent of urine in Nimbus group; more people catheterised in Airwave group.	1. Nimbus I alternating pressure mattress (n=22) Modular with rows of figure of 8 shaped cells. Two sets of cells are inflated and deflated over 10-minute cycle. 2. Pegasus Airwave alternating pressure mattress (n=19) Double layer mattress with a 3-cell alternating cycle lasting 7.5 mins. All patients were subject to the standard hospital protocol for wound dressings; details of this are not provided.	4 weeks	Complete healing at 4 weeks: 1. 10/16 2. 5/14 Median rate of reduction in ulcer area: 1. 11cm^2/day 2. 8 cm^2/day	Allocation by random number list kept separate from trial coordinator. Withdrawal rates by group and reasons for withdrawal stated. 11 patients (24%) died or moved to other hospitals.

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Evans (2000)	12 hospital and 20 nursing patients, ≥65 years with either grade 3 or 4 ulcer, or grade 2 ulcer and one or more of the following: difficult to reposition in bed, unable to tolerate 30 degree tilt, unable to move in bed, in bed for >20hr/24hr, ≥108kg and bed bound, undergone spinal anaesthetic.	1. NIMBUS 3 alternating pressure mattress replacement system (n=17) 2. APMRS for hospital patients or alternating pressure mattress overlay for nursing home patients (n=15). Turning and wound care standardised for two groups.	2 weeks. Wound surface area (WSA) was calculated twice-weekly by planimetry.	Median (range) absolute reduction in WSA /day: *Hospital subjects*: 1. 0.12 cm^2 (0-0.21) 2. 0.08 cm^2 (0.04-0.33) *Nursing home subjects*: 1. 0.11 cm^2 (0.04-0.41) 2. 0.05 cm^2 (0-0.48) Median (range) relative reduction in WSA/day: *Hospital subjects*: 1. 2.44% (0-7.14) 2. 1.34% (1.11-2.88) *Nursing home subjects*: 1. 1.57% (0.45-5.00) 2. 0.99% (0-2.54) Median comfort scores: *Hospital patients*: 1. 5 (very comfortable) 2. 4 (comfortable) *Nursing home patients*: 1. 5 (very comfortable) 2. 4 (comfortable)	All measures of wound surface area showed no statistically significant differences. The NIMBUS 3 patients had statistically significantly higher comfort scores. Small study sample size means that differences in clinical effectiveness cannot be demonstrated. Large proportion of patients did not complete follow-up (11/20 in nursing home group, 75% on hospital group). But intention-to-treat analysis was undertaken.
Ewing (1964)	Elderly patients, average age 72.5 years, confined to bed, with reduced mobility in the legs due to neurological disorder, or fixed joints, peripheral vascular disease. No baseline data given and baseline comparability not described.	1. Sheepskin under both legs (n=18) 2. No sheepskin (n=18) Both groups received 4-hourly washing, drying, powdering of the skin, light massage of pressure points, bed cradle.	6 months.	Relief of redness and pressure ulcer healing: 1. 14/18 2. 0/18	Mode of allocation unclear - stated as random selection. Poorly designed and reported study.

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Ferrell (1993)	Elderly nursing home residents with multiple medical problems, and with trunk or trochanter pressure ulcers (Shea stage 2 or greater). Where patient had multiple ulcers, larger ulcer chosen as index ulcer. Patients excluded if expected to survive less than 1 month; if they had already participated in the study; if surgery to the ulcer was planned. Groups appear well matched at baseline including for ulcer area; exception is patients in LAL Bed group had significantly lower serum albumin.	1. Low air loss bed (KINAIR) (n=43) 2. 10cm convoluted foam overlay on top of standard foam mattress (n=41) Both groups similar co-interventions as per standard care – ie. mobilisation as much as possible; 2-hourly turning during waking hours; avoidance of head-of-bed elevation; avoidance of dragging patients on sheets; nutritional support; infection control.	33-40 days	Wound surface area was traced 2x per week on plastic film and area measured using planimetry. Ulcers completely healed (covered with epithelium): 1. 26/43 (60%) 2. 19/41 (46%) Median (IQR) decrease in ulcer area (mm^2/day): 1. 9.0 (4.0-19.8) 2. 2.5 (0.5-6.5)	Randomisation in blocks of 10; 5 to each treatment. Assignments were sealed in individual envelopes and opened sequentially. A priori sample size calculation; study terminated at interim analysis as difference much larger than expected. Not clear how many randomised therefore, while numbers and reasons for withdrawal are listed, it is impossible to calculate attrition rates.
Keogh (2001)	Patients from two surgical and two medical wards who were: >18 years; Waterlow score of 15-25; tissue damage no greater than grade 1.	1. Profiling bed with a pressure-reducing foam mattress/cushion (n=50) 2. Flat-based bed with a pressure-relieving/redistributing mattress/cushion (n=50)	5-10 days	Healing of existing grade 1 ulcers 1. 4/4 2. 2/10	The extent of follow-up difficult to ascertain. No difference between the groups in terms of transferring in and out of bed.
Groen (1999)	Nursing home patients, ≥60 yrs with pressure ulcer on trunk of grade 3I (superficial cutaneous or subcutaneous necrotic) or grade 4 (deep subcutaneous necrotic).	1. Foam replacement mattress: 3 layers polyurethane foam designed to be a comfort, load-distributing and support layer. N=60 2. Secutex water mattress: placed on top standard hospital mattress, 3 PVC sections holding 26 litres water each, with heating element. N=60. Standard turning protocol (every 2-3 hours) for both groups.	4 weeks	Patients with healed ulcers at 4 weeks: 1. 45% 2. 48% Mean pressure ulcer severity score at 4 weeks (SD not given): 1. 1.1 2. 1.7 Ulcers reported to have improved at the same rate in each group. No significant differences at four weeks reported for pain, maceration or eczema.	Authors noted that water mattresses are heavy and difficult to transport, are potentially unhygienic and may induce hypothermia. Withdrawals: 11 from Group 1, 8 from Group 2, but not stated at which timepoints withdrawals occurred. Reasons for withdrawals included severe illness and discharge. No intention-to-treat analysis

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Mulder (1994)	49 nursing home patients with stage 3-4 pressure ulcers. Single centre trial.	1. Air suspension bed (Therapulse, Kinetic concepts): a pulsating air suspension therapy (cushions alternatively inflate and deflate but classed as LAL rather than AP). N=31. 2. Convoluted foam mattress overlay (Geomatt, SpanAmerica). N=18. Wound care and repositioning standardised for two groups.	Maximum 12 weeks or until ulcers healed, whichever first.	Wound closure: 1. 5/31 (16.1%) if intention-to-treat analysis undertaken 2. 3/18 (16.6%) Pressure ulcer improvement (by stage 1 or more, including healed completely): 1. 15/31 (48%) 2. 8/18 (44%)	Wound surface area assessed by photoplanimetry. Ulcer volume = ulcer length x width x depth (of deepest ulcer point). No intention-to-treat analysis. Enrolled 49: 10 dropped from study (no reasons given), 8 died, 1 lost to follow up, 1 dropped due to protocol violation. No information from which groups withdrawals came from. No explanation of why stated 1:1 randomisation ratio resulted in such disproportionate groups.
Munro (1989)	40 male patients, mean age 67.2 yrs, from Veterans' Administration Medical Center, with grade 2-3 pressure ulcers.	1. Air-fluidised bed (Clinitron). N=20. 2. Standard bed plus usual nursing measures such as sheepskin or gel pads placed beneath pressure ulcers. N=20.	15 days	Average ulcer diameter at day 15: 1. 1158mm^2 (from baseline average of 2660mm^2) 2. 2051mm^2 (from baseline average of 1464mm^2) i.e. mean size of ulcers shrank over time in the Clinitron group and expanded over time in the standard care group. Mean patient satisfaction score (n=18 only): 1. 57.5 (SD 6.1), n=8 2. 48.6 (SD 12.3), n=10 p=0.067 Final ulcer area as % of baseline area: 1. 44% 2. 140% Mean (SD) nursing time (minutes per 8 hour shift): 1. 95 (48) 2. 75 (35)	No statistically significant difference in patient pain perception, nursing time. No economic evaluation undertaken. Assessed cost of supplies used to treat ulcers (significantly less in Clinitron group) but no cost-benefit analysis that included cost of beds themselves or bed-related supplies or maintenance costs. Methods of randomisation and allocation concealment not stated.

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Russell (2000)	141 patients from care of the elderly units with pressure ulcer of ≥grade 2. Enrolled over 18 months during 1997-8. Average age 83.9 and 84.6 years in the two groups. N.B. Patients excluded if randomised equipment unavailable (not stated how often this occurred).	Two types of alternating cell mattress systems with pressure-relieving cushions: 1. Huntleigh Numbus 3 with Aura cushion and 4 hourly turning. N=70. 2. Pegasus Cairwave Therapy System with Proactive 2 seating cushion and 8 hourly turning. N=71.	18 months. Unclear re length of the intervention period.	Ulcer healing - any type: 1. 65/71 (91%) 2. 65/70 (93%) Sacral ulcer healed: 1. 32/71 (45%) 2. 36/70 (51%) Heel ulcer healing (at 12 months, N=86: 1. 13/40 (33%) 2. 26/46 (57%) p=0.025 Heel ulcers (at 18 months, N=113: 1. 19/58 (33%) 2. 30/55 (55%) p=0.019	No differential difference in losses to follow up between the groups: 13/70 in Gp1, 16/71 in Gp 2. Denominators listed in Table 2 of results (Gp 1:71, Gp 2: 70) appear different from abstract (Gp 1: 70, Gp 2: 71). Insufficient information on outcome measurements. Ulcer healing was recorded by weekly camera and nurse gradings - called 'improvement factor'. No information on randomisation processes or allocation concealment. No control group used.
Russell (2003)	158 patients with grade 1 or 2 pressure ulcers admitted to hospital between April 2001 and April 2002. Mean age 80 years. Baseline Waterlow scores 21.8 and 21.3 in each group. Baseline Burton scores 14.6 and 14.2 in each group. Excluded patients previously enrolled in the trial, obese patients (>25 stone), those with ≥ grade 3 ulcers. Patients well matched at baseline.	1. Nimbus 3 alternating pressure, multicell mattress with 10 minute cycle time (n=83). 2. RIK static, fluid overlay mattress (n=75). All patients had standard 4 hourly re-positioning, but could have additional turning at the patient's request. The effect of this co-intervention on treatment effect is unclear.	Unclear, presumably until discharge from enrolment hospital.	Improved ulcer response - overall 1. 60/83 (72.3%) 2. 56/75 (74.750 p=0.67 Improved ulcer response - worst ulcer 1. 63/83 (75.9%) 2. 63/75 (84.0%) p=0.053 Length of stay 1. 22.17 days 2. 20.05 days p=0.23	Robust randomisation and allocation concealment methods. Power calcs stated. No blinding of treatment allocation to patients or clinicians described. Blinded photographic assessment of ulcer grading was carried out. Enrolled 199 patients, excluded 41 from analysis as discharged before more than one outcome assessment could be made. No information re reliability, specificity or sensitivity for identification and/or classification of ulcers.

Study	Patients	Support surfaces (sample size)	Follow-up period	Healing of established ulcers	Notes
Strauss (1991)	People with at least one grade 3 or 4 pressure ulcer (Shea classification); who would probably require future hospitalisation for the pressure ulcer; who had severely limited mobility; for whom home air-fluidised therapy was a practical option; likely to comply; live at least one year; aged 16 or over. N.B. While baseline data were presented by group for many variables, baseline ulcer area was not presented or discussed.	1. Home air-fluidised therapy (CLINITRON) when grade 3 or 4 ulcers present plus the consultative and technical services of a visiting nurse specialist (n=47) 2. Conventional or standard therapy, patient specific and as prescribed (n=50) but included alternating pressure pads, air-filled mattresses, water-filled mattresses, high-density foam pads.	36 weeks	Pressure ulcers classified by blinded observers as improved; unchanged; worse; or not assessable. Proportion of patients improved: 1. 19/22 2. 9/13 Pressure ulcer-related hospitalisations per patient - mean (SD): 1. 0.2 (0.5) 2. 0.6 (0.9) Pressure ulcer-related hospital days per patient - mean (SD): 1. 3.6 (8.7) 2. 16.9 (30.6)	Method of randomisation not stated. 7 AF patients and 17 standard therapy patients had missing or uninterpretable pressure ulcer photogaphs/nurse notes and could not be reviewed for improvement by the blinded nurse assessors (73% follow up). Six air-fluidised beds had minor bead leaks and seven overheated. Several patients noted dry skin and one experienced mild dehydration.

Table of comparisons: dressings

Comparisons	Number of trials	Number of patients
1. topical agent *vs* no treatment	**1**	**14**
1.1 insulin *vs* no treatment	1	14
2. topical agent *vs* placebo	**9**	**405**
2.1 topical growth factor *vs* placebo	7	356
2.2 topical collagenase *vs* placebo	1	28
2.3 'active cream' *vs* placebo	1	21
3. topical agent *vs* topical agent	**7**	**548**
3.1 topical collagenase *vs* topical collagenase	1	92
3.2 topical collagenase *vs* other topical agent	2	163
3.3 dextranomer polysaccharide paste *vs* hydrogel	2	175
3.4 dextranomer polysaccharide paste *vs* collagenase	1	25
3.5 topical growth factor *vs* topical growth factor	1	93
4. topical agent *vs* traditional dressing	**7**	**197**
4.1 dextranomer polysaccharide paste *vs* standard tx	4	109
4.2 collagenase *vs* standard treatment	1	20
4.3 hydrogel *vs* gauze dressing	1	40
4.4 streptokinase enzyme prep *vs* zinc oxide gauze	1	28
5. topical agent *vs* modern dressing	**7**	**444**
5.1 polyhydroxyethyl methacrylate paste *vs* hydrocolloid	1	43
5.2 hydrogel *vs* hydrocolloid	3	254
5.3 collagenase *vs* hydrocolloid	1	43
5.4 dextranomer polysaccharide paste *vs* collagen sponge	1	12
5.5 dextranomer polysaccharide paste *vs* calcium alginate	1	92
6. modern dressing *vs* traditional dressing	**12**	**579**
6.1 hydrocolloid *vs* moistened gauze	6	296
6.2 hydrocolloid *vs* povidone iodine gauze	1	76
6.3 semi occlusive dressing *vs* moistened gauze	1	38
6.4 polyurethane dressing *vs* moistened gauze	1	48
6.5 hydrogel dressing *vs* moistened gauze	1	41
6.6 noncontact normothermic tx *vs* standard wound care	2	80
7. modern dressing *vs* modern dressing	**16**	**994**
7.1 hydrocellular dressing *vs* hydrocolloid dressing	2	72
7.2 hydrocellular dressing *vs* polyurethane foam dressing	1	20
7.3 hydrocolloid dressing *vs* calcium alginate dressing	1	110
7.4 hydrocolloid dressing *vs* polyurethane foam dressing	3	130
7.5 hydrocolloid dressing *vs* hydropolymer dressing	3	366
7.6 hydrocolloid dressing *vs* collagen dressing	1	65
7.7 hydrocolloid dressing *vs* change indicator dressing	1	35
7.8 hydropolymer dressing *vs* silicone dressing	1	38
7.9 hydrogel dressing *vs* hydrogel dressing	1	50
7.10 polyurethane foam *vs* low adherence dressing	1	50
7.11 radiant heat dressing *vs* alginate dressing	1	58

Comparisons	Number of trials	Number of patients
8. modern dressing *vs* placebo	**1**	**49**
8.1 wound closure system *vs* placebo	1	49
All comparisons	**60**	**3,230**

Table of included studies: dressings

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Topical agent		**No treatment**						
van Ort (1976) [5] Setting and length of treatment: nursing home. Treatment continued for 15 days.	I: Topical application of ten units of U-40 regular insulin (USP) twice a day for 5 days. Insulin was dropped from a syringe and exposed to the air to dry. No dressing was applied, n = 6.	C: All participants received routine supportive nursing care including position changes, increased fluid intake, high protein diet, and local massage. Only patients in the treatment group received insulin therapy, n = 8.	14	Inclusion criteria: Decubitus ulcers; skin break due to pressure, evidence by epidermal injury involving erythema, pallor, cyanosis and superficial erosion. Size of ulcer between 1.0 cm and 7.0 cm. Skin breakdown in existence 14 days or less prior to admission to study. Exclusion criteria: Not stated.	Area of wound: Not stated. Other characteristics: mean age (years): 72.5 (all groups) M:F 1:5 (I) 1:7 (C) Authors state no statistically significant differences on a range of other variables, including body build, blood glucose, fluid and protein intake, number and location of ulcers, mobility, incontinence, diabetes mellitus, endocrine, circulatory, digestive, genitourinary or musculoskeletal disease, use of antibiotics, anticoagulants, parenteral insulin, oral hypoglycaernic, steroids or vitamins.	Healing rate: healing rate favoured intervention group (p=0.05). Primary data not available. Assessed by photography.	No *a priori* sample size calcs. No blinding. Randomisation procedure stated.	No withdrawals. Time to healing appeared to depend on age, number of pressure ulcers, respiratory, nervous system and musculoskeletal disease and mental disorder, and antibiotic therapy, but the results of significance tests are not presented.
Topical agent		**Placebo**						
Lee (1975) [6] Setting and length of treatment:	Collagenase enzyme preparation (Santyl) applied at 250 units per gram of white	Placebo (heat-inactivated Santyl) applied in the same proportions as for I, n = 11.	28	Inclusion criteria: Patients with advanced pressure ulcers. Exclusion criteria:	Mean wound area (cm2): Not stated. Mean wound volume	Mean (SD) % change in wound volume: I: +13.14 (59.8), n=17 C: +78.79 (94.6),	No *a priori* sample size calcs. No description of blinding. Randomisation	Withdrawals: I: Patients were removed from day 6 to day 30 (termination of the trial). C: Patients were withdrawn from day 3 to

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
setting not stated. Patients were treated for 4 weeks or until complications developed or the patient died. Measurements were taken weekly and on completion of the study.	petroleum, n = 17.	Before application of either treatment the wound was washed with sterile saline (pH 7.5). Each application was applied once daily to each wound unless more frequent cleansing was required because of contamination from incontinence of urine, faeces or both. All wounds were covered with a sterile gauze pad.		Not stated.	(cm3): I: 15.44 (19.92 SD) C: 1.25 (1.62 SD) Other characteristics: All groups Mean age (years): 67.6 (13.7 SD) M:F ratio: 1:2.7 Baseline wound volume is significantly different between groups ($p < 0.01$). 11 patients with 28 advanced pressure ulcers were included in the study. All had chronic disease and were in poor physical condition. Four had neoplastic disease; four had atherosclerotic heart disease or had a cerebrovascular accident, or both; two had Parkinson's disease; and one had a femoral neck fracture.	n=11 Two diameters of the wound measured and a colour photograph taken. In addition a volume mould was made with Jeltrate or Kerr No.1, and the volume determined by water displacement.	procedure not stated.	day 10. No patient in this group continued to be treated after 10 days. One wound treated with I (enzyme) experienced mild bleeding and a burning sensation.
Le Vassueur (1991) [7] Setting and length of treatment: hospital and nursing home patients. Treatment	Active cream F14001 (extract of barley plant at 1% concentration in cetomacrogol cream base), n = 8.	Placebo cream (not stated), n = 13.	21	Inclusion criteria:grade 1 and 2 pressure ulcers. Exclusion criteria: not stated.	Ulcer size (cm2): I: 9.6 (3.9 SD) C: 9.0 (2.0 SD) Other characteristics: Age (years): 82.5 (I), 81.5 (C) Norton score: 10.9 (I), 12.9 (C) Duration (months): 7.6 (1), 3.5 (C)	Mean (SD) time to healing (days): I: 18.4 (12.4), n=8 C: 29.1 (13.0), n=13 Ulcer size: not enough data given at 4 weeks of treatment to enable meta-analysis, only $p<0.05$. Assessed by weekly	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	No statement of withdrawals.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
continued for 6 weeks.						photography.		
Rees (1999) [8] Setting and length of treatment: 14 USA hospitals. Treatment continued for 16 weeks or until ulcer completely healed, whichever came first.	rhPDGF-BB Becaplermin gel (all 3 formulae, n=93) I1: Growth factor (rhPDGF-BB 100μg/ml daily) alternated with placebo gel every 12 hours, n=31 I2: Growth factor (rhPDGF-BB 300μg/ml daily) alternated with placebo gel every 12 hours, n=32 I3: Growth factor (rhPDGF-BB 100μg/ml twice daily), n=30	Placebo gel twice daily, (n=31) All patients: debridement of ulcers to remove fibrin and necrotic tissue, systemic treatment of wound infections, off-loading pressure from affected area, maintenance of moist wound environment, nutritional support.	124	Inclusion criteria: patients with 1-3 chronic (minimum 4 weeks of previous treatment) full thickness (stage 3-4) pressure ulcers with bone tissue involvement; target ulcer volume between 10-150ml after debridement. Exclusion criteria: Albumin ≤2.5g/dl, total lymphocyte count ≤1000, vitamin A or C levels outside normal range; osteomyelitis of affected area; target volume after debridement <10 or >150 ml; topical antibiotics, antiseptics, enzymatic debriding agents used within preceding seven days; ulcers due to electrical, chemical or radiation insult; patients with cancer, concomitant diseases (e.g. connective tissue disease), treatment (eg radiation therapy) or medication (e.g. corticosteroids, chemotherapy, immunosuppressive agents); women who were pregnant,	Median (± IQR) target ulcer volume (ml): I1: 16.6 ± 15.1 I2: 17.2 ± 19.7 I3: 17.6 ± 33.8 C: 19.6 ± 21.9 Other characteristics: Mean (± SD) age (years): I1: 48 ± 13.1 I2: 49 ± 12.5 I3: 51 ± 18.3 C: 50 ± 13.6 M:F ratio: I1: 5.2:1 I2: 5.4:1 I3: 6.5:1 C: 4.2:1 Median (± IQR) duration (weeks): I1: 22 ± 32 I2: 33 ± 40 I3: 22 ± 52 C: 30 ± 43	Complete healing: I1: 7/31 I2: 6/32 I3: 1/30 C: 0/31 >90% healing: I: 49/93 (all GF) C: 9/31	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	No statement of withdrawals. Wound-related, treatment-emergent adverse events (no. patients with an event): I1: 2/31 I2: 6/32 I3: 9/30 C: 4/31

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				breastfeeding or not on acceptable birth control.				
Mustoe (1994) [9] Setting and length of treatment: nursing homes or hospitals. Treatment for 28 days, follow-up of 5 months.	I1: Growth factor (rhPDGF-BB 100μg/ml), n=15 I2: Growth factor (rhPDGF-BB 300μg/ml), n=12 Treatments applied daily as a topical spray, at a volume of 10 ml/cm2. All wounds dressed daily with moist saline gauze dressings and mechanically debrided as necessary during treatment period. Intermittent pressure relief was obtained through turning regimens according to nursing home and hospital routines. Pressure-reducing mattresses were not used.	C1: Placebo, n=14	41 pts 44 ulcers	Inclusion criteria: clinical confirmation of grade 3 or 4 pressure ulcers in adults, with total surface area between 4 and 100 cm2 and no evidence of surrounding cellulites or malignant neoplasms in the area of the ulcer or elsewhere. Exclusion criteria: venous or arterial ulcer implicated in the cause of the ulcer; existence of significant endocrine disease or malignant neoplasms in past 5 years; use of immunotherapy, cytotoxic chemotherapy or an investigational drug or drugs.	Mean wound volume (cm3): C1: 10.8 ± 13.2 I1: 5.5 ± 6.1 I2: 7.1 ± 8.8 Other characteristics: Mean age: 73.4 (C1), 73.5 (I1), 67.5 (I2) M:F 1:1.8 (C1), 1:2.8 (I1), 1:1.4 (I2) Duration (months): 2 (C1), 5.2 (I1), 3.9 (I2) % of patients at grade: III 21.4 (C1), 26.7 (I1), 25 (I2) IV 78.6 (C1), 73.3 (I1), 75 (I2) Location (%): Ischium 29 (C1), 20 (I1), 17 (I2) Sacrum 43 (C1), 33 (I1), 42 (I2) Trochanter 21(C1), 27 (I1), 17 (I2) Other 7 (C1), 20 (I1), 25 (I2) Groups were also comparable on baseline laboratory values e.g. blood albumin, haemoglobin and protein.	Complete healing at 4 weeks: I1: 4/16 I2: 3/14 C: 1/14 Healing at 5 mths: majority remained unhealed, no data suitable for meta-analysis. Reduction in wound area: after adjustment for initial wound size, reported as no significant differences, primary data not given. Time to achieve 50% healing: reported as p=0.22, primary data not given. Assessed by acetate moulding and planimetry; time to healing.	No *a priori* sample size calcs. Blinded outcome assessment reported. Randomisation procedure not stated.	No withdrawals reported. After 5 months follow-up, the majority of ulcers remained unhealed and static in size.
Robson (1992a) [10] Setting and length of treatment:	Growth factor (r-bFGF at 3 concentrations: 100 μg/ml (n=11) 500 μg/ml (n=11) 1000 μg/ml (n=12)	Placebo, not stated (n=14) All patients were denervated in the area of ulceration	50	Inclusion criteria: Hospitalised patients aged 18–65 years, grade 3 or 4 pressure ulcers between 10 and 200 cm2	Baseline data are only present for all r-bFGF groups combined Initial ulcer size: not stated, but	?Men % reduction in wound volume: I: 69% C: 59% (no measure of precision)	No *a priori* sample size calcs. Blinded outcome assessment reported.	Withdrawals: one patient in placebo group removed from trial because of possible neoplasm.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
multicentre trial of hospitalised patients. Treatment continued for 22 days.	Treatments given at different application schedules, at a dose volume of 1.01 ml/cm2. Wound packed with saline-moistened sterile gauze changed after 12 hours. (Note: 35 patients entered this arm of the trial, but data were only provided for 34).	because of congenital or acquired spinal cord pathology. Standard pressure-relieving support surfaces were used as appropriate.		extending from bone to subcutaneous tissue. Mechanical debridement > 24 hours before treatment. Normal or clinically insignificant abnormalities in complete blood count, coagulation, blood chemistry, and urinalysis. Exclusion criteria: Arterial or venous disorder, or wound due to vasculitis; clinically significant systemic disease or malnutrition; recent steroidal therapy; penicillin allergy.	reported that there were no significant group differences. Other characteristics: Age (years): 37.8 (I), 37.9 (C) Duration (months): 17.7 (I), 25.9 (C) M:F 3.9:1 (all groups) No statistically significant differences were found between baseline characteristics (Wilcoxon test). No group differences in ethnicity.	≥ 70% wound volume reduction: I: 21/35 C: 4/14 Measured by planimetry and acetate moulding.	Randomisation procedure not stated.	Blinded observers reported significant differences in visual improvement of overall healing, favouring r-bFGF (I1, I2, I3). No statistical tests reported. Fibroblast and capillary counts appear from a histogram to favour r-bFGF but the differences appear small and no statistical tests are reported.
Robson (1992b) [11] Setting and length of treatment: inpatient setting. Treatment continued for 28 days; follow-up for up to 5 months.	Growth factor r-bFGF at 3 concentrations: 1 μg/ml (n=4) 10 μg/ml (n=4) 100 μg/ml (n=5) Treatment given daily for 4 weeks at a dose of 0.01 ml/cm2 of ulcer surface. After treatment the wound was left open to allow absorption. Each ulcer was packed with sterile gauze and closed with Biobrane.	Placebo, not stated (n=7)	20	Inclusion criteria: Ulcers between 25 and 95 cm2 with full-thickness skin loss (grade 3 or 4) or penetrating to bony prominence (grade 4), with no past or present evidence of malignancy, with mechanical debridement of necrotic tissue at least two days prior, and normal or clinically insignificant results on pretreatment blood count, and coagulation, chemistry and urinalysis. Exclusion criteria: Arterial or venous	Mean wound depth (cm): C1: 2.8 ± 0.4 (range 1.5-5.2) I1: 1.7 ± 0.5 (range 0.5-2.7) I2: 1.6 ± 0.6 (range 0.8-3.5) I3: 2.8 ± 1.0 (range 1.6-6.8) (Comparison of means by ANOVA: NS.) Mean wound volume (cm3): C1: 12.9 ± 3.8 (range 5-33) I1: 13.8 ± 4.8 (range 5-26) I2: 15.8 ± 4.0 (range 9-28) I3: 11.6 ± 5.5 (range 4-33) (Comparison of means	Mean (SD) % reduction in wound volume at 4 weeks: I1 (1 μg/ml): 63 (30), n=4 I2 (10 μg/ml): 55 (30), n=4 I3 (100 μg/ml): 93.5 (8.9), n=5 C: 78.2 (14.8), n=7 Assessed using wound gauge, mould weight.	No *a priori* sample size calcs. Blinded outcome assessment reported. Randomisation procedure not stated.	No withdrawals reported. Histological evaluation of the tissue biopsies found no treatment-related group differences in cellular influx or extracellular matrix deposition. The 100 μg/ml "tended to have greater fibroblastic and endothelial cell influx", but no data presented.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				disorder resulting in ulcerated wounds; clinically significant disease; significant malnutrition; recent use of steroidal therapy; immunotherapy or cytotoxic chemotherapy; diabetes.	by ANOVA: NS.) Wound duration (months): C1: 14.2 ± 6.2 (range 1-37) I1: 11.6 ± 5.5 (range 3-27) I2: 16 ± 7.1 (range 4-36) I3: 17.3 ± 12.4 (range 4-67) (Comparison of means by ANOVA: NS.) Other characteristics: Age (years): C1: 27±2 (range 22-35) I1: 40 ± 8 (range 21-56) I2: 43 ± 5 (range 32-54) I3: 29 ± 4 (range 21-45) (Comparison of means by ANOVA: NS.)			
Robson (1994) [12] Setting and length of treatment: inpatients. Treatment until healing or maximum of 28 days.	Growth factor interleukin I-beta at 3 strengths (n=18): I1: 0.01 μg/cm^2 I2: 0.1 μg/cm^2 I3: 1.0 μg/cm^2 0.01 ml/cm^2 was delivered by spray after saline cleansing. Wounds were then air-dried and dressed with saline-moistened dressing, changed 12 hours later. Treatment applied	C1: Placebo, not stated (n=6) All patients were denervated in the area of ulceration because of congenital or acquired spinal cord pathology. Pressure-relieving support surfaces were used as appropriate. Patients on non air fluidised beds re-positioned every 2 hours.	24	Inclusion criteria: Pressure ulcers extending from the bone to the subcutaneous tissue (grade 3/4 ulcers). Exclusion criteria: Significant renal, hepatic, cardiac, endocrine or haematologic disease, or neoplastic disease producing ulcerated wounds; arterial or venous disorders resulting in ulcerated wounds; systemic sepsis from	No statistically significant differences were reported between groups in race, gender, tobacco use, ulcer location, age, height, weight, or ulcer stage or size at baseline. No data are presented. All pressure ulcers were located on the sacrum, ischium or trochanter.	?Mean % of initial wound size by 4 weeks: I1: 22 I2: 35 I3: 45 C1: 22 Measured by photography, planimetry and acetate moulding.	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	Withdrawals: I1: 1 I2: 0 I3: 1 C1: 0 Of the two withdrawals, one left hospital before completion of study and one was withdrawn because of osteomyelitis at base of ulcer. These were replaced; unclear how this was done. Effect of treatment on fibroblasts assessed but not reported in detail.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
	at three different dosages of 0.01, 0.1 and 1.0 to six patients per group (total n = 18).			the pressure ulcer; lack of cooperation; unsuitability, inability to provide informed consent; whirlpool therapy requirements; HIV+; use of investigational drugs within one month before study entry; or treatment of the target ulcer with cytokines within three months of entry.				
Robson (2000) [13] Setting and length of treatment: inpatients, USA hospital. Treatment until healing or 35 days maximum.	Growth factor 3 types: I1: 2 μg/cm^2 GM-CSF (granulocyte macrophage colony stimulating factor) applied topically for 35 days (n=15). Applied as a spray, 15 minutes of air drying, non-adherent dressing next to the wound then dry gauze to fill the ulcer crater. I2: 5 μg/cm^2 bFGF (basic fibroblast growth factor) applied topically for 35 days (n=15). Applied as above. I3: 2 μg/cm^2 GM-CSF applied topically for 10 days, followed by 5 μg/cm^2 bFGF applied topically for 25 days	C: Comparative placebo (n=15). Applied as in intervention group. All patients were kept on pressure-relief surfaces for the 35-day treatment period, and fixed turning schedules were maintained.	61	Inclusion criteria: Spinal patients with grade 3/4 pressure ulcers of >8 weeks duration and ulcer volume of 10-200 cm^3 Exclusion criteria: Significant diabetes, renal insufficiency, vasculitis, hepatic, immunologic, cardiac or haemorrhagic disease, malnutrition, systemic steroidal therapy, immunotherapy, chemotherapy, cytokine therapy within 90 days or investigational study drug within 30 days.	Mean (± SD) ulcer volume (cm^3): I1: 32.77 ± 21.06 I2: 33.81 ± 26.12 I3: 38.16 ± 38.3 C: 45.19 ± 34.79 Mean (± SD) ulcer duration (months): I1: 6.8 ± 6.1 I2: 14.9 ± 16.4 I3: 12.1 ± 14.6 C1: 13.1 ± 14.2 Other characteristics: Mean (± SD) age (years): I1: 48.8 ± 11.8 I2: 51.7 ± 11.3 I3: 51.3 ± 11.2 C1: 47.1 ± 10.8	>85% healing rate at 36 days: I1: 3/15 I2: 6/15 I3: 4/16 C: 0/15 Complete closure at 1 yr: I1: 8/14 I2: 10/14 I3: 9/13 C: 10/13 Median (range) wound volume (cm^3) at day 36: I1: 9.29 (0.88-40.62) I2: 4.42 (0.22-20.80) I3: 7.48 (0.22-99.65) C: 8.85 (2.12-45.84) Median (range) % wound closure on day 36: I1: 70% (3-99) I2: 79% (42-99) I3: 73% (29-98) C: 72% (39-84) Assessed by planimetry, alginate moulds and colour	No *a priori* sample size calcs. Blinded outcome assessment reported (used comparative placebos). Randomisation procedure not stated.	Withdrawals: Nil at 35 days in any group. At 1 year: I1: 1 lost, 0 deaths I2: 1 lost, 0 deaths I3: 0 lost, 3 deaths C: 1 lost, 1 death Payne (2001) paper had long-term (one year follow up) outcomes. Costing data: Procedural cost saving per ulcer healed: I1: US$7,800 I2: US$9,000 I3: US$8,300 C: US$7,000

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
	(n=16). Applied as above.					photography.		
Landi (2003) [14] Setting and length of treatment: USA & Italian nursing homes. 6-week treatment period, or until ulcer healed.	2.5S murine nerve growth factor solution 50 μg/ml, dropped daily on the lesion and allowed to dry for 2-3 minutes, n=19. All patients received routine care which included turning program, pressure-relieving mattress, wound irrigation with normal saline, use of debriding enzymes, and application of opaque hydrocolloid occlusive barriers.	Placebo: balanced salt solution, indistinguishable from intervention solution in presentation, colour, density or odour; dropped onto the lesion in an identical manner, n=19.	38	Inclusion criteria: patients with pressure ulcer of the foot that ranged in size from 1-30 cm^2. Exclusion criteria: had lesion for <1month before admission, terminal illness, diabetes, peripheral vascular disease.	Mean (+ SD) ulcer area (mm2): I: 1012 + 633 C: 1012 + 655 Mean (+ SD) ulcer duration (days): I: 13 + 4 C: 12 + 5 Mean (+ SD) ulcer stage: I: 3.2 + 0.8 C: 3.0 + 0.7 Other characteristics: Mean (+ SD) age (years): I: 80.2 + 3.0 C: 80.2 + 4.7 M:F ratio: I: 1:2.6 C: 1:2.6	Mean (SD) ulcer area (cm2): I: 27.4 (32.9), n=18 C: 52.6 (33.4), n=18 Mean (SD) reduction in ulcer area (cm2): I: -73.8 (39.3), n=18 C: -48.5 (38.4), n=18 Complete healing: I: 8/18 C: 1/18 No information regarding how measurements were carried out.	No *a priori* sample size calcs. Blinded outcome assessment reported. Randomisation procedure stated: computer-generated list, stratified by age group, sex, ulcer surface area.	Withdrawals: I: 1 death C: 1 lost These patients were not included in the analysis. Noted that none of patients had systemic or local side effects during either treatment regime.
Topical agent		**Topical agent**						
Burgos (2000a) [15] Setting and length of treatment: multicentre trial at 8 Spanish hospitals. Treatment was for 8 weeks or until ulcer healing, whichever	Collagenase ointment 24 application interval, n=46 All ulcers were cleaned with saline, collagenase ointment applied and then covered with paraffin gauze and a conventional dressing.	Collagenase ointment 48 application interval, n=46	92	Inclusion criteria: hospitalised or institutionalised patients, either gender, ≥55 years, with stage 3I pressure ulcer for <1 year. Exclusion criteria: end-stage diseases, localised or systemic signs and/or symptoms of infection, or hypersensitivity to collagenase.	Mean (+ SD) ulcer size: Not stated. Mean (+ SD) ulcer duration (months): I: 3.3 + 2.3 C: 3.3 + 2.2 Mean (+ SD) ulcer score (Arnell scale): I: 17.3 + 6.8 C: 18.5 + 6.0 Other characteristics:	Complete healing: I: 12/43 C: 9/43 Mean (SD) ulcer area reduction at 8 weeks (cm2): I: 7.9 (12.2), n=34 C: 9.5 (11.8), n=29 Assessed at 1 week intervals with photography, acetate tracing and planimetry; and graded ulcer	No *a priori* sample size calcs. No blinding of treatment allocation. Randomisation procedure not stated.	Withdrawals: I: 3 discontinued during first week, no reasons given. C: 3 discontinued during first week, no reasons given. Less pain intensity seen in the 24 hour interval group (p=0.004). Adverse reactions: I: 3/43 (rash, ulcer bed necrosis, ulcer worsening)

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
came first.				All eligible patients had an active run-in period with collagenase ointment for 1-5 weeks. If 10-30% tissue granulation developed (assessed visually), then they qualified for randomisation.	Mean (+ SD) age (years): I: 80.1 + 9.7 C: 79.0 + 11.7 M:F ratio: I: 1:1.9 C: 1:2.3	characteristics on 5-point scale.		C: 3/43 (infection, ulcer bed necrosis x 2 patients)
Rees (1999) [8] Setting and length of treatment: 14 USA hospitals. Treatment continued for 16 weeks or until ulcer completely healed, whichever came first.	I3: rhPDGF-BB Becaplermin gel 100 microgm twice daily I3: rhPDGF-BB Becaplermin gel 100 microgm twice daily I1: rhPDGF-BB Becaplermin gel 100 microgm once daily	I1: rhPDGF-BB Becaplermin gel 100 microgm once daily I2: rhPDGF-BB Becaplermin gel 300 microgm once daily I2: rhPDGF-BB Becaplermin gel 300 microgm once daily	61 63 62	Inclusion criteria: patients with 1-3 chronic (minimum 4 weeks of previous treatment) full thickness (stage 3-4) pressure ulcers with bone tissue involvement; target ulcer volume between 10-150ml after debridement. Exclusion criteria: albumin ≤2.5g/dl, total lymphocyte count ≤1000, vitamin A or C levels outside normal range; osteomyelitis of affected area; target volume after debridement <10 or >150 ml; topical antibiotics, antiseptics, enzymatic debriding agents used within preceding 7 days; ulcers due to electrical, chemical or radiation insult; patients with cancer, concomitant diseases (e.g. connective tissue disease), treatment (eg	Median (± IQR) target ulcer volume (ml): I1: 16.6 ± 15.1 I2: 17.2 ± 19.7 I3: 17.6 ± 33.8 C: 19.6 ± 21.9 Other characteristics: Mean (± SD) age (years): I1: 48 ± 13.1 I2: 49 ± 12.5 I3: 51 ± 18.3 C: 50 ± 13.6 M:F ratio: I1: 5.2:1 I2: 5.4:1 I3: 6.5:1 C: 4.2:1 Median (± IQR) duration (weeks): I1: 22 ± 32 I2: 33 ± 40 I3: 22 ± 52 C: 30 ± 43	Complete healing: I3: 7/31 I1: 1/30 >90% healing: I3: 18/31 I1: 12/30 Complete healing: I3: 7/31 I2: 6/32 >90% healing: I3: 18/31 I2: 19/32 Complete healing: I1: 1/30 I2: 6/32 >90% healing: I1: 12/30 I2: 19/32	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	No statement of withdrawals. Wound-related, treatment-emergent adverse events (no. patients with an event): I1: 2/31 I2: 6/32 I3: 9/30 C: 4/31

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				radiation therapy) or medication (e.g. corticosteroids, chemotherapy, immunosuppressive agents); women who were pregnant, breastfeeding or not on acceptable birth control.				
Pullen (2002) [16] Setting and length of treatment: patients in 17 German hospitals that provided acute care and rehab services for the elderly. Treatment was until complete wound debridement or 4 weeks maximum.	Collagenase (1.2 U/g) ointment twice daily, n=66 Both ointments were applied by nurses in 2mm layer to the ulcer and covered with gauze. They were not irrigated between treatments. Physician determined type of mattress and frequency of repositioning.	Fibrinolysin / deoxyribonuclease (1 U Loomis and 666 U Christensen /g) twice daily, n=69	135	Inclusion criteria: stage 2-4 pressure ulcers with fibrinous and/or necrotic slough, over 54 years age, ulcer size between 2-14.5 cm. If several ulcers present, the worst was chosen as the reference ulcer. Exclusion criteria: history of alcohol or drug dependency, end-stage malignant disease, known hypersensitivity to collagenase or fibrinolysin/DNAse, planned co-medication with local antiseptics, antibiotics, occlusive wound dressings, hydrogels or hydrocolloids, ulcers covered with black eschar only.	Mean (+ SD) ulcer size: Not stated. Mean (+ SD) ulcer duration (months): I: 1.3 + 0.6 C: 1.4 + 1.0 Ulcer staging (Seiler): Stage 2: I: 18/66 C: 20/69 Stage 3: I: 44/66 C: 43/69 Stage 4: I: 4/66 C: 6/69 Other characteristics: Mean (+ SD) age (years): I: 78.4 + 8.9 C: 79.7 + 8.1 M:F ratio: I: 1:1.1 C: 1:0.9	$\geq$ 50% decrease in necrotic area: I: 28/60 C: 22/61 Decrease in wound area, wound healing, wound depth: no primary data given, only noted there were no statistically significant (p>0.1) differences. Visual assessment of photographs every 4 days by masked, independent dermatologist assessors.	*A priori* sample size calcs undertaken. Described as double-blinded but no description of blinding methods for care-givers, but stated outcome assessors blinded to treatment used. Randomisation procedure not stated.	Withdrawals: I: 16 protocol violations, 6 photos not assessable C: 27 protocol violations, 8 photos not assessable Adverse events: I: 45 patients, 118 events C: 34 patients, 103 events No serious events were attributed to probably or possibly the effect of the study medication.
Alvarez (2002) [17] Setting and length of treatment: 3	Collagenase ointment 250 bacterial collagenase units per gram of white petroleum USP	Papain-urea ointment: 8.3 x 10^3 papain USP units per gram and urea 100mg per gram (Accuzyme), once	28	Inclusion criteria: >18 years old, in hospital for > 2 weeks, full or partial thickness pressure ulcer requiring debridement	Mean (SD) ulcer size (cm2): I: 9.9 (10.66) C: (9.8 (8.25) Ulcer staging (Seiler):	Mean (SD) % nonviable tissue (compared with baseline) at 4 weeks: I: 1 (3), n=8	No *a priori* sample size calcs. No blinding of outcome assessment.	Withdrawals: I: 2 not assessable C: 0 Both treatments reported to be easy and

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
centres. Treatment was for 4 weeks or until complete ulcer debridement, whichever occurred first.	(Santyl), once daily in 2mm thick layer, n=14 Pre-randomisation 2 week screening period where target ulcer was cleaned with saline and a non-adherent dressing applied. Patients with stable or improving ulcers were eligible for enrolment.	daily in 2mm thick layer, n=14 All patients had pressure-relieving surfaces provided.		(i.e. have nonviable tissue attached to the base of the wound), normal vascular studies ulcer was located on the foot. Exclusion criteria: clinical signs of infection, cellulites, osteomyelitis, inadequate nutrition, uncontrolled diabetes, other clinically significant conditions that would impair wound healing inclusive of renal, hepatic, haematologic, neurologic, immunologic disease; received corticosteroids, immunosuppressive agents, radiation or chemotherapy <1 month prior to study entry.	Stage 2: I: 2/12 C: 2/14 Stage 3: I: 2/12 C: 3/14 Stage 4: I: 6/12 C: 4/14 Other characteristics: Mean (range) age (years): I: 74 (21-101) C: 76 (25-97) M:F ratio: I: 1:1.4 C: 1:1.3	C: 75 (68), n=8 Assessed with acetate tracing and planimetry, and clinical assessment.	Randomisation procedure stated: computer-generated list.	convenient, and not to be associated with any pain or discomfort.
Parish (1979) [18] Setting and length of treatment: community (nursing home) 4-week trial.	Dextranomer polysaccharide beads (Debrisan) applied to a depth of at least 3 mm covered with a dry dressing. Changed 1-3 times daily depending on exudate, n = 14 wounds from seven patients.	Collagenase enzyme preparation (Santyl) applied daily after a saline wash and covered with a dry dressing, n=11 wounds from five patients.	25 ulcers	Inclusion criteria: Patients with pressure ulcers, residing in a nursing home. Exclusion criteria: Not stated.	Mean wound size = √ of surface area (cm): I: 4.5 C: 3.2 No statistical difference between the groups for ulcer size. Other characteristics: Age range (years): 29-57 (I), 28-59 (C) M:F ratio: Not stated Mean duration	Complete healing (number of wounds): I: 6/14 C: 1/11 Complete healing (number of patients): I: 4/7 C: 1/5 Wounds measured, photographed on enrolment, but no information about further outcome	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	No withdrawals. No side effects reported by patients with any of the treatments.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
					(months): Not stated. Wound area: < 4 cm_2 - 18 (I), 15 (C) 4-13 cm_2 - 25 (I), 5(C) > 13 cm_2 -25 (I), 27 C) Non-viable tissue area: < 3 cm_2 - 18 (I), 15 (C) 3-9 cm_2 - 27 (I), 24 (C) > 9 cm_2 - 23 (I), 28 (C) Other characteristics: Median age (years) 81 (I), 79 (C) M:F ratio 1:1 (I), 1:1.4 (C) Ulcer duration: < 1 mth - 22(I), 4(C) 1-3 mths- 35(I), 28(C) >3 mths - 11(I), 15(C) Ulcer grade: 1 - 1 (I), 0 (C) 2 - 10 (I), 16 (C) 3 - 45 (I), 38 (C) 4 - 12 (I), 13 (C) Authors state groups were well matched. All patients gave written consent and were capable of participating in the trial.	measurement. Number of wounds completely cleansed: I: 14/68 C: 13/67 Median (range) % reduction in wound area: I: 7 (-340, 98), n=68 C: 35 (-185, 91), n=67 Percentage reduction in area of non-viable tissue (wound area x (% yellow + % black tissue) x 1/100). Photographs were taken at the initial and final assessment.		
Colin (1996) [19] Setting and length of treatment: open, multicentre, multinational, parallel group trial. Six different centres were involved with approximately equal numbers of patients in each trial. Assessments were made every 7 days until the wound was cleansed or on the completion of 21 days.	Dextranomer polysaccharide (Debrisan) paste, n=68	Hydrogel (Intrasite gel), n=67 The two interventions were applied in accordance with the manufacturers' instructions. An absorbent plastic film dressing (Melolin) was used as a standardised secondary dressing for both treatments. Where a patient had more than one wound only the largest was evaluated in the trial. Other wounds were treated with the same randomised dressing if this was considered appropriate by the clinical investigator.	135	Inclusion criteria: Male and female patients ≥ 16 years with pressure ulcers present in any area that needed cleansing. Exclusion criteria: Pregnancy, immunodeficiency, clinical infection of the wound, hard black eschar covering more than 20% of the wound, diabetes, inability to follow the demands of the protocol for any reason, non-consenting patients.			*A priori* sample size calcs undertaken. No blinding of outcome assessment. Randomisation procedure not stated.	Withdrawals: I: 19 lost to followup, two died, four adverse reactions (one related to pain on application of the agent, no details on the other three). C: 11 lost to follow-up, two died, and one adverse reaction. Five adverse events were reported, one in the C group (hydrogel) and four in the I group (dextranomer polysaccharide). The only one considered to be dressing related was pain reported by one patient in the I group. C was found to be easier to apply and remove than the I. C was also found to be associated with less pain.
Thomas (1993) [20] Setting and length of treatment: 2-week trial. After 14 days those	Dextranomer polysaccharide beads (Debrisan) made into a paste with polyethylene glycol 600 and water. The paste was applied to a depth of 10 mm	Hydrogel dressing (Intrasite Gel) applied to a depth of 5 mm. Covered with a perforated plastic film absorbent dressing held in place with tape or a bandage,	40	Inclusion criteria: Hospitalised patients with grade 3 or 4 pressure ulcers. The wounds had to be covered or partially covered with yellow/brown slough.	Mean wound area (cm2): I: 15.6 (16.2 SD; range 1.5-68.9) C: 22.2 (23.4 SD; range 2.6-91.4) % wound area covered in slough:	Number wounds cleansed by 14 days: I: 1/20 C:8/20 After 14 days all ulcers were reassessed.	No a priori sample size calcs. No description of blinding. Randomisation procedure: computer-generated list.	Withdrawals: Up to 14 days: I: three because of difficulty in applying the dressing. Classed as failures in the results. C: one patient because the case report forms

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
wounds showing no improvement were withdrawn while the remaining wounds were followed for a further 14 days.	over a layer of polyamide net, n = 20.	n = 20. Dressings were changed as required, and the wound cleansed with saline before reapplication.		Exclusion criteria: Age < 16 years, insulin dependent diabetes, immunosuppression, pregnancy, cellulites and redness of the surrounding tissue (indicative of infection).	I: 75.3 (22.4 SD; range 20-100) C: 73.5 (29.7 SD; range 20-100) Other characteristics: Mean age (years): 81.0 (I), 83.5 (C) M:F ratio: 1:5.7 (I), 1:3.8 (C) Ratio of grade 3:4 ulcers 5.7:1(I), 3.8:1 (C) Values are only given for 39 of the 40 patients entering the trial.	Wounds showing no evidence of debridement were classed as failures and withdrawn. The remaining wounds were followed for another 14 days. Number wounds cleansed by 28 days: I: 5/20 C: 8/20 Wound cleansing was determined by measuring the % of total wound area covered in slough.		were mislaid. Up to 28 days: Withdrawals occurred over the follow-up period leaving four patients in the C group and two patients in the I group. C (hydrogel) had to be changed more frequently than I (dextranomer polysaccharide). However, even with frequent dressing the cost of the C per patient was less than for the I. Mean cost per patient: I: £44.70 C: £22.60 (NB. Only successes costed not failures)
Topical agent		**Traditional dressing**						
Ljungberg (1998) [21] Setting and length of treatment: spinal cord injury patients, US hospital. Treatment continued for a maximum of 15 days.	Dextranomer paste (Debrisan), every 8-12 hours, n=15 Following surgical debridement, ulcer was cleaned with mild soap and water, and rinsed with saline. Whilst still wet, either the Debrisan paste or saline-soaked gauze was applied, and the ulcer then covered with a dry sterile dressing. No other topical	Conventional saline dressings, every 8-12 hours, n=15	30 ulcers 23 pts	Inclusion criteria: spinal cord patients, >18 years, with an exudative pressure ulcer. Exclusion criteria: not stated.	Mean (SD) ulcer size: Not reported. Ulcer staging (Eltorai): Stage 2: I: 10/15 C: 12/1 Stage 3: I: 4/15 C: 3/15 Stage 4: I: 1/15 C: 0/15 Other characteristics: Age (years): 23-73 (both groups) M:F ratio: 1:0 (both groups)	Ulcer improvement (> 25% improved granulation from baseline): I: 10/15 C: 8/15 Assessed by photography, grading system.	No a priori sample size calcs undertaken. No blinding of outcome assessment. Randomisation procedure not stated.	Withdrawals not reported. No patients reported adverse events.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Nasar (1982) [22] Setting and length of treatment: hospital-based trial. Assessments were made every 3 days by an independent observer and a photograph taken once a week. Treatment was continued until the wound reached the end point, or for a maximum of 94 days.	treatment was permitted. Dextranomer polysaccharide (Debrisan) applied as a stiff paste twice daily for the first 3 days and daily thereafter, n = 9. Prior to initiation of the trial all hardened sloughs were cut off and all patients were nursed on a large cell ripple mattress. The only concurrent therapy was ultraviolet light applied to 12 square inches of skin to produce first degree erythema with the ulcer masked from the ultraviolet rays.	Eusol and paraffin packs were applied to the wound and dressings were changed three times daily for the first three days and thereafter twice daily. Melolin dressings were used throughout held in place by micropore tape. A savlon sachet was used each time the dressing was changed, n = 9.	18	Inclusion criteria: Patients with deep pressure ulcers of approximately similar size. Exclusion criteria: Urinary tract infection.	Mean wound size: Not stated. Other characteristics: Mean age (years): 83.2 (I), 77.4 (C) M:F ratio: Not stated Mean duration (months): Not stated Anaemia, hypoalbuminaemia, hypovitaminosis, and high blood urea were corrected if present. Scrupulous control of diabetic patients was ensured. Patients with urinary incontinence were catheterised. Pressure ulcers were mostly on the foot or heel in both groups.	Wounds healed (= cleansed and <25% original size): I: 6/9 C: 5/9 Mean time to wound healing (days): I: 39.3, n=9 C: 62.0, n=9 (no measure of precision) Wound area was measured using celluloid squares and the entire wound photographed. End point was reached when the wound was clean and granulating and appeared to be less than 25% its original size (= healed).	No a priori sample size calcs. Blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: I: Three wounds. Two due to patient death; one as a result of patient discomfort. C: Four wounds. One due to patient death; three switched to dextranomer (two after 16 days and one after 48 days). Wounds treated with C (Eusol) were observed to be associated with a rise in blood urea to 11 mmol/l. Cost of materials calculated for each treatment for average treatment time in that group. C treatment was 1.6 times more costly than I.
Parish (1979a) [18] Setting and length of treatment: Community (nursing home) 4-week trial.	Dextranomer polysaccharide beads (Debrisan) applied to a depth of at least 3 mm covered with a dry dressing. Changed 1-3 times daily depending on exudate, n = 14 wounds from seven patients.	Sugar and egg white applied after a saline wash. Changed four times a day. Allowed to dry and not covered, n = 9 wounds from five patients.	23 ulcers	Inclusion criteria: Patients with pressure ulcers, residing in a nursing home. Exclusion criteria: Not stated.	Mean wound size = √ of surface area (cm): I: 4.5 C: 2.4 No statistical difference between the groups for ulcer size. Other characteristics: Age range (years): 29-57(I), 32-70 (C) M:F ratio: Not stated	Complete healing (number of wounds): I: 6/14 C: 0/9 Complete healing (number of patients): I: 4/7 C: 0/5 Wounds measured and photographed on enrolment, but	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	No withdrawals. No side effects reported by patients with any of the treatments.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Parish (1979b) [18] Setting and length of treatment: Community (nursing home) 4-week trial.	Collagenase enzyme preparation (Santyl) applied daily after a saline wash and covered with a dry dressing, n=11 wounds from five patients.	Sugar and egg white applied after a saline wash. Changed four times a day. Allowed to dry and not covered, n = 9 wounds from five patients.	20 ulcers	Inclusion criteria: Patients with pressure ulcers, residing in a nursing home. Exclusion criteria: Not stated.	Mean duration (months): Not stated Mean wound size = √ of surface area (cm): I: 3.2 C: 2.4 No statistical difference between the groups for ulcer size. Other characteristics: Age range (years): 28-59 (I), 32-70 (C) M:F ratio: Not stated Mean duration (months): Not stated	no information about outcome measurement during the trial. Complete healing (number of wounds): I: 1/11 C: 0/9 Complete healing (number of patients): I: 1/5 C: 0/5 Wounds measured and photographed on enrolment, but no information about outcome measurement during the trial.	No *a priori* sample size calcs. No description of blinding. Randomisation procedure not stated.	No withdrawals. No side effects reported by patients with any of the treatments.
Moberg (1983) [23] Setting and length of treatment: hospitalised patients. 3-week trial.	Cadexomer iodine polysaccharide powder (Iodosorb) applied daily to a depth of 3 mm. Removed by running water saline or wet swab, n = 19.	Standard treatment was variable. It included: saline dressings, enzyme-based debriding agents, and non-adhesive dressings, n = 19. All patients were subject to: attention to nutrition; improvement of hygiene; removal of pressure by using decubitus mattresses, turning the patient every 2 or 3 hrs, and optimal mobilisation.	38	Inclusion criteria: Hospitalised patients with pressure ulcers. Exclusion criteria: Confirmed or suspected malignancies, moribund, iodine sensitivity, psychiatric illness, severe psoriasis, any other criteria that might make a patient unsuitable for a clinical trial or unable to give informed consent.	Mean wound area (cm2): I: 9.6 (1.8 SEM) C: 12.4 (4.3 SEM) Other characteristics: Mean age (years): 72.6 (I), 80.1 (C) M:F ratio: 1:4.3 (I), 1:2.6 (C) Mean duration (mths): 6.2 (I), 6.2 (C) Values are only available for the patients not withdrawn from the study.	Mean (SD) wound area reduction at 3 wks (cm2): I: 2.9 (5.2), n=16 C: 2.5 (4.7), n=18 Mean (SD) % wound area reduction at 3 wks: I: 30.9 (46.0), n=16 C: 19.6 (31.4), n=18 Number ulcers reduced by >50% at 3 wks: I: 8/16 C: 1/18 Mean (SD) wound area reduction at 8 wks (cm2): I: 7.0 (5.2), n=14 C: 5.3 (7.6), n=13 Mean (SD) % wound area reduction at 8 wks:	No *a priori* sample size calcs. Blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: I: Three withdrawals. Two patients felt they were getting worse and one had skin irritation and oedema around a sacral ulcer and chose not to continue. C: One withdrawal where the wound had grown and the patient was moved to another hospital. I caused three patients to experience smarting after application, one patient had minor skin irritation and another had an exacerbation of psoriasis. Overall pain as a result of the wound was

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
						I: 76.2 (30.7), n=14 C: 57.4 (33.9), n=13 Number ulcers reduced by >50% at 8 wks: I: 6/14 C: 1/13 Perimeter of the wound was traced and the area calculated by planimetry or measurement of the longest diameter.		significantly less in patients treated with I. I was easy to apply and remove.
Agren (1985) [24] Setting and length of treatment: Single-blind trial for 8 weeks. One of the authors was responsible for measuring all the wounds at weekly intervals. An independent surgeon from another hospital assessed the photographs.	Streptokinase/streptodornase enzyme preparation (Varidase Topical) applied to a sterile gauze compress. Dressings changed twice daily, n = 14.	Zinc oxide (400 mg ZnO/cm_2) applied to a sterile gauze compress. Dressings changed once daily, n = 14. All dressings were secured with porous acrylic-based tapes. Where multiple wounds existed they were all treated uniformly, but only the largest was monitored. Prior to treatment loosely attached necrotic material was removed, but no surgical debridement was performed thereafter. No patients received antibiotics. Nursing care	28	Inclusion criteria: Elderly inpatients and outpatients with one or more necrotic pressure ulcers. Exclusion criteria: Not stated.	Median wound area (cm_2): I: 4.2 (range 1.2-18.2) C: 5.8 (range 1.2-26.0) Other characteristics: Median age (years): 86 (I), 81 (C) M:F ratio: 1:3.7 (I), 1:1.8 (C) Diabetes mellitus (n): 4 (I), 5 (C)	Complete debridement (disappearance of necrotic tissue): I: 6/14 C: 7/14 Median (range) time to debridement (days): I: 21 (7-42) C: 23 (7-56) Median % change in wound area: I: +18.7 C: -2.4% (no precision measure) Wound area was traced and the size measured by planimetry. A photograph was taken at each assessment.	No *a priori* sample size calcs. No blinding of outcome assessment reported. Randomisation procedure stated: block randomisation with block size 2 in matched pairs.	Withdrawals: I: Three patients were withdrawn because of unsuccessful treatment. In one of these patients a skin reaction occurred on the heel after 3 weeks of treatment. In another patient necrosis developed to 8x its original size. In the third patient *Pseudomonas Aeruginosa* infection developed after 6 weeks. C: No withdrawals All withdrawals were included in the analysis. I (enzyme) was associated with an increase in wound size. This may be due to excessive wound debridement, or inhibition of tissue growth by the enzyme.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
		followed its usual procedure.						
Mulder (1993) [25] Setting and length of treatment: A multicentre trial (three independent sites). Assessments of ulcer size made weekly for 8 weeks or until the ulcer was healed. Where possible, each patient evaluated by same investigator throughout the trial.	Hydrogel (Clearsite), changed twice a week, n=23	Saline solution and moistened gauze, changed three times a day, n = 21. Dressings were changed either by the patient or the care giver, after they had received appropriate instructions.	44	Inclusion criteria: Grade 2 and 3 pressure ulcers ≥1.5 cm x 0.5 cm, but ≤10 cm x 10 cm. All patients had to be >18 years and have a life expectancy of at least two months. Exclusion criteria: Grade 4 wounds or those with tendon, bone, capsule, or fascia exposure; pregnancy; chemotherapy; prior wound infection; extensive undermining of the ulcer (> 1 cm); AIDS; patients receiving > 10 mg of corticosteroids.	Area of wound (cm2): Not stated. Other characteristics: Mean age (years): 56.7 (I), 57.2 (C) M:F 1:3.6 (I), 1:9.5 (C) Ulcer stage: Grade 2 - 8 (I), 5 (C) Grade 3 - 4 (I), 18 (C) Race (patients): Black - 4 (I), 6 (C) White - 17 (I), 14 (C) Hispanic - 1 (I), 0 (C) No statistically significant differences between the groups.	Mean (SD) % ulcer area reduction: I: 8.0 (14.8), n=20 C: 5.1 (14.8), n=20 Perimeter of ulcer traced on to a transparency and area determined by computer. Largest length, width and depth of the wound was measured and a photograph was taken at each assessment.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure: computer generated scheme.	Withdrawals: I: 3 patients were omitted from the final analysis. No reasons are given for these withdrawals. C: no withdrawals. Three patients were not evaluable and their data are not presented in the baseline characteristics. One case of inflammation occurred in the I group, and another patient had excoriation, which was possibly related to I treatment. There were no adverse reactions to C treatment.
Topical agent		**Modern dressing**						
Brod (1990) [26] Setting and length of treatment: Academic skilled nursing facility caring for the elderly. Treatment	Polyhydroxyethyl methacrylate (Poly-hema) dissolved in polyethylene glycol, applied as a paste which solidified to a flexible dressing, n = 27.	Hydrocolloid dressing (DuoDerm, Granuflex) applied as a sheet with adhesive backing, n = 16. Surgical debridement took place before randomisation in three patients. Dressings were	43	Inclusion criteria: Grade 2 or 3 pressure ulcers as assessed by inspection, and estimated life expectancy of ≥6 months. Normal marrow, hepatic and renal functioning. Exclusion criteria: Not stated.	Median area of wound (cm2): I: 2.5 C: 1.9 (p = 0.09) Other characteristics: All groups Mean age (years): 84.5 M:F Not stated Wound duration	Complete healing rates: I: 13/25 C: 10/16 Median time to complete healing (days): I: 32 C: 42 (no measure of precision)	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated, but patients were randomised in 60:40 ratio, stratified by	Withdrawals: I: Two deaths. C: One death (due to concurrent illness); two patients (7.4%) discontinued treatment because of adverse effects or poor response. DuoDerm easier to apply, being a paste. Complications were

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
continued to complete ulcer healing (maximum treatment length approx. 100 days)		changed routinely twice weekly, with additional dressings if dressing came off or became contaminated or disrupted.			(months): Not stated	Absolute healing rate to wk 6 (cm2/wk): I: 0.18 C: 0.10 (no measure of precision) Methods of measurement not stated.	lesion stage.	uncommon, but no data presented.
Brown-Etris (1996) [27] Setting and length of treatment: hospital, long-term care, home or outpatients. Medical centres (no other details). Trial participation was until 10 weeks, or treatment change was indicated or the wound healed, whichever came first.	I1: Topical hydrogel (Transorbent) n=66	I2: Hydrocolloid dressing (Duoderm CGF, Granuflex CGF), n = 55 Evaluation took place weekly, dressing changes occurred every 7 days or more frequently.	121	Inclusion criteria: Patients > 18 years with one or more pressure ulcers. Grade 2, 3 or 4 only. Wound size between 2 and 80 cm2 and < 1 cm deep, clinically noninfected, eschar free, with ≥75% granulation base with fixed wound margins. Adequate nutritional intake by mouth, tube or hyperalimentation. Exclusion criteria: Grade 1 ulcers or grade 4 ulcers with exposed tendon or bone; wound size < 2 cm2 or > 80 cm2, or > 1 cm deep; wounds covered with necrotic eschar or necrotic wound base containing > 25% slough; diagnosis or	Mean surface area of wound: Not stated. Other characteristics: All groups Mean age (years): 70 M:F 1:1 Duration (months): < 1 23% (I1), 31% (I2) 1–3 38% (I1), 49% (I2) 4–6 10% (I1), 14% (I2) 7–12 13% (I1), 2% (I2) > 12 16% (I1), 4% (I2) Location: Sacrum 33% (I1), 37% (I2) Trochanter 17% (I1), 26% (I2) Heel 16% (I1), 8% (I2) Ischium 16% (I1), 13% (I2) Malleolus 10% (I1),	Wound surface area reduction: data presented as ?mean wound surface area reductions by initial stage and size of ulcer, but no measures of precision (SD) given, therefore no data available for meta-analysis. No statistically significant difference between treatment groups reported. Area reduction assessed by gravimetric planimetry with wound tracing onto plastic film and photography. Independent analysis by biostatistical	No *a priori* sample size calcs. Blinded outcome assessment. Randomisation procedure not stated, but stratified by surface area and stage.	Withdrawals: 19 randomised patients were not included in the analysis as they did not complete the first three weeks of the study, or missed two or more sequential weekly visits. Withdrawals reported but not by treatment group or reasons given. No significant differences in clinical wound infection, odour, or dressing changes/week.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				suspicion of osteomyelitis at study wound site; carcinomatosis, or signs or symptoms of wound clinical infection; inadequate nutritional intake; sinus tract, tunneling or > 0.5 cm of wound margin undermining.	4% (I2) Spine 6% (I1), 2% (I2) Knee 2% (I1), 0% (I2)	analysis firm. Change in level of wound margin undermining assessed.		
Darkovitch (1990) [28] Setting and length of treatment: maximum 60-day trial unless wound healed, patient discharged or withdrawn by clinician. Measurements taken at each dressing change or at least weekly intervals.	I1: Hydrogel (Biofilm), n=62	I2: Hydrocolloid dressing (DuoDerm, Granuflex), n=67 All wounds were initially cleansed with hydrogen peroxide and saline. Patients with an oily skin were degreased to allow for a 1.25 inch adhesion belt around the wound. Although this was not maintained where the wound was > 20 cm2, instead utilizing 4 x 4 inch dressings. Dressings were usually changed every 3-4 days and washed in saline before reapplication. All patients lay on pressure-reducing mattresses.	90 pts 129 ulcers	Inclusion criteria: Patients in acute care facilities and nursing homes with grade 1 or 2 pressure ulcers, ulcers (size > 2 cm2). Exclusion criteria: Receiving radiation therapy; infection, sinus tracts or fistulae in the wound; a blood sugar level > 180 mg/dl; no improved nutritional status.	Mean area of wound (cm2): I1: 11.0 (range, 0.2-100) I2: 9.2 (range, 0.4-64) Other characteristics: All groups Mean age (years): 75 M:F 1:1.6 Ratio of grade I:II ulcers: 1:1.3 (I1), 1:1.6 (I2) Serum albumin (g/dl): 2.8 (I1), 2.7 (I2) No. grade I wounds: 27 (I1), 31 (I2) No. grade II wounds: 35 (I1), 67 (I2) There was a significant difference between the age of patients in the acute care setting (69 years) and the extended care facilities (83 years).	Complete healing at 60 days: I: 24/60 C: 12/67 Complete healing or improved at 60 days: I: 56/62 C: 52/67 Mean reduction in wound area at 60 days (cm2): I: 7.5 C: 3.7 (no measure of precision given) Perimeter of ulcer traced and in some cases photographed to determine the size of the ulcer.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: Six extreme results were exempt from the analysis to make it more meaningful. Three patients in the I1 group and one in the I2 group had wounds that enlarged by > 10% per day. One patient in each group was excluded because their wounds decreased by more than 25% per day. Hydrogels such as Biofilm (I1) offered the ability to absorb excess fluid without degradation and maintain a moist environment. Patients appeared to prefer I1 too because of the lack of odour, cushioning and lightness. The gel layer in I2 was found to degrade easily, which necessitated mechanical cleansing of the wound, which damaged the healing tissue layers.
Mulder (1993) [25] Setting and length of treatment: a multicentre	Hydrogel (Clearsite), changed twice a week, n=23	Hydrocolloid dressing (DuoDerm, Granuflex) changed twice a week, n = 20.	43	Inclusion criteria: Grade 2 and 3 pressure ulcers ≥1.5 cm x 0.5 cm, but ≤10 cm x 10 cm. All patients had to be	Area of wound (cm2): Not stated. Other characteristics: Mean age (years):	Mean (SD) % ulcer area reduction: I: 8.0 (14.8), n=20 C: 3.3 (32.7), n=21 Perimeter of ulcer	No *a priori* sample size calcs. No blinded outcome assessment.	Withdrawals: I: 3 patients were omitted from the final analysis. No reasons are given for these withdrawals. C: 0 withdrawals

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
trial (three independent sites). Assessments of ulcer size made weekly for 8 weeks or until the ulcer was healed. Where possible, each patient evaluated by same investigator throughout the trial.				>18 years and have a life expectancy of at least two months. Exclusion criteria: Grade 4 wounds or those with tendon, bone, capsule, or fascia exposure; pregnancy; chemotherapy; prior wound infection; extensive undermining of the ulcer (> 1 cm); AIDS; patients receiving > 10 mg of corticosteroids.	56.7(I), 63.1 (C) M:F 1:3.6 (I), 1:5.6 (C) Ulcer stage: Grade 2 - 8 (I), 9 (C) Grade 3 - 14 (I), 13 (C) Race (patients): Black - 4 (I), 3 (C) White - 17 (I), 16 (C) Hispanic - 1 (I), 1 (C) No statistically significant differences between the groups.	traced on to a transparency and area determined by computer. Largest length, width and depth of the wound was measured and a photograph was taken at each assessment.	Randomisation procedure: computer generated scheme.	Three patients were not evaluable and their data are not presented in the baseline characteristics. One patient treated with C had mild irritation, another showed minor sensitivity. One case of inflammation occurred in the I group, and another patient had excoriation, which was possibly related to I treatment.
Palmieri (1992) [29] Setting and length of treatment: Wound clinic. Treatment was continued until all wounds had healed.	Polysaccharide beads (Debrisan) were applied directly to the wound bead and replaced daily, n = 24, in total in trial, n for pressure ulcers only unknown. All wounds were sharp debrided prior to randomisation. In addition all wounds were treated to ensure negative bacterial cultures at baseline.	Collagen sponge applied directly to the wound after saline nebulisation. The dressing was checked every day and, if the collagen sponge was swollen or partially reabsorbed, more sponge was applied without removing the previous one. Greasy sponge and regular non-allergenic tape completed the dressing, n = 24 in total, n for pressure ulcers only unknown.	12 pressure ulcers only	Inclusion criteria: Venous leg ulcers; pressure ulcers; diabetic gangrene; pressure ulcers; post-traumatic wounds; burns and radioactive ulcers. Note: Data are only given here for pressure ulcers. Exclusion criteria: Additional treatments with drugs (with the exception of digitalis).	Wound area: Not stated. Other characteristics: All groups Age range (years): 58-75 M:F 1:0.6 Wound type: Leg ulcers -12 Diabetic gangrene -12 Pressure ulcers -12 Post traumatic - 12	?Mean ('average') time to healing (days): I: 47 C: 20 (measure of precision not noted, ?SEM, ?SD) Grading by clinical assessment only.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	No withdrawals. Needed to read results off graph, no primary data given in the text. No information re numbers allocated to each group for pressure ulcer patients only.
Sayag (1996) [30] Setting and	Polysaccharide beads (Debrisan paste) applied to a depth of 3 mm	Calcium alginate dressings (Algosteril) applied directly on to wound to cover the	92	Inclusion criteria: Patients aged ≥60 years hospitalised for ≥ 8 weeks, with a	Mean area of wound (cm2): I: 16.1 ± 12.5 SD C: 20.1 ± 12.9 SD	Mean (SD) wound area reduction per wk (cm2):	*A priori* sample size calcs. No blinded	Withdrawals: I: 22 C: 10

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
length of treatment: a multicentre trial based at 20 centres (17 specialising in the care of elderly people and three in dermatology). Assessments were made on a weekly basis by the same assessor.	over the wound surface, n = 45.	entire area, n=47. In both groups a sterile gauze was applied as a secondary dressing. No other local treatments were used except for saline solution, the use of which was not restricted. Dressings were inspected and changed daily or at least every four days depending on the degree of exudate.		pressure ulcer graded 3 or 4 and surface area from 5-100 cm2.. Ulcers were located on the sacrum, ischium, trochanters and heels. Exclusion criteria: More than half the total ulcer area had granulating tissue; ulcer covered by necrotic plaque; active infection requiring local or systemic antibiotic therapy; severe renal failure.	Other characteristics: Mean age (years): 80.4 (SD 9.1) (I), 81.9 (SD 8.9) (C) M:F 1:2.8 (I), 1:2.9 (C) Mean (SD) duration (months): 3.0 (3.2) (I), 3.5 (3.8) (C) Wound grade: III - 30 (I), 33 (C) IV - 15 (I), 14 (C) No significant difference between the two groups. Where patients had multiple wounds only one was selected for study.	I: 0.27 (3.21), n=45 C: 2.39 (3.54), n=47 Number wounds with >75% area reduction: I: 6/45 C: 15/47 Number wounds with >40% area reduction: I: 19/45 C: 35/47 Area of ulcer measured by planimetry, digitised twice and the area calculated by computer. The mean of the two values was used to determine individual ulcer area. A photograph was taken of each wound at every evaluation.	outcome assessment. Randomisation procedure stated: sealed envelopes.	All withdrawals were included in the analysis and few were considered to have improved at the last evaluation. End point data were not available for one patient in the C group due to admission to a special care unit. Reasons for withdrawals: I: death (6); adverse event (1); deterioration or stagnation of ulcer after 4 weeks (15). C: death (5); transfer (2); deterioration of health (1); deterioration or stagnation of ulcer after 4 weeks (2). On average the number of dressing changes per week was similar: 4.28 (1.49 SD) for C and 4.52 (1.42 SD) for I. 8% of C and 33% of I patients experienced adverse effects.
Burgos (2000b) [31] Setting and length of treatment: multicentre trial at seven Spanish hospitals. Treatment was for 12 weeks or	Collagenase ointment (Iruxol), applied daily in 1-2 mm thick layer, n=18	Hydrocolloid dressing (Varihesive), changed every 3 days, n=19.	43 ulcers 37 pts	Inclusion criteria: aged ≥55 years, stage 3 ulcer for <1 year. Exclusion criteria: end-stage organ disease, localised or systemic signs and/or symptoms of infection, or hypersensitivity to collagenase.	Mean (SD) ulcer size: Not reported. Mean (SD) ulcer staging score (Arnell): I: 17.7 (3.4) C: 20.2 (5.9) Ulcer age (months) (range): I: 3.2 (2.0) C: 2.6 (1.9) Other characteristics:	Mean (SD) ulcer area change (cm2): I: -9.1 (12.7), n=18 C: -6.2 (9.8), n=19 Mean % ulcer area reduction:: I: 44.2 C: 27.9 (no measure of precision) Complete healing: I: 3/18 C: 3/19	No *a priori* sample size calcs. No blinding. Randomisation procedure stated: computer-generated list, block randomisation (size=4).	Withdrawals (n=8): I: 8 (death, n=3, discharge n=3, transfer n=3) C: 6 (death n=1, deterioration n=1, discharge n=1, protocol violation n=2, lack of efficacy n=1) Costing data: Significantly reduced nursing time for

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
until ulcer healing, whichever occurred first.					Age + range (years): I: 81.9 + 12.7 C: 78.6 + 10.4 M:F ratio: I: 1:1.2 C: 1:1.25	Assessed via measurement, photography, acetate tracing and planimetry.		hydrocolloid dressing 4.6 mins/patient/day vs 8.6 for collagenase.
Modern dressing		**Traditional dressing**						
Mulder (1993) [25] Setting and length of treatment: A multicentre trial (three independent sites). Assessments of ulcer size made weekly for eight weeks or until the ulcer was healed. Where possible, each patient evaluated by same investigator throughout the trial.	Hydrocolloid dressing (DuoDerm, Granuflex) changed twice a week, n = 20.	Saline solution and moistened gauze, changed three times a day, n = 21. Dressings were changed either by the patient or the care giver, after they had received appropriate instructions.	41	Inclusion criteria: Grade 2 and 3 pressure ulcers ≥1.5 cm x 0.5 cm, but ≤10 cm x 10 cm. All patients had to be >18 years and have a life expectancy of at least two months. Exclusion criteria: Grade 4 wounds or those with tendon, bone, capsule, or fascia exposure; pregnancy; chemotherapy; prior wound infection; extensive undermining of the ulcer (> 1 cm); AIDS; patients receiving > 10 mg of corticosteroids.	Area of wound (cm2): Not stated. Other characteristics: Mean age (years): 63.1 (I), 57.2 (C) M:F 1:5.6 (I), 1:9.5 (C) Ulcer stage: Grade II - 9 (I), 5 (C) Grade III - 13 (I), 18 (C) Race (patients): Black - 3 (I), 6 (C) White - 16 (I), 14 (C) Hispanic - 1 (I), 0 (C) No statistically significant differences between the groups.	Mean (SD) % ulcer area reduction: I: 3.3 (32.7), n=21 C: 5.1 (14.8), n=20 Perimeter of ulcer traced on to a transparency and area determined by computer. Largest length, width and depth of the wound was measured and a photograph was taken at each assessment.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure: computer generated scheme.	No withdrawals in either group. Three patients were not evaluable and their data are not presented in the baseline characteristics. One patient treated with I had mild irritation, another showed minor sensitivity. There were no adverse reactions to C treatment.
Alm (1989) [32] Setting and length of treatment:	Hydrocolloid dressing (Comfeel) changed when necessary. This included Comfeel	Wet saline gauze changed routinely twice daily n=31 ulcers. 50 patients with 56	56	Inclusion criteria: Patients on long-term wards with pressure ulcers. Exclusion criteria:	Wound size: Median depth (mm): 1.75 (I), 2.00 (I), Median area (cm2): 2.02 (I), 2.44 (C)	Complete healing at 6 weeks: I: 11/25 C: 5/31	No *a priori* sample size calcs. Blinded outcome assessment. Randomisation	Withdrawals: I: 2 C: 3 Drop-outs occurred because of death for

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
long-stay wards (multicentre). Treatment was initially for 6 weeks; if healing not complete, treatment continued for 3-6 weeks.	Ulcus sheet, paste and powder. Sheet: sodium carboxymethylcellulose particles embedded in an adhesive elastic mass. Paste: sodium carboxymethylcellulose, guar cellulose and xanthan cellulose n=25 ulcers	pressure ulcers were randomised.		Patients with a Norton score < 7.	Other characteristics Mean age (years): 84 (I), 83 (C) M:F approx. 1:3 (all groups) Duration (months): 4.6 (I), 4.8 (C) Norton score: 12 (I), 13 (C) Body weight (kg): 50 (I), 50 (C) About one-third of ulcers were on the heel, and one third on the sacral region.	Median remaining ulcer area at 6 weeks: I: 0% C: 31% (no measure of precision) Assessed by weekly photography of ulcer, evaluated by dermatologist blinded to treatment.	procedure not stated, but stratified by Norton score, ulcers rather than patients randomised.	reasons unrelated to treatment, or violation of protocol or unknown reasons. One patient was lost because data were incomplete. Patients in the hydrocolloid (I1) group were reported to have the most favourable healing distribution function, though the overall difference was non-significant. No difference in pain at dressing changes.
Barrois (1992) [33, 34] Setting and length of treatment: 56 days or earlier if ulcer healed.	Hydrocolloid dressing (Granuflex standard), n=38 Cleansing was carried out with saline, and debridement with forceps if necessary.	Standard dressing (tulle gauze) impregnated with povidone-iodine antiseptic, n=38	76	Inclusion criteria: Patients with open necrotic pressure ulcers or ulceration. Exclusion criteria: Not stated.	Mean surface area of wound: 15 cm2 (all patients). Surface area of ulcers reported as comparable between treatment groups, no details presented. No other baseline details of patients.	Complete healing at 8 weeks: I: 10/38 C: 9/38 Overall improvement at 8 weeks: I: 32/38 C:27/38 Mean % reduction in surface area: I: 10%/week C: 7%/week (no measure of precision) Healing assessed as ulcers improved (totally or partially healed). Tracing took place every seven days, photographs at days	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: I: Two patients due to deterioration in pressure ulcer. C: Five patients due to deterioration in pressure ulcer. No adverse effects observed, but no data are reported. Mean dressings used: Granuflex: 2.4/week Standard: 5.1/week ($p < 0.0001$).

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
						0, 28, 56.		
Colwell (1993) [35] Setting and length of treatment: academic tertiary care centre. Average length of time in study = 17 days, range 6-56 days.	Hydrocolloid dressing (DuoDerm; Granuflex) extending at least 2.5 cm beyond ulcer margins, changed every four days or as needed, n = 33. All patients were placed on pressure-reducing surface (foam overlay or low air loss bed), and in both groups ulcers and surrounding skin were cleansed with warm tap water and dried.	Moist gauze dressings with 0.9% sodium chloride solution, loosely applied and covered with sterile dry gauze dressing and a secondary dressing to keep inner dressing moist, secured with hypoallergenic tape. Changed every Six hours, or as needed, n = 37.	94 pts 157 ulcers	Inclusion criteria: Patients with pressure ulcers. Exclusion criteria: Underlying condition or treatment likely to affect healing. Clinically infected ulcers, grade 1 or 4 pressure ulcers, or pressure ulcer that could not be accurately graded. Patients were excluded if they did not remain in the study for $\geq$ 8 days, or were receiving other ulcer therapy likely to confound results (e.g. hydrotherapy).	No. of ulcers: C: 48 (49%) I: 49 (51%) Ulcer location: Sacrum/coccyx C: 29 (60%) I: 27 (55%) Other C: 19 (40%) I: 22 (45%) Duration of ulcer: < 1 month C: 25 (60%) I: 27 (59%) 1-3 months C: 21 (45%) I: 19 (41%) Ulcer grade II: C: 33 (69%) I: 21 (44%) Ulcer grade III: C: 15 (31%) I: 28 (56%) Initial ulcer length (cm): C: 1-21 I: 1-12 Initial ulcer width (cm): C: 0.4-10 I: 1-10 Initial ulcer area (cm): C: 2.3 I: 2.4 Total : 70 patients with 97 pressure ulcers Other characteristics: Mean age (years): 68 (C), 68 (I) M:F 1:1.1 (all groups) No significant differences in continence or general	Number of ulcers with complete healing at 8 weeks: I: 11/48 C: 1/49 Reported no statistically significant difference between groups in total ulcer surface area at end of study, stage of ulcer, length of time in study, change in ulcer length or width, but no primary data presented. Measured by tracing every 4th day on acetate film and measuring with electronic planimeter. Width and length recorded. % of pressure ulcers completely healed calculated.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: of 94 patients initially enrolled, 24 did not complete eight days of treatment for reasons not given, five were discharged prior to completion of eight days of treatment, 12 died of unrelated causes, five were lost to follow up. Two dropped out because of colonization with methicillinresistant *Staphylococcus aureus,* one because ulcer progressed to grade 4. No other outcomes reported, though a major focus of the paper was cost-effectiveness. Total cost per case was much lower with I than C.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
					health; typical patient had poor health, nutritional status, and was confused and debilitated. Significantly more grade 2 ulcers in I group, hence groups were stratified by ulcer grade for analysis. Significantly fewer I patients with diabetes.			
Kraft (1993) [36] Setting and length of treatment: tertiary care veteran's hospital. Patients treated for 24 weeks.	Non-adherent semiocclusive foam wound dressing with an adhesive cover (Epi-Lock), n = 24.	Saline-moistened gauze, changed once every 8 hours, n = 14. Standardised dressing procedures applied in both groups.	38	Inclusion criteria: Patients with pressure ulcers. Exclusions criteria: Grade 1 and 4 pressure ulcers; infected ulcers; patients on special beds; unstable insulin-dependent diabetes; serum albumin < 2 g; haemoglobin < 12 g; Class IV congestive heart failure; chronic renal failure; severe peripheral vascular disease; severe chronic obstructive pulmonary disease.	Wound area: Not stated. Other characteristics: Mean age: 56 years (all groups). Geriatric but mainly spinal cord injured patients. Duration of ulcers: ranged from new to 5 years. Ulcers in existence two months or less in 53% of subjects. Previous hospitalisation for pressure ulcer treatment (usually saline) reported in 53% of patients. Grade 2 ulcers were present on 22 patients and grade 3 were found on 16 patients.	Number of patients with healed ulcers by week 12: I: 10/24 C: 2/14 Number of patients with healed ulcers by week 24: I: 10/24 C: 3/14 Assessed at weeks 3, 6, 12, and 24 by same rater using staging system.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: I: 10/24 (42%) C: 3/14 (21%) (*p = 0*.26) I: 11 (five where staff requested removal, and four because of reactions to treatment) C: Six (two deaths, one reaction to saline, three other reasons). Grade 2I ulcers showed most healing by six weeks. Grade 3 ulcers healed more slowly. Epi-lock (I) dressing required fewer dressings per week and less nursing time, so that the overall weekly dressing cost for Epi-lock was US$21 vs. US$75 for saline.
Sebern (1986) [37, 38]	Polyurethane sterile dressing (moisture vapour	Wet-to-dry gauze dressing, with saline on the contact layer,	48 pts 77	Inclusion criteria: Patients with grade 2 or grade 3 pressure	Median area of wound (cm2): Grade 2I:	Complete healing for grade 2 ulcers at	No *a priori* sample size calcs. No	Withdrawals: 23 drop-outs in less than three weeks; most

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Setting and length of treatment: home care setting. Treatment continued for 8 weeks.	permeable). Changed daily to three times a week depending on adherence of dressing, n = 100 ulcers. Study protocol included a turning schedule and wheelchair push-ups. Wheelchair-dependent patients were given a silicone gel pad or dense foam cushion, or an alternating pressure pad for patients in bed. The same protocol for pressure relief and wound irrigation was used in both groups.	covered with dry gauze and pad. Changed every 24 hours, with saline used to loosen dressing, and irrigation with half-strength hydrogen peroxide and saline. If wound was contaminated, povidone iodine was applied for two minutes and rinsed away with saline, n = 100 ulcers.	ulcers	ulcers receiving visits from nursing service. Exclusion criteria: Wound containing eschar, grade 1 or 4 ulcers, patient had terminal illness, white cell count < 4000, or patient had three or more existing ulcers; necrotic ulcers; pressure ulcers > 50 cm2.	I: 1.9 C: 3.4 Grade 3: I: 6.1 C: 4.5 Other characteristics: Mean age (years): 76.3 (I), 72.4 (C) Grade 2: 59%(I), 30% (C) Grade 3: 41%(I) 70% (C) No statistically significant group differences in height, weight and PULSES score. All participants had a chronic illness, and according to PULSES score were very severely disabled. All patients had chronic illness (mostly focal cerebral disorders, spinal cord disorders, neurological disorders, and miscellaneous chronic conditions, e.g. cardiac causes) and poor nutrition. 5-9% of ulcers were on the foot.	eight weeks: I: 14/22 C: 0/12 Median % decrease in wound area, Grade 2 ulcers: I: 100%, n=22 C: 52%, n=12 (no measure of precision) Median % decrease in wound area, Grade 3 ulcers: I: 67%, n=15 C: 44%, n=28 (no measure of precision) Wound area measured with a clear plastic measuring card and the area calculated by assuming an elliptical shape.	blinded outcome assessment. Randomisation procedure stated: random number list used to assign ulcer treatments.	frequently due to death, hospitalisation, and inability to comply with the study protocol for pressure relief. No differences in supply costs, but costs of treatment (including nursing visits) for grade 2 ulcers significantly lower with I ($p < 0.05$). Less pain with I, though no data presented.
Xakellis (1992) [39] Setting and length of treatment: Intermediate-level long-term	Hydrocolloid dressing rimmed with tape, changed if non-occlusive and changed twice weekly to allow wound assessment. Cleaned with	Saline gauze (nonsterile 8-ply 4 x 4-inch gauze dressing moistened with saline covered with two non-sterile gauze dressing rimmed with tape), n = 21.	39	Inclusion criteria: Patients with skin break over a bony prominence. Exclusion criteria: Grade 1 or 4 pressure ulcers; rapidly fatal disease, or	Median wound surface area (cm2): I: 0.66 C: 0.38 (NS) Other characteristics: Age (years): 77(I), 84 (C)	Complete healing at 6 months: I: 16/18 C: 18/21 Median time to healing (days):	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: I: Two withdrawals C: Three deaths. Median nursing cost (including cost of nursing time) was significantly lower for the hydrocolloid group (I), though total

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
care facility. Treatment period six months maximum.	normal saline at this time, n = 18.	Routine care to all participants included repositioning every two hours and cleaning of incontinence with warm water as required. Necrotic tissue was debrided using sharp debridement at enrolment and during treatment as necessary. All patients were placed on an air mattress and an air-filled wheelchair cushion.		anticipated discharge within one week; skin ulcers from cause other than pressure – e.g. venous stasis ulcers.	M:F 1:12 (all groups) Norton score: 11 (I), 13 (C) No statistically significant group differences in other baseline measures, including comorbidities (diabetes, stroke, cancer, dementia, urinary tract infection, Foley catheterisation, other mobility-limiting condition), incontinence, nutritional status, % with exudate, erythema, necrotic tissue, maceration, ulcer grade 2 or 3, location of ulcer, or history of ulcer at same site.	I: 9 C: 11 (no measure of precision) Time to 75% healing (days): I: 14 C: 26 (no measure of precision) Assessed number of wounds healed i.e. with epithelial covering by inspection and absence of moist surface by palpation.		nursing costs using local nursing wages were not significantly different, though at national wage rates hydrocolloid treatment was cheaper.
Chang (1998) [40] Setting and length of treatment: hospital, Malaysia. Treatment period was eight weeks or less if ulcer healed.	Hydrocolloid dressing (DuoDerm), changed every seven days or earlier if leaking, n=17	Saline soaked gauze dressing, changed daily, n=17	34	Inclusion criteria: stage 2 or 3 pressure ulcer, ≥18 years age. Only one pressure ulcer per patient was eligible for study entry. Exclusion criteria: immunocompromised, infected ulcers, known sensitivity to study dressings.	Ulcer area: Not stated. Mean (range) age: 57.6 (20-85) years - all patients. Mean duration of ulcer: 33 days (range 2-274) - all patients. Stage 2 ulcers: I: 11/17 C: 7/17	Change in mean surface area from baseline: I: -34%, n=17 C: +9%, n=17 (no measure of precision) Assessed with acetate tracings, colour photography.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	No withdrawals reported. Performance data all favour DuoDerm for dressing adherence, exudate handling ability, comfort, pain, ease of use. No difference in costs (using nursing time data) between the two treatments. Adverse events: I: 0 C: 1, wound infection Sponsored by ConvaTec.
Matzen (1999) [41] Setting and	Hydrocolloid dressing (hydrogel, Coloplast),	Saline soaked gauze dressing, changed daily, n=15	32	Inclusion criteria: stage 3 or 4 non-infected pressure ulcers.	Ulcer area: Not stated. Median (range) age: I: 82 (32-97) years	Relative mean (SD) wound volume (%) at 12 weeks:	No *a priori* sample size calcs. No blinded	Withdrawals: I: 9 (illness n=5, death n=2, missing schedule n=1, patient withdrew

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
length of treatment: hospital patients, Denmark. Followed for 12 weeks or until ulcer healed, including at home.	changed daily, n=17 Surgical debridement carried out on all patients prior to randomisation. All ulcers were dressed with Comfeel transparent dressing.			Exclusion criteria: diseases or drugs known to impair healing.	C: 84 (46-89) years Mean duration of ulcer: Not stated. Median (range) ulcer stage: I: 4 (3-4) C: 4 (3-4) M:F ratio: I: 1:7.5 C: 1:4.0	I: 26 (20), n=17 C: 64 (16), n=15 Complete wound healing: I: 5/17 C: 0/15 Ulcer volume measured by amount of water needed to fill cavity. Assessed weekly.	outcome assessment. group. Randomisation procedure not stated.	n=1) C: 11 (treatment failure n=6, other illness n=3, death n=1, patient withdrew n=1) No difference in odour, pain, comfort or length of time dressing required.
Thomas (1998) [42] Setting and length of treatment: nursing homes and home care services. Treatment was for 10 weeks.	Hydrogel dressing, one eighth inch thick layer, changed daily, n=22 Ulcer cleansed with saline, treatment dressing applied, then covered with dry sterile nonwoven gauze, held in place with thick dressing.	Saline soaked gauze, changed daily, n=19 Concomitant use of other topical medications to the study ulcer was not permitted.	41	Inclusion criteria: aged ≥ 18 years, stage 2-4 pressure ulcers ≥1 cm2. Only one pressure ulcer per patient was evaluated. Exclusion criteria: ulcers of nonpressure aetiology, wounds with sinus tracts and/or undermining >1cm, clinically infected wounds, severe illness, life expectancy < 6 months, those HIV positive, or alcohol or drug dependent, pregnant or breast-feeding, diagnosis of cancer or on chemotherapy.	Mean (SD) ulcer area (cm2): I: 8.9 (9.3) C: 5.9 (6.0) Mean duration of ulcer: Not stated. Ulcer stage II: I: 8/16 C: 6/14 Ulcer stage III: I: 6/16 C: 7/14 Ulcer stage IV: I: 2/16 C: 1/14 Other characteristics: Mean (SD) age: I: 79 (9) years C: 72 (13) years M:F ratio: I: 1:1.3 C: 1:0.6	Complete wound healing at 10 weeks: I: 10/16 C: 9/14 Mean (?SD ?SEM) healing time (weeks): I: 5.3 (2.3), n=10 C: 5.2 (2.4), n=9 Assessed weekly by ulcer tracings and photographs.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals (n=11): I; 6 (death n=4, ulcer worsening n=1, hospitalised n=1) C: 5 (death n=2, ulcer worsening n=1, hospitalised n=1, protocol violation n=1)
Kloth (2002) [43]	Noncontact normothermic wound therapy,	Standard wound care, n=22. This involved daily	53 pts 56	Inclusion criteria: Inpatients with stage 3 and 4 pressure	Mean (SD?) ulcer area (cm2): I: 5.4 (1.7)	Wound closure by 12 weeks: I: 10/21	No *a priori* sample size calcs. No	Withdrawals (n=13): death or deterioration n=10, non-compliant n=3.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Setting and length of treatment: seven USA long-term care facilities. Treatment was for 12 weeks.	(Warm-Up), n=21. This involved wearing a sterile, noncontact wound dressing (cover) 24 hours per day, 7 days per week for 12 weeks or until wound closure. The radiant heat element was inserted into the wound cover and activated for three separate one-hour periods, with at least two hours between warming sessions.	removal of moisture retentive dressing (hydrofibers, alginates, hydrogels, hydrocolloids, saline-moistened gauze, saline-impregnated gauze), irrigation with saline, and application of fresh dressing. All other enzymes, pastes and other impregnated dressing were prohibited. All patients were on 2-hourly turning schedules and alternating pressure mattresses.	ulcers 43 analysed	ulcers. Exclusion criteria: poorly controlled diabetes, terminal illness, wound undermining >1cm, clinical signs of infection, >50% wound covered with necrotic tissue after debridement, allergy to adhesives.	C: 4.1 (0.8) Mean (SD?) age of ulcer (days): I: 106.3 (22) C: 151.0 (36) Other characteristics: Mean (SD?) age (years): I: 78.1 (3) C: 77.9 (4) M:F ratio: I: 1:1.3 C: 1:2.1	C: 8/22 Change in wound surface area per week treated (cm2): I: 0.52 ± 0.11, n=21 C: 0.23 ± 0.03, n=22 (measure of precision not noted, ?SD, ?SEM) Assessed by wound tracings, digital imagery with 3D stereophotogrammetry.	blinded outcome assessment. Randomisation procedure stated: random number generator. Unit of randomisation was ulcers.	Not noted in which treatment group these withdrawals occurred.
Whitney (2001) [44] Setting and length of treatment: Variety of USA care settings: primary care, home care, acute care, and long-term care facilities. Treatment was for eight weeks or until ulcer healed whichever	Noncontact normothermic wound therapy (Warm-Up Active Wound Therapy), n=15. This involved a dressing with an open cell foam border and a noncontact transparent film cover that lies above the wound surface and contains a pocket. An infrared warming card connected to a temperature control unit was inserted three times daily for	Standard wound care, n=14. standard wound care, n=22. This involved reapplication of a moisture-retentive dressing (hydrofibers, alginates, hydrogels, hydrocolloids, saline-moistened gauze, saline-impregnated gauze), every 8-24 hours.	40	Inclusion criteria: ≥18 years age, stage 3 or 4 pressure ulcer, English speaking. Exclusion criteria: wound infection, existing dermatitis, recurrent ulcer, sensitivity to adhesives, corticosteroids, end-stage disease with <3 months' life expectancy.	Mean (SD) ulcer area (cm2): I: 10 (10) C: 7 (9) Wound duration <1yr: I: 11/15 C: 7/14 Wound duration ≥1yr: I: 2/15 C: 7/14 Wound stage III: I: 7/15 C: 11/15 Wound stage IV: I: 8/15 C: 3/14 Other characteristics:	Complete wound healing by eight weeks: I: 8/15 C: 6/14 Mean (SD) rate of wound healing (cm/day): I: 0.012 (0.008), n=15 C: 0.004 (0.006), n=14 Assessed by acetate tracings, planimetry, digital and Polaroid photography, and Pressure Ulcer Status Tool evaluations.	No *a priori* sample size calcs. No blinded outcome assessment. group (n=11). Randomisation procedure not stated, but used block randomisation with varied block sizes.	Withdrawals (n=11): I: nonadherence to protocol / withdrawal n=2, C: nonadherence to protocol / withdrawal n=6, infection n=1, clinician decision to change treatment n=1, peri-wound maceration n=1.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
occurred first.	one-hour treatments.				Mean (SD) age (years): I: 63 (21) C: 53 (19) M:F ratio: I: 1:0.9 C: 1:0.4			
Modern dressing		**Modern dressing**						
Belmin (2002) [45] Setting and length of treatment: geriatric hospital wards. Treatment was for eight weeks or until ulcer healed whichever occurred first.	Hydrocolloid dressing for eight weeks (DuodermE), n=53. If patients had deep ulcers, a hydrocolloid paste could be applied to the hydrocolloid dressing.	Calcium alginate dressing for four weeks (UrgoSorb), then hydrocolloid dressing for four weeks (Algoplaque), n=57 If patients had deep ulcers, a hydrocolloid paste could be applied to the hydrocolloid dressing. No paste could be added to the calcium alginate dressing.	110	Inclusion criteria: Pressure ulcer on sacrum, pelvic girdle or heel; surface area less than 50 cm2; granulation tissue area not covering more than 50% ulcer surface; no clinical evidence of active local infection. Exclusion criteria: Se albumin below 25 g/L; if being treated with radiotherapy, cytotoxic drugs, or cortocosteroids; or if surgical or palliative care needed.	Mean (SD) ulcer area (cm2): I: 14.7 (10.4) C: 12.6 (8.0) Mean (SD) age of ulcer (weeks): I: 7.2 (6.8) C: 7.7 (6.6) Other characteristics: Mean (SD) age (years): I: 84.8 (7.1) C: 82.2 (7.9) M:F ratio: I: 1:2.8 C: 1:2.1	Mean (SD) ulcer surface area at eight wks (cm2): I: 7.4 (10.2), n=53 C: 5.0 (8.2), n=57 Surface area reduction ≥ 40% at eight wks: I: 31/53 C: 43/57 Mean (SD) change in surface area at eight wks (cm2): I: -5.2 (7.2), n=53 C: -9.7 (7.1), n=57	*A priori* sample size calcs stated. No blinded outcome assessment. Randomisation procedure not stated, but was stratified by centre and used block randomisation, size=4.	Withdrawals (n=44): I: death n=11, transfer n=1, worsening health n=1, local adverse event n=1, pressure ulcer impariment. C: death n=8, transfer n=2, local adverse event n=3, pressure ulcer impairment n=3. Some performance data reported: ease of use, pain, odour, number of dressings. No cost data reported.
Banks (1997) [46] Setting and length of treatment: community patients. Treatment was for six weeks or until ulcer ligthly exudating whichever	Hydrocellular dressing (Allevyn), n=10	Polyurethane foam dressing (Lyofoam Extra), n=10	20	Inclusion criteria: adult patients with moderate to heavily exuding wounds. Exclusion criteria: patients with necrotic wounds, pregnant or breastfeeding mothers, patients with grade 1 or 4 pressure ulcers, patients already enrolled in this or another clinical trial within the past	Mean (SD) ulcer area (cm2): not reported. Mean (range) age of ulcer (weeks): I: 17.8 (4 weeks-1 year) C: 17.9 (1 week-2 years) Other characteristics: Mean age (years): I: 76.69 C: 74.95	Ulcer healing by six weeks: results given for all enrolled patients, including those with leg ulcers and other wounds. Data not presented for pressure ulcer patients separately.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure stated: computer-generated sequence.	Withdrawals (n=20, I: 9 C: 11): I: wound infection n=7, surrounding skin ulcerness n=1, cavity wound requiring different treatment n=1. C: death n=1, lack of efficacy n=1, wound infections n=4, heart failure n=1, chest infection n=1, logistic problems n=1, skin maceration n=1, antibiotics for UTI n=1.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
occurred first.				month.	M:F ratio: I: 1:1.6 C: 1:6.5			Patient comfort and ease of use results reported.
Seeley (1999) [47] Setting and length of treatment: USA, long-term facilities and wound centre outpatient clinic. Treatment was for eight weeks or until ulcer healed whichever occurred first.	Hydrocellular dressing (Allevyn), n=20	Hydrocolloid dressing (Duoderm CGF Border Dressing), n=20	40	Inclusion criteria: adults with stage 2 or 3 pressure ulcers. Exclusion criteria: ulcers smaller than 1cm2 or larger than 50cm2; patients with infected ulcers; patients with uncontrolled diabetes, known history of poor compliance with medical treatment.	Mean (SD) ulcer area (cm2): I: 6.84 (8.19) C: 4.61 (5.56) Mean (SD) age of ulcer (weeks): I: 11.8 (7.4) C: 23.1 (38.9) Other characteristics: Mean (SD) age (years): I: 75.7 (18.6) C: 76.7 (19.5) M:F ratio: I: 1:1.2 C: 1:1.1	Wound closure at eight weeks: I: 8/20 C: 6/19 Wound appearance improved by eight weeks: I: 12/20 C: 11/19 ?Mean % reduction in ulcer area by eight weeks: I: 50 C: 52 (no measure of precision)	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure stated: computer generated list, stratified by initial ulcer size.	Withdrawals (n=14, I: 8 C: 6): I: patient request n=1, lost n=3, adverse event n=2, death n=1, other n=1. C: adverse event n=2, death n=1, other n=3. Some performance data reported: ease of use, pain, odour, number of dressings. No cost data reported.
Bale (1998a) [48, 49] Setting and length of treatment: community-based trial with patients followed until wound healed, up to maximum of eight weeks.	Hydrocellular dressing (Allevyn), n=17 Dressings were only changed if there was leakage or specific indication, such as wound pain investigation.	Hydrocolloid dressing (Granuflex), n=15	32	Inclusion criteria: Pressure ulcers, leg ulcers and other wounds were included. Included stage 2 and 3 pressure ulcers. Exclusion criteria: Pregnant or lactating women, patients with stage 1 or 4 pressure ulcers, wounds too large to be covered by one dressing, wounds expected to heal within one week, wounds with sloughly or necrotic tissue, or	Mean surface area of wound: Not stated for pressure ulcer patients only. Other characteristics: Mean age (years): 76 (I), 78 (C) M:F 1:3.3 (all groups)	Complete wound healing by eight weeks: I: 10/17 C: 4/15 Assessment made by visual inspection.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated, used block randomisation, size=4.	Withdrawals only reported for all 100 enrolled patients, not stated for pressure ulcer patients only: 14 patients withdrawn due to adverse incidents, of which seven (maceration, overgranulation and pain) were related to dressings. Four patients excluded from analysis: one due to lost case report forms, two patients spent < 7 days in study, so insufficient data; and one protocol violation.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				grossly infected wounds. Only data for pressure ulcers reported here.				Patient-assessed comfort of dressings was also analysed. Hydrocellular dressings (I) were more comfortable, but results not stratified by wound type. Funding from Smith & Nephew Ltd.
Banks (1996) [50] Setting and length of treatment: Community setting. Length of treatment up to 4-6 weeks (pressure ulcers).	Hydropolymer dressing (Tielle), n=50 Dressings were changed every seventh day.	Hydrocolloid dressing (Granuflex, improved formulation), n=49	99	Inclusion criteria: Patients with grade 2 and 3 pressure ulcers, or venous leg ulcers. Exclusion criteria: Not stated. Only data for pressure ulcers reported here, not additional 100 patients with leg ulcers.	Mean surface area of wound (mm2): C: 286.24.7 I: 263.6 Other characteristics: Mean age 78.6 (C), 80.1 (I) M:F 1:2.2 (all groups) No significant differences in ulcer duration, wound area, ulcer grade distribution, visual appearance, exudate, odour, or pain at baseline. Approximately half of the pressure ulcers in each group were on the heels. Wounds were free of clinical infection, and had a maximum dimension of 8 cm.	Complete wound healing by 4-6 weeks: I: 12/50 C: 15/49 Wound appearance improved by 4-6 weeks: I: 39/50 C: 39/49 Number with reduced wound size: I: 35/46 C: 35/45 Method of wound assessment not noted.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: C: 4 I: 4 (both groups of patients) No difference in comfort or ease of removal between the two treatments.
Thomas (1997) [51] Setting and length of treatment: Community setting with	Hydropolymer dressing (Tielle), n=50	Hydrocolloid dressing (Granuflex), n=49 In both groups wounds were cleansed with sterile normal saline and	99	Inclusion criteria: grade 2 or 3 pressure ulcers; wound less than 10mm deep and maximum diameter of 8cm. Exclusion criteria:	Mean (SD) ulcer area (cm2): not reported. Age of ulcer (months): <1 month I: 8 C: 9	Complete wound healing by six weeks: I: 10/50 C: 16/49 Mean % reduction in ulcer area by six	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure	No withdrawals reported. Some performance data reported: ease of use, pain, odour, mean time dressings in place. No cost data reported.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
patients followed until wound healed, up to maximum of six weeks.		both groups had access to appropriate pressure-relieving support surfaces.		under 16 years age; known history of poor compliance with medical treatment; considered unlikely to survive the study period; previous adverse reaction to the materials under test; clinically infected wounds.	1-3 months I: 21 C: 18 >1 months I: 20 C: 21 Other characteristics: Mean (SD) age (years): I: 80.1 (10.2) C: 78.6 (14.3) M:F ratio: I: 1:1.2 C: 1:1.1	weeks: I: 75 C: 55 (no measure of precision)	stated: sealed envelopes.	Seven patients in the hydrocolloid dressing group and 10 in the hydropolymer group reported adverse events that were thought to relate to the dressing. Trauma or erythema on removal, skin maceration, bleeding, excess granulation tisse and wound dehydration.
Banks (1994a) [52] Setting and length of treatment: hospital based. Final assessment was after six weeks of treatment or sooner if wound healed.	Polyurethane dressing (Spyrosorb), n=13	Hydrocolloid dressing (Granuflex E), n=16	29	Inclusion criteria: Aged > 16 years, with shallow, moist ulcers of grade 2 or 3 that could be covered adequately with a single 10 cm x 10 cm dressing, who could be managed to prevent further lesions developing. Exclusion criteria: Patients with lesions involving tissues other than skin & subcutaneous fat; dry or necrotic lesions (included once debrided); patients taking systemic corticosteroids; patients whose ulcers had been dressed with either treatment in past two weeks, or who had previously shown sensitivity to either dressing;	Mean wound area (cm2): C: 2.4 I: 1.4 Other characteristics: Median age (years): 74 (C), 73 (I) M:F 1.1:6 (all groups) Median duration (days): 6.5 (C), 7 (I) Wound location: Buttock - 56% (C), 62% (I) Sacrum - 38% (C), 31% (I) Other - 6% (C), 8% (I)	Complete wound healing by six weeks: I: 10/13 C: 11/16 Median time to wound healing (days): I: 13.36, n=10 C:12.69, n=11 (no measure of precision) Wounds traced an acetate sheets at each dressing change.	No *a priori* sample size calcs. No blinded outcome assessment. Withdrawals and reasons reported by treatment group. Randomisation procedure not stated.	Withdrawals: C: Four all due to wound- or dressing-related problems. I: Three withdrawals (two due to wound- or dressing-related problems). No differences in comfort, or length of time dressings remained in situ. Spyrosorb significantly easier to remove and associated with significantly less pain at dressing changes ($p < 0.005$). No difference in appearance or odour. Trial sponsored by C.V. Laboratories and Calgon Vestal Laboratories.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				infected ulcers; patients incapable of giving an opinion about the dressing; patients incontinent of urine or faeces with sacral pressure ulcers or site likely to be soiled.				
Banks (1994b) [53, 54] Setting and length of treatment: patients resident in the community treated for six weeks unless the pressure ulcer had healed.	Polyurethane dressing (Spyrosorb), n=20 Patients in both groups were provided with pressure-relieving mattresses and cushions. Dressings were changed when the area discoloured by exudate was < 1cm from edge. Cleansing with warmed saline was undertaken if necessary. No topical applications were allowed.	Hydrocolloid dressing (Granuflex E), n=20	40	Inclusion criteria: Aged > 16 years, with shallow, moist ulcers of grade 2 or 3 that could be covered adequately with a single 10 cm x 10 cm dressing, who could be managed to prevent further lesions developing. Exclusion criteria: Patients with lesions involving tissues other than skin and SC fat, grade 1, 4 or 5 pressure ulcers, dry or necrotic lesions (included once debrided); patients taking systemic corticosteroids; patients whose ulcers had been dressed with either of the treatments in the previous two weeks, or who had previously reacted to either dressing; infected pressure ulcers; patients incapable of giving an opinion about the dressing; patients incontinent of	Mean wound area (cm2): C: 1.51 I: 1.47 Other characteristics I1 I2 Median age (years): 73 (C), 71 (I) M:F 1.1:1 (all groups) Median duration (days): 21 (C), 56 (I) Wound location: Buttock - 45%(C), 50%(I) Sacrum - 5%(C), 20%(I) Other - 50%(C), 30%(I)	Complete wound healing by six weeks: I: 12/20 C: 10/20 Wound improved (healed or greatly improved) by six weeks: I: 18/20 C: 10/20 Wound size measurements carried out using a structured light method to measure the area of the wound tracings.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure not stated.	Withdrawals: I: Two withdrawals for reasons unrelated to wound C: Two for wound deterioration; two for overgranulation; two for discomfort; four for reasons unrelated to the wound. Spyrosorb (I) reported to be easier to remove ($p < 0.005$). No significant differences in reported pain on removal, or comfort, or mean number of days which dressing remained in place.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
				urine or faeces with sacral pressure ulcers or site likely to be soiled.				
Bale (1997) [55] Setting and length of treatment: hospital setting, five UK centres. Treatment was for 30 days or until ulcer healed whichever occurred first.	Polyurethane foam dressing, n=29	Hydrocolloid dressing, n=31	61	Inclusion criteria: aged 18 years or over, able to undestand and consent to the trial; stage 2 or 3 pressure ulcers with largest diameter ≤11cm and no signs of wound infection. Exclusion criteria: history of poor compliance; previous involvement in the study; pregnant.	Ulcer area: <5 cm2 I: 14 C: 10 5-<10 cm2 I: 6 C: 6 10-<20cm2 I: 4 C: 9 ≥20cm2 I: 5 C: 6 Mean (SD) age of ulcer (weeks): not reported. Other characteristics: Median age (years): I: 73 C: 74 M:F ratio: I: 1:1.4 C: 1:1.1	Complete wound healing by four weeks: I: 7/29 C: 5/31	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure described as open randomisation list, stratified by centre.	Withdrawals (n=40, I: 18, 62% C: 22, 71%): I: patient discharged n=5, death n=6, adverse event n=3, patient request n=2, dressing unsuitable n=1, wound deteriorated n=1. C: patient discharged n=8, death n=2, adverse event n=2, patient request n=2, dressing unsuitable n=3, wound deteriorated n=2, lack of progress n=1, dressing rolling n=2. Large withdrawal rate (40/61=66%). Some performance data reported: ease of use, wear time, absorbency, pain on removal. No cost data reported.
Banks (1994c) [56] Setting and length of treatment: hospital and community. 12 weeks, or until wound	Polyurethane foam dressing (Lyofoam A), n=26	Low-adherence dressing secured with vapourpermeable film (Tegaderm), n = 24. Dressing changed when necessary. Patients also had	50	Inclusion criteria: Grade 2 or 3 pressure ulcers. Exclusion criteria: Terminal illness, necrotic or infected ulcers, ulcers > 6-7cm in any direction, or patient unavailable for full 12 weeks.	Mean area of wound (no. of patients): ≤ 1 cm2: 11 (I), 12 (C) ≥ 1 cm2, 2 (I), 2 (C) ≤ 2.5 cm2: 0 (I), 0 (C) ≥ 2.5 cm2: 6 (I), 1 (C) Other characteristics: 68% of patients aged	Complete wound healing by 12 weeks: I: 19/26 C: 15/24 Assessed by weekly visits of trial coordinator.	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure stated: independent statistician	Withdrawals: I: 7 C: 9 12 withdrawals (no other information) and four patients died. No significant group differences in pain on removal or comfort, nurse assessed ease of

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
healed.		access to pressure-relieving equipment.			> 75 years M:F 1:1.8 36% had body mass index < 19 kg/m2. Most common wound was sacral site (53%) followed by buttocks (32%), trochanter and foot, not heels (both 6%), and heels (3%). Duration of ulcer not known for 28% of patients. Not reported by group.		prepared sealed envelopes.	application or removal.
Seaman (2000) [57] Setting and length of treatment: home and long-term care facilities in the US. Treatment was for five dressing changes, or until wound healed.	Change indicator dressing (SIG), n=17	Hydrocolloid dressing (Comfeel), n=18 The investigator did the initial 1-3 dressing changes while teaching the caregiver. The caregiver then performed at least two dressing changes under supervision.	35	Inclusion criteria: stage 2, 3 or 4 pressure ulcers, aged 18 years or over. Patient's caregiver must also be willing to consent. Exclusion criteria: pressure ulcer greater than 6cm x 6cm at maximum length and width; patients undergoing radiation treatment to the area, who had known hypersensitivity to any of the test products or who were in involved in any concomitant research.	Mean (SD) ulcer area (cm2): I: 4.2 (6.1) C: 4.9 (4.1) Mean (SD) age of ulcer (weeks): not reported. Other characteristics: Mean age (years): I: 78 C: 66 M:F ratio: I: 1:2.4 C: 1:1	Complete wound healing by ~2 weeks: I: 6/17 C: 1/18 ?Mean % wound surface area reduction: I: 60 C: 22 (no measure of precision)	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure stated: computer generated list prepared by company making intervention product, stratified by initial wound depth.	Withdrawals reported but not by treatment group or reasons (n=2). Withdrawn patients included in the analyses (intention-to-treat analysis). Sponsored by company making intervention product (SIG, ConvaTec).
Graumlich (2003) [58] Setting and length of treatment: 11 USA nursing	Collagen dressing (Medifil), once daily, n=35	Hydrocolloid dressing (DuoDerm) twice weekly, n= 30	65	Inclusion criteria: 18 years of age or older; at least one stage 2 or 3 pressure ulcer. Exclusion criteria: Hypersensitivity to collagen or bovine	Median (IQR) ulcer area (mm2): I: 121 (63, 338) C: 174 (50, 436) Median (IQR) age of ulcer (weeks): I: 3.0 (1.6, 8.0)	Complete wound healing by eight weeks: I: 18/35 C: 15/30 Mean (SD) wound area healed per day	*A priori* sample size calcs. Blinded outcome assessment. Randomisation procedure stated:	Withdrawals (n=11, I:6, C:5). I: withdrew n=1, died n=3, hospitalised n=2. C: dies n=2, hospitalised n=1, lost to follow-up n=2.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
homes. Treatment was for eight weeks, or until wound healed whichever occurred first.				products, concomitant investigational therapy, previous enrolment in the trial; osteomyelitis, cellulitis; malnutrition; ulcers covered by eschar or necrotic material; ulcers covered by orthopedic casts or support surfaces; burn ulcers;diabetic foot ulcers distal to tarsals;life expectancy less than eight weeks; anticipated transfer to acute care within eight weeks.	C: 6.5 (2.0, 12.0) Other characteristics: Mean (SD) age (years): I: 82.0 (9.9) C: 80.6 (12.2) M:F ratio: I: 1:1.7 C: 1:1.7	(cm2/day): I: 0.6 (1.9), n=35 C: 0.6 (1.6), n=30	computer generated list prepared independently, stratified by diabetes status, block randomisation (variable size blocks: 4-10), central telephone allocation.	Withdrawn patients included in the analyses (intention-to-treat analysis).
Honde (1994) [59] Setting and length of treatment: hospital, multicentre. Either eight weeks or until ulcer healing, whichever occurred first.	Amino acid copolymer membrane dressing (Inerpan), n=80	Hydrocolloid dressing (Comfeel), n=88	168	Inclusion criteria: Hospitalised patients > 65 years old, with grade 2 to 4 pressure ulcer < 10 cm diameter. Exclusion criteria: Signs and symptoms of clinical infection (treated before entry); necrotic pressure ulcers with black crust (removed before entry); pressure ulcers on irradiated skin; ulcers requiring surgery; deep ulcers extending to bone with risk of osteomyelitis complications; patients on airfluidised beds.	Mean surface area (cm2): I: 8.99 C: 6.85 (NS) Other characteristics: Age (years): 80 (I), 84 (C) M:F 1:2.6 (all groups) Grade distribution: Grade 2 - 64%(I), 54% (C) Grade 3 - 30%(I), 40% (C) Grade 4 - 6% (I), 6% (C) No significant differences in weight, height, systolic or diastolic blood pressure, Norton score or range of plasma measures assessing nutritional status.	Complete wound healing by eight weeks: I: 31/80 C: 23/88 Median (range) eight healing time at 8 weeks (days): I: 32 (13-59), n=80 C: 38 (11-63), n=88 Analysis adjusted for initial wound depth found difference in favour of Inerpan (p = 0.044). % change in area from baseline: reported to be higher with Inerpan (p = 0.09) but no data presented. Wounds assessed	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure stated: computer generated list prepared independently.	Withdrawals: n=38 I: Four for emergent reasons (mainly necrosis); ten for reasons unrelated to treatment (mainly death, transfer or discharge). C: Six for emergent reasons (mainly necrosis); 18 for reasons unrelated to treatment (mainly death, transfer or discharge). Investigators' unblended assessment at completion of study favoured Inerpan. Unclear what this assessment was based on. Ease of care similar in each group. Sponsored by company making Inerpan.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
						by tracings, planimetry and colour photography at each visit.		
Meaume (2003) [60] Setting and length of treatment: three nursing homes in France, Belgium and Italy. Treatment was for eight weeks or until ulcers healed.	Self-adherent soft silicone dressing (Mepilex Border), changed at least once weekly, n=18 Extra fixation or hydrating gel (Normlgel) could be used if needed.	Self-adherent hydropolymer dressing (Tielle), changed at least once weekly, n=20	38	Inclusion criteria: age 65 years or older; stage 2 pressure ulcers; a Modified Norton Scale score of 11 or above; a red/yellow wound (according to the Red-Yellow-Black system); ulcer had not shown signs of improvement in the previous four weeks. Exclusion criteria: underlying disease that might interfere with the treatment of the pressure ulcer (as determined by the investigator); food and/or fluid intake score of two or below on the Modified Norton Scale; allergic/hypersensitivity problem with any materials in the dressings; wound larger than 11cm x 11cm; wound with black necrotic tissue or clinical signs of local infection.	Mean (range) ulcer area (cm2): I: 4.9 (0.7-25.3) C: 5.4 (0.2-26.0) Mean (range) age of ulcer (weeks): I: 8.3 (1-24) C: 13.0 (1-52) Other characteristics: Mean (range) age (years): I: 83.8 (74.9-95.1) C: 82.5 (66.4-91.9) M:F ratio: I: 1:8 C: 1:4	Complete wound healing by eight weeks: I: 8/18 C: 10/20 Wound healed or improved by eight weeks: I: 15/20 C: 19/20	No *a priori* sample size calcs. No blinded outcome assessment. Randomisation procedure stated: computer-generated randomisation list, stratified by centre, block size unknown to investigators, sealed envelopes.	No withdrawals reported. Adverse events report: I: hypergranulation tissue development n=1, other - unrelated to support surface n=3. C: hypergranulation tissue development n=1, surrounding skin trauma n=1, skin redness n=1, other - unrelated to support surface n=2. Some performance data reported: number of dressing changes, ease of use, leakage, odour, surrounding tissue damage. No cost data reported.
Bale 1998b [61] Setting and length of treatment:	amorphous hydrogel (Sterigel), daily, n=24	amorphous hydrogel (Intrasite), daily, n=22 A low-adherence dressing (Telfa) and	50	Inclusion criteria; patients with necrotic pressure ulcers. Exclusion criteria: wounds >8am in	Mean (range) ulcer area (cm2): I: 14.7 (6.6-49) C: 9.4 (1.0-36) Mean (range) age of	Complete wound debridement by 4 weeks*:* I: 14/26 C: 9/24	*A priori* sample size calcs. Blinded outcome assessment. Randomisation	Withdrawals & reasons reported by treatment group (n=12, I: 5, C: 7). I: died n=3, lost to follow-up n=1, patient requested withdrawal n=1.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
Hospital and community settings. Treatment was for 4 weeks or until wound debridement, whichever was sooner.		a semipermeable film (Tegaderm) were used as secondary dressings in both groups.		diameter (because of the size of the secondary dressing use); disease resulting in immunosupression; pregnant or nursing mothers; participation in any other clinical trial less than one month prior to this study; already enrolled in the trial.	ulcer (months): I: 5.1 (5 days-4 years) C: 4.7 (11 days-4 years) Other characteristics: Mean (range) age (years): I: 78 (20-93) C: 77 (38-99) M:F ratio: I: 1:1.9 C: 1:1.4	Outcomes were assessed every 7 days.	procedure stated: computer-generated random number list.	C: died n=4, wound infection n=3. Some performance data reported: pain, maceration, patient comfort, odour. No cost data reported.
Price (2000) [62] Setting and length of treatment: hospital setting. Treatment was for six weeks or until wound healing, whichever was sooner.	Radiant heat dressing (Warm-Up), changed daily, heated twice daily for one hour (morning and evening), n=25	Alginate dressings, changed as indicated, n=25	58	Inclusion criteria: stage 3 or 4 non-infected pressure ulcers. Exclusion criteria: existing dermatitis; history of hypersensitivity to adhesive products; oral corticosteroids.	Mean (SD) ulcer area (cm2): I: 7.3 (7.0) C: 9.8 (12.0) Mean (SD) age of ulcer (months): not reported. Other characteristics: Mean (SD) age (years): I: 75.72 (16.8) C: 69.76 (16.2) M:F ratio: I: 1:2.1 C: 1:1.5	Complete wound healing by six weeks: I: 3/25 C: 2/25 Mean (SD) change in ulcer area by six weeks (cm2): I: -4.03 (4.3), n=25 C: -3.89 (8.1), n=25 Mean (SD) change in ulcer area by six weeks (%): I: -54.62 (39.9), n=25 C: -22.84 (75), n=25 Outcomes were assessed weekly.	No *a priori* sample size calcs. No blinded outcome assessment, but blinded data analysis. Randomisation procedure stated: computer-generated list, allocation concealment by opaque envelopes.	Withdrawals (n=8, I: 7, C: 1): died n=3, condition deterioration n=3, support surface-related deterioration n=1, patient request to withdraw n=1. Some performance data reported: pain, maceration. No cost data reported.
Modern dressing		**Placebo**						
Ritz (2002) [63] Setting and length of treatment: high-risk	Provant wound closure system (uses radiofrequency stimuli to induce fibroblast and epithelial cell	Placebo: standard care plus twice daily treatment with a Provant support surface transparently modified so that no treatment was given,	49	Inclusion criteria: stage 2 or 4 pressure ulcers, ≥18 years age, Exclusion criteria: change in Norton Risk Assessment score ≥7	?Mean wound area (cm2): Stage 2 ulcers: I: 3.0 C: 4.4 Stage 3 ulcers: I: 11.3	Wound closure at six weeks for stage 2 ulcers: I: 8/8 C: 4/11 Wound closure at	No *a priori* sample size calcs. Blinded outcome assessment. Randomisation procedure not	No reporting of withdrawals.

Study and setting	Intervention (I)	Comparator (C)	n	Inclusion / exclusion criteria	Baseline characteristics	Objective outcome measures / results	Quality assessment notes	Withdrawals Other notes
patients, setting not stated. Treatment was for 12 weeks or until ulcer closure or until discharge home, whichever occurred first.	proliferation), active, twice daily plus standard care, n=16.	n=18.		within 30 days, osteomyelitis, immune dysfunction or repeated systemic infection, cancer, concurrent treatment with other wound-healing support surfaces (e.g. hyperbaric oxygenation, electrical stimulation).	C: 4.4 ?Mean age (years): Stage 2 ulcers: I: 72 C: 69 Stage 3 ulcers: I: 75 C: 63	12 weeks for stage 3 ulcers: I: 4/8 C: 1/7 ?Mean (SD?) wound closure rates, stage 2 ulcers (cm2/day): I: 1.192 (0.20), n=8 C: 0.68 (0.17), n=11 ?Mean (SD?) wound closure rates, stage 3 ulcers (cm2/day): I: 1.29 (0.41), n=8 C: 0.36 (0.22), n=7 Not stated how measurements were assessed.	stated.	

Table of included studies: nutrition

Study	Methods	Participants	Interventions	Outcomes	Comments	Methodological quality
Chernoff (1990)	RCT. Method of randomisation not described. Blinding method not described.	12 institutionalised tube-fed patients with pressure ulcers.	A) High protein (16% of calories) (n=6) B) Very high protein (25% of calories) dietary formula (n=6) Monitoring for eight weeks.	Pressure ulcer healing measured in % of decreasing surface.		B
Norris (1971)	RCT double-blind crossover study.	14 patients with a pressure ulcer. Exclusion: neoplastic disease, terminal phase of illness, superficial pressure ulcers, deep ulcer with sinus tract. Setting: chronic disease hospital, Baltimore.	A) 3 capsules of Zinc sulphate (200 mg) (n=7) B) 3 placebo capsules per day (n=7) for a period of 24 hours. After 12 weeks patients switched groups.	Volume of pressure ulcer (crater)(Pories method)	Only three of the 14 patients completed the study. Volume measured at four-week intervals.	B
Taylor (1974)	RCT double blind	20 surgical patients with pressure ulcers, baseline groups comparable.	A) 500 mg ascorbic acid twice daily. B) Inert placebo twice daily All patients had standard hospital bed and mattresses, the same basic hospital diet and similar local therapy	Areas of the pressure ulcers assessed weekly subjectively, by pressure area tracings and by photography assessment.		B

			to the pressure ulcers.			
Ter Riet (1995)	RCT multi-centre. Investigators blinded to treatment allocation. Intention-to-treat analysis and sensitivity analysis.	88 patients with pressure ulcers (partial thickness skin loss or worse) Exclusion: Difficulty with swallowing, frequent vomiting, osteomyelitis, in the ulcer area, idiopathic haemochromatosis, thalassemis major, cushing syndrome or disease, pregnancy, radiotherapy in the ulcer area, use of antineoplastic agents, or systemic glucocorticosteroids, terminally ill patients, patients for whom surgical treatment of the ulcer (other than debridement) had been planned, patients already taking over 50 mg vitamin C per day. Patients with grade 2 ulcers could be included if de-epithelialisation had persisted for at least seven days without interruption. Setting: 11 nursing homes and one hospital in south Netherlands. Baseline: good for 5 of 8 cluster variables.	A) 500mg ascorbic acid twice daily and ultrasound or 500mg ascorbic acid twice daily with sham ultrasound (n=43) B) 10mg of ascorbic acid twice daily with ultrasound or 10 mg of ascorbic acid with sham ultrasound(N=45) for 12-week period	Ulcer volumes, surface area, healing velocity, overall visual mark, wound survival time, wound closure, probabilities per unit time.	Most patients had nutrition deficiencies on admission.	B

Table of included studies: surgery

Study	Objective	Design/methods	Measurement /intervention/procedure	Patients/ population	Findings /results	Comments
Akguner M et al. (1998), Turkey	To investigate 18 chronic, wide and deep pressure ulcers in 14 patients between 1990 and 1996.	Case series.	Gracilis myocutaneous flap. Patients with ulcers > 3cm and present for 3 months or > were included. 4 bilateral 10 unilateral.	14 SCI patients 5 female 9 male.	10 with unreported complications, 4 with reported complications.	Limited baseline data. Follow up time not stated. Sutures removed on 15th day and pressure on site allowed on 21st day which wound indicate healing time. Healing time not stated co-interventions not described.
Akan IM et al. (2001), Turkey.	To report on the use of a modified bilateral V-Y advancement flap (pac man flap) in the repair of sacral and trochanteric pressure ulcers.	Case series.	Modified bilateral V-Y advancement flap (pac man flap). Sacral ulcer 10 Trochanteric 3 Jan 1998-May 2000. All wounds debrided. Follow-up range 3-14 months (7.84)	13 patients, 8 male, 5 female. Age range 15-55 (31). Ulcer size range 10-22 cm (15.84cm).	All wounds healed. No breakdown or recurrence in the follow-up period observed.	Time to heal? Co-interventions?
Bocchi A et al. (2002), Spain.	To report on the treatment of decubitus ulcers in patients with spina bifida.	Case series.	Debridement and removal of bony prominence if appropriate. Ischial: G M M rotation flap. Gracile Muscle M advancement flap. Sacral: G M F rotation flap G M M R Flap G M T flap G M M V-Y advancement flap. Fasciocutaneus thoracolumbar-sacral rotation flap.	52 patients spina bifida. Age range 5-18.	20 surgical treatment. 4 recurrence. All conservatives healed (32).	Baseline data? Time to heal? Follow-up?

			Paravertabral osteomuscular flap Trochanteric: F rotation/Transposition Thigh flap. Advancement bipedical thigh skin flap G M M R Flap Broad latera muscle flap. M F L tensor flap Heel: Cutaneous rotation/transposition skin flaps Lateral calcaneal skin flap Fasciocutaneous plantar flap Short toe flexor muscle flap Malleolar: Reverse fasciosubcutaneous flap Island sural flap Short allux abductor muscle flap Plantar: Rotation/transposition/V-Y adv Flap Plantar fasciocutaneous flap. Co- interventions: 2-hrly position change water mattress ROHO air mattress air fluidised mattress			
Chan J et al. (2003), USA	To identify clinical features of patients undergoing hemipelvectomy for life-threatening septic complications of decubitus ulcers.	Retrospective chart review.	Hemipelvectomy for decubitus ulcers. 8 patients from 1989-1998. Osteomyelitis in seven patients. Necrotising fascititis in one patient. 4 – standard hemipelvectomy. 4 – modified hemipelvectomy. Type of closure: Standard flap-7	8 patients. All male, mean age 51. 5 caucasian, 3 african. All SCI all with pressure ulcers with pelvic osteomyelitis or life-threatening soft-tissue infection. Those with SCI not due to	Re-operations – 3 Soft tissue resection – 2 Bone resection – 1 Post op complications – 2 MOF – 1 SCI (L1) Resp Ar –1 SCI (C5) 30 ay mortality. 25% (2 0f 6).	No details of healing rate of ulcers. Follow up of ulcer? Baseline data for ulcers?

			Wound left open – 1	trauma or with incomplete cord injury were excluded. Mean of 2.5 comorbid conditions.		
Eshaque D et al. (1994), Bangladesh	To evaluate the treatment of sacral pressure ulcers using myocutaneous flaps.	Case series.	Conservative treatment 10 patients (which includes excision of the ulcer). Surgical treatment including excision and primary closure, myocutaneous flap (10 patients), skin graft and transposition.	25 patients 24 male, 1 female. mean age 43.56 years.	10 conservative treatment, 9 healed, 1 loss to follow up. 15 surgical primary healing in 6, complications in 4 of which 3 went on to heal after infection control and 1 required a skin graft.	Very limited baseline data. Interventions need clarifying. Conservative treatment inclusive of surgical excision?
Esposito G et al. (1992), Italy	To evaluate the use of skin expansion in reconstruction of pressure ulcers.	Case series.	680ml skin expanders. Repair of ischial ulcers.	10 patients (8 paraplegic) 1 medullar section and 1 spina-bifida. 7 previous ops, 4 2 or more previous ops. Age range 21-66.	No ulcer recurrence in median follow-up time of 12 months. No recurrence of ulcers in median follow-up period.	Healing rate? Baseline data?
Foster R et al. (1997), USA	To evaluate the treatment of pressure ulcers using surgery.	Case series	Debridement and flap coverage in single stage in 75%. Co-interventions include bed rest and air fluidised bed for 10-14 days. Healing defined as: a healed wound within one month post op. Failure defined as: non healed wound. Follow up one month – nine years. (10.7m) Average wound size post debridement = 75cm^2 Flap selection: Inferior GMIs 34 Gluteal thigh 27	87 patients(64 male, 23 female). Mean age 49 range 16-90yrs. Chronic wound (present for >3 months) 52% of the 112 ulcers. 89% paraplegic, 4% quadriplegic, 7% ambulatory.	Results (primary healing)% Overall 83% 89% of single stage cases Inferior GMIs 94 Gluteal thigh 93 Gracilis 75 V-Y hamstring 58 Tensor Fascia lata 50 Anterior thigh 100 Rectus abdominis 100 Time to heal averaged 38 days. Average length of stay 21 days and 16.5 for those without prior complications.	

			Gracilis 16 V-Y hamstring 12 Tensor Fascia lata 12 Anterior thigh 6 Rectus abdominis 5		Complications. 37% of reconstruction. 60% of ulcers had previous flap surgery. No significant difference between the flap success of those with and without prior flap repair. Analysis gave statistical significance that smaller defects of and average of 59.6 cm^2 were less likely to heal (p=0.0089). Healed wounds averaged 82.9cm^2. Subset analysis of patients with small wounds 0-75cm^2 showed that 71% had more than one risk factor for wound healing.	
Geoffrey G and Hallock MD (1994), PA?	To evaluate the random posterior thigh fasciocutaneous flap in the treatment of ischial pressure ulcer.	Case series.	Random posterior thigh fasciocutaneous flap. 10-year period.	7 patients with ischial sores.	2 recurrences in the follow-up period of 5 years. Recurrence in 6 week post op. 5 year follow up patient developed new pressure ulcer.	Baseline data not available Healing time not available.
Hiroyuki O et al (1995), Japan	To describe the closing of a sacral ulcer using a modified gluteus maximus V-Y advancement flap for sacral ulcers: the gluteal fasciocutaneous flap method.	Case series.	The gluteal fasciocutaneous flap. 1988-1995. Ulcers with average 6.7x7.6cm treated with unilateral gluteal fasciocutaneous flaps. Ulcers with average 11.1x11.2 treated with bilateral gluteal fasciocutaneous flaps.	24 patients. 19 sacral ulcers (5 radiation ulcers sacrum) 18 patients ambulatory. Ulcer size. 5-15cm.	All wounds healed without necrosis. Complications in 3 patients. Follow up 2-60 months (24.3). Blood loss 250ml	Time to heal? Co-interventions?
Hovius SER et al. (1988), Netherlands	To descibe experience with the	Case series.	Lateral calcaneal artery flap. From 1974- 1986.	7 patients 7 flaps. Age range 21-83.	4 patients developed complications. Longest follow	Baseline data for ulcer size and severity not

	lateral calcaneal artery flap in patients with chronic ulcers of the heel or lateral ankle.			average. 47.14. 5 male 2 female.	up 12 years patient developed hyperkeratosis.	available. Healing time? Co-interventions?
Josvay J and Donath A (1998), Hungary	To evaluate 10 year experience using the modified hamstring musculaocutaneous flap for the coverage of ischial pressure ulcer.	Case series.	Modified hamstring musculaocutaneous flap. 10 year period. No flexion of the affected joint for 3 weeks. No loading for 2 months. Follow-up ambiguous. Suggestion of last op 6 months prior to reporting.	10 patients (11 ulcers)	Healing achieved in all patients. No recurrence reported during follow up. Healing not clear, report in 1 case as 8 months.	
Klein NE et al. (1988), Canada	Presentation of a philosophy and technique using proximal femoral resection (modified girdlestone technique) for dealing with defects from pressure ulcers in paraplegic patients.	Case series.	Proximal femoral resection and vastus lateralis muscle flap.	10 SCI patients. Inclusion criteria included other pressure ulcers had to be healed. 8 male 3 female. Age range 25-69. 3-9 years post SCI. All infected trochanteric and or ischial pressure ulcers over a diseased hip. 4 previous resections. Number of debridements ranged from 1-6, 6 requiring only 1 debridement.	Complications in 6 of 10. 3 lost to follow up, 5 healed and sitting. 2 healed but developed new ulcer. Follow up 2- 26 months. Average time to discharge 9.5 weeks (7.5-12)	Baseline data? Co-interventions? Time to heal?
Little J W et al. (1982), USA	To report on an alternative flap	Case series.	Gluteus medius-tensor fasciae latae flap. 8 flaps over 2 years.	8 patients. All paraplegic. Age	All healed without complications or recurrences.	Baseline data limited. Co-interventions?

	repair for uncomplicated defects of the trochanter, the gluteus medius-tensor fasciae latae flap.			range 32-81 years. Defects up to 8x12cm.		Healing time? Follow-up?
Margara A et al (2002), Italy	A proposed protocol for the surgical treatment of pressure ulcers based on 15 years of experience with 337 cases.	Not clear from reporting if data were collected prospectively or retrospectively and from what.	Total ulcer 337 treated throughout study period 1985-2000. Sacral ulcers 149 Ischial ulcers 121 Trochanteric 67. Protocol adopted in 1992. Outcomes before this period were compared. Group A (140) group. *Ischial 57* Island gluteus major muscle flap 23 Gracilis rotation flap 18 V-Y advancement hamstring flap 10 Advancement local fasciocutaneous 6 *Sacral ulcers 68* Gluteus maximus island flap 34 V-Y gluteus maximus advancement myocutaneous flap 29 Local fasciocutaneous flap 5 Trochanteric ulcers 29 Rotation tensor fasciae latae 10 Island tensor F L 17 Local F flap 2 Group B (157) protocol	297 patients all SCI 271 male 26 female. 337 pressure ulcers. Grade 3,4 (NPUAP) Group A (140) male 129, female 11 age 42+/-11.94. Group b (157) male 142, female 15 age 41+/-11.44.	Significantly better results with group B for repair of ishial ulcers (p=,0.005) Significantly better results found for sacral ulcers in group B (p=<0.005) Recurrence rates for the 2 groups. A 24.79% B 9.80%	

			group. *Ischial* V-Y thigh posterior compartment 64 *Sacral* V-Y gluteus maximus muscle 81 Trochanteric Rotation tensor muscle fasciae latae 38. Success defined as intact without infection, haematoma and pain at 60days. Or failure. Recurrence determined if failure post 6months. Co-intervention Vacuum assisted closure. Oral fluids 30ml/kg 24 hrs. Vitamins/minerals No smoking nutrition of 30-35kcal/kg BW Protein of 1-2g/kg 24hrs physiotherapy; muscles stretching and electrical stimulation of antagonist muscles, muscle relaxants dantrolene, baclofen, zanidia. Psychosocial interventions to assess compliance. Support surfaces. Air fluidised for 10-15 days then DUO deteq.			
Maruyama Yu et al. (1980), Japan	To report on the use of a gluteus maximus myocutaneous island flap for repair of sacral ulcers.	Case series?	Gluteus maximus myocutaneous island flap Longest follow-up 1 year.	8 patients.	All healed, no recurrence in follow-up period.	Demographics limited. Baseline data? Co-interventions? Time to heal?

Norman H and Schulman MD (1980), USA	Report on use of bipedicle tensor fascia lata musculocutaneous flap to close trochanteric pressure ulcers.	Case series.	Bipedicle tensor fascia lata musculocutaneous flap. Weight on flaps 10days +	6 trochanter pressure ulcers. Defects up to 17cm diameter.	All 6 wounds healed primarily.	Baseline data? Co-interventions? Follow-up? Not clear if patients or ulcers?
Rollin D and Faibisoff B (1982), Canada	Evaluation of the role of myocutaneous flaps.	Case series.	Myocutaneous flaps 1 year follow-up (min) 4 trochanteric 2 ischial 1 sacral ulcer	7 patients (11 flap repairs)	No recurrances reported. Pressure damage reported. Atrophy of muscle flap resulting in localised depression.	Baseline data? Co-interventions? Atrophy not reported in other studies?
Rubayi S (1999), USA	The efficacy of single-stage surgical management of pressure ulcers compared to multistage	Retrospective review.	10 year period. 1986-1996. Included: those with grade 4 ulcers near pelvic girdle and proximal lower extremities not responsive to conservative treatment. Flaps used: Gluteus maximusMR flap. V-Y advancement tensor fascialata musculocutaneous flap. V-Y hamstring Mflap. Girdlestone procedure for those with hip joint involvement. Vastus lateralis Gracilis muscle flap. Ulcers: Ischial 220 Trochanteric 150 Sacral 50. Co-interventions Air fluidised bed. Physiotherapy at 4 weeks. Sitting programme at 6 weeks.	120 patients. SCI. Age range 15-81 (37.5) male 113, female 7. Average ulcers per patient 3.5.	Hospital stay. Multi 19 Single 9.5 Op time Multi 2.5 each surgery Single 4.7 Ave ulcers /patient Multi 3.5 Single 3.5 Blood loss Multi 575 Single 980	Baseline data?
Schessel ES and	To report on the	Case series.	Excisional debridement and	49 patients (52	38 of 52 ulcers healed without	

Ger R (2001), USA.	management of pressure ulcers with contant-tension approximation.		contant-tention approximation. 5 year period Ulcers: sacral 21 ischial 13 heel 16 9 patients died within 1 month of treatment (with closed wounds) 5 lost to follow-up, 3 of which had closed wounds.	ulcers) Average age 75. 22 male 27 female.	recurrence. Time to heal 2-48 months. Sacral ulcers healed 15 of 23 Time of closure 5.21days Average follow-up 12.46 months. 3 died. 2 recurrences. Trochanteric ulcer healed 10 of 12. Average time of closure 13.1 days Average follow-up 15.4 months. 7 died. Heel ulcers healed 13 of 14. Average time to closure 14.46 days Average follow-up 25.6 months 1 died. 1 complication	Co-interventions.
Tavakoli K et al. (1999)	Evaluation of 8 years study using hamstring flaps, V-Y musculocutaneous flap for the repair of ischial pressure ulcers.	Follow-up study.	Hamstring V-Y musculocutaneuos flap. Initial op 1988-1993. Initial follow up mean (20 months) 2nd follow-up period 18-90 months. Mean 62 months. 4 patients lost to follow-up, 4 patients died at follow-up. Living patients 19.	Initially 27 patients (37 ulcers). This follow-up study 19 (29 ulcers). Mean age 43.7, 13 male, 10 female.SCI.	Initial follow-up 1993. 33% recurrence 14.8% re-advancement 14% non-healing ulcers. 2nd follow-up 1997. Recurrence rates 41.4 (47.8)% period 0.5-70 months. 89.5% have intact flaps at time of follow up. Pelvic osteomyelitis reported as cause of death in 1 patient.	Baseline data (to fine initial study output) Co-interventions? Time to heal?
Tellioglu AT el al. (1999), Turkey.	Report on ischial pressure ulcers treated with sensate gracilis myocutaneous flap.	Case series.	Sensate gracilis myocutaneous flap Period 1995-1997. Mean follow up 8 months range 1.5-14 months.	12 patients all ischial ulcers. Median age 32.5 years, ten male 2 female. All SCI under L3.	All healed, no recurrence in follow-up period.	Baseline data? Co-intervention?

Tizian C et al. (1986), Germany.	Report on one-stage treatment of multilocated pressure ulcers using myocutaneous island flaps.	Case series.	Gluteus maximus island flap and biceps femoris flap. Period 1982-1986. Previous ops in 7. Follow-up (12 of 14 patients 2-60 months). Co-interventions: Nutrition Pressure relief	32 patients. Single ulcer 18 (sacral) multi 14 all paraplegic. All grade 5-6 (campbell) age range 19-63 (38) ulcers defect size: ischial 2.5-12cm sacral and trochanter 7-17cm	Healing achieved in all cases. One report of complication.	Only appears to give results for those with multi ulcers although consistent with title. Baseline data? Co-interventions? Time to heal?
Watier E et al. (1999), France.	Report on experience of ischial pressure ulcers.	Retrospective review.	Grffith fasciocutaneous flap + Biceps Semitendinous Hamstring Gluteusmaximus Alon Fasceocutaneous Gluteus maximus Musculocutaneus island 10 year period. Co-interventions: Air- fluidised bed.	34 patients mean age 41 +/- 15.2 years range 22-74. 27 male 7 female. All paraplegic or tetraplegic. 61 procedures.	Recurrence rate in first two years in 85% of cases. No significance in early complications of those with or without recurrences rates.	Baseline data? Co-interventions? Time to heal?
William D et al. (1989) USA.	To report on hemipelvectomy for end-stage pressure ulcers.	Case series.	Internal hemipelvectomy. Multiple previous ops. Follow-up 4-30 months.	5 patients. Paraplegic 2 reported cases 17 ops in 10 years and 15 ops in 5 years.	Healed ulcers without recurrence (follow-up 2 years in reported cases). Left hospital at 6 weeks.	Baseline data? Co-interventions? Time to heal?

Table of included studies: mobility and positioning

Study	Objective	Design/Method	Population/Setting	Intervention/ Measurements	Results/Findings	Authors' conclusions	Comments
Bates-Jensen BM et al. (2003) USA	To examine the skin health outcomes of an exercise and incontinence intervention.	Randomised controlled trial with blinded assessments of outcomes at 3 points over 8 months. Ethics approval. Consent obtained from individual patients or carers. Blinded assessment.	4 nursing homes. 190 incontinent residents Recruited from same population community, all meeting inclusion criteria: not acutely ill and receiving care in those care areas, not terminally ill with life expectancy of < 3 months, incontinent of urine, free of catheter and able to follow on-step instructions.	Intervention group: Research staff provided exercise and incontinence care every 2 hours from 8:00 a.m. to 4:30.p.m. (4 daily care episodes) 5 days per week for 32 weeks. Control group: Received usual care from nursing home staff.	Skin health outcomes: Skin health total score includes 8 skin conditions: (maceration, papules,macules,oedema, scaling, blanchable erythema, non pressure related ulcers and pressure ulcers (grade 1-4). Pressure ulcer area. Mean Sd. Intervention group: Baseline. All regions 0.24+/- 0.82 Back distal 0.15+/- 0.6 Post 2 assessment. All regions 0.19+/- 0.65 Back distal 0.05+/- 0.3 Control group: Baseline. All regions 0.17+/- 0.84 Back distal 0.07+/- 0.5 Post 2 assessment. All regions o.5+/- 1.9 Back distal 0.23+/- 0.83 p-values: All regions .319 Back distal .059 Covariate Analysis p-value: 0.73.	Incontinence and exercise interventions led to improvements in four major risk factors relating to skin health. Effects were limited primarily to back distal perineal region.	

DATA EXTRACTION TABLES ECONOMIC EVALUATION: DRESSINGS AND DEBRIDEMENT

1
Authors: Aguilo Sanchez et al. (2001)*
Setting/Perspective of the analysis: Hospital, Spain
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Hydrocolloid dressing. (C) Saline moistened gauze
Funding: Coloplast Products Medicos SA and Abbott Laboratories

METHOD	RESULTS	OVERVIEW

Design: RCT, patients were randomised at the moment of hospitalisation.
 	
Sample: (I) sample of patients n=35. (C) sample of patients n=35. Analysis of treatment completers
 	
Level of effectiveness evidence: Level 1
 	
Inclusion: PU of diameter no greater than 12cm. Grade 2 and 3 PU
 	
Exclusion: Those patients with systemic infection, active vasculitis, lupus erythematosus or cryoglobulinemia. Those who were allergic to the products or those having immunosuppressive therapies. PU were not linked to muscle or tendon
 	
Outcome/s: Complete heal
 	
Resource use: Materials & nursing time
 	
Currency: Spanish Pesetas (Pta), price year not stated
 	
Follow-up: NS
 	
Assessments: Nurses
	Cost:
	Average cost of materials: (I) Pta 11,323.63 (+/-10,828.45) vs. (C) Pta7,577.99 (+/-53.334.46)
	Average cost of nursing time: (I) Pta 2,658.96 (+/-2,549.68) vs. (C) Pta 5,264.33 (+/-2,957.63)
	Total daily cost of treatment: (I)= Pta 180.50 vs. (C) Pta 209.36
	
	Effectiveness:
	Complete heal: (I)=20 patient's PU vs. 10 in group (C)
	For (I) treatment quality was excellent for 40% of patients (n=14) vs. 23% for (C) patients (n=8)
	For (I) treatment quality was good for 31% of patients (n=11) vs. 20% for (C) patients (n=7)
	For (I) treatment quality was bad for 17% of patients (n=6) vs. 54% for (C) patients (n=19)
	Four patients did not respond in group (I) vs. 1 non-responder in group (C)
	
	Cost-effectiveness:
	Cost and outcomes not synthesised. More PU healed in (I) and the daily cost of treatment was lower, therefore (I) appears to be the more cost-effective option, dominating (C).
	
	Uncertainty assessed:
	Costs were reported as means with SD. However, no statistical analysis of total costs was performed.
		Conclusions: (I) was more cost-effective than (C). The total costs were lower due to a higher success rate and less nursing time required. However, the unit cost of (I) treatment material was higher.
		
		Comment: It is not clear what the total cost of treatment was or how the total daily cost of treatment was calculated. The length of follow-up was not stated. The loss to follow-up was high. No statistical analysis to compare total costs was performed.

*NB Taken from an abstract written in English

2
Authors: Bale et al. (1998)
Setting/Perspective of the analysis: National Health Service, UK
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Hydrocellular dressing. (C) Hydrocolloid dressing
Funding: Smith and Nephew Limited

METHOD	RESULTS	OVERVIEW
Design: Open, prospective randomised parallel group trial. Patients were randomised in blocks of 4 Sample: 100 patients, 32 of which had PU. (I) = 15 PU, (C)=17 PU. If a patient had >1 PU, the largest was entered into the study. At admission, in group (I) 65% of PU were grade 2, 35% were grade 3 PU. In group (C) 40% of PU were grade 2, 60% were grade 3 PU. Analysis of treatment completers Level of effectiveness evidence: Level 1 Inclusion: Grade 2 or 3 PU Exclusion: Pregnant and lactating women, grade 1 or 4 PU, wounds which were too large to be covered by one dressing, PU expected to heal within one week, PU with sloughy or necrotic tissue or grossly infected wounds, patients in the trial for at least one week Outcome/s: Wounds completely healed at 8 weeks Resource use: Materials used as recorded by nurses and costed using unit costs from the published literature Currency: UK £ Sterling, 1994 values Follow-up: Maximum of 8 weeks Assessments: Nurses assessing PU at every dressing change	Resources: (I) changed every 3.6 days vs. (C) changed every 4.1 days, (P=0.15) Cost: Cost of treatment per patient, whether PU healed or not, was £50 in the (I) group and £76 in the (C) group Effectiveness: 59% of PU healed in the (I) group, 27% in the (C) group Cost-effectiveness: Cost and outcomes not synthesised. More PU healed in (I) and the daily cost of treatment was lower, therefore (I) appears to be the more cost-effective option, dominating (C). Uncertainty assessed: A number of one-way sensitivity analyses were undertaken, including varying the costs applied if withdrawn prior to 8 weeks, but did not alter the findings. Statistical analysis to compare average dressing wear time across interventions.	Conclusions: (I) more cost-effective than (C). Comment: The cost of labour time to change dressings was omitted. Some patients were withdrawn from the study (the authors do not say which wound group they are in). More patients were withdrawn from the (C) group and this could bias results in favour of this group. Across all wounds, at 7 weeks the number of wounds healed was very similar across groups but data were not presented on PU 7-week comparisons.

3
Authors: Bergemann et al. (1999)
Setting/Perspective of the analysis: Hospital, Germany
Type of economic evaluation: Cost-consequence analysis
Interventions: (I1) Gauze, (I2) Impregnated gauze, (I3) Calcium alginate, (I4) Hydroactive 1 (hydroactive wound dressing in combination with enzymatic wound cleaning (collagenese), (I5) Hydroactive 2 (hydroactive wound dressing in combination with enzymatic wound cleaning (collagenese) during the first seven days of treatment
Funding: Beiersdorf AG and Knoll AG

METHOD	RESULTS	OVERVIEW
Design: A spreadsheet model using data from four hospitals. An expert panel was consulted to help structure the model. Care of four sizes of PU were considered i.e. PU of 5cm x 8 cm, 8cm x 12 cm, 10cm x 15cm, 12cm x 20cm. It was assumed that the bigger the wound, the longer the treatment duration required Sample: 120 patients in total but this included patients with venous leg ulcers too Level of effectiveness evidence: Level 3 and 4 Inclusion/exclusion: As for design Effect/s: Not compared to costs. However, in order to calculate total costs the number of wound dressing changes until PU healing or discharge from hospital was required Resource use: Use of material and personnel time Currency: German Mark DM, 1997 values Follow-up: Between 22 days and 50 days depending on size of wound and type of treatment applied Assessments: Nurses	Resource use: Varied across wound surface area and informed by the expert panel Cost: Cost savings of between DM1,138 (DM538 to 1739) for (I4) vs. (I2) and DM8,234 (DM4610 to DM 11,858) for (I4) vs. (I1) were estimated Effectiveness: Equal efficacy assumed or a decrease in the length of hospital stay of 10% for (I4) and/or (I5) Cost-effectiveness: Outcomes were incorporated with cost estimates Uncertainty assessed: Two-way sensitivity analysis was undertaken on the total costs associated with each intervention as well as the following parameters used to calculate costs; personnel costs per minute, time required to change a dressing, total number of wound dressing changes, and results remained fairly robust. Monte Carlo simulation was used to estimate the variation in inputs into the model (95% CI).	Conclusions: Despite the higher material costs of (I4) and (I5), the reduced labour costs, due to quicker time to heal and reduced duration of treatment or time to inpatient discharge, that were assumed resulted in lower total costs relative to the three comparators. Comment: The model assumed that use of (I4) and (I5) reduced inpatient stays by 10%. PU were followed in the model not only until PU heal but sometimes instead until inpatient discharge: hence the PU may remain unhealed and does not fully take into account effectiveness. It is unlikely that all treatments are equally efficacious.

4
Authors: Burgos et al. (2000)
Setting/Perspective of the analysis: Hospitals, Spain
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I) Collagenese ointment. (C) Hydrocolloid occlusive dressing
Funding: Laboratories Knoll, SA

METHOD	RESULTS	OVERVIEW
Design: Multi-centre, non-blind parallel group study. Randomisation by computer-generated randomisation list into blocks of 4 patients Sample: (I) n=18 patients/PU. (C) n=19, patients/PU Level of effectiveness analysis: Level 1 Inclusion: Grade 3 PU for <1 year Exclusion: End-grade organ disease, localised or systemic signs &/or symptoms of infection (fever, local erythema, regional lymph node swelling) of hypersensitivity to (I) Intention to treat: No Outcome/s: Reduction of PU area Resource use: Nurse time and treatment supply including ancillary supplies Currency: Spanish Pesetas Pta, price year 1998 Follow-up: 12 weeks or until complete heal, whichever occurred first. Duration of study 1 year. Assessments: Weekly by nurses	Resource use: (I)=1/day, (C)=0.42/day. Staff time per patient/day in minutes was 8.6 (+/-5.3) in the (I) group and 4.6 (+/-2.8 in the (C) group Cost: Total costs: (I)=Pta 41,488 (95%CI: Pta 26,191-Pta 56,784) (C)=Pta 32,963 (95%CI: Pta 23,389-Pta 42,538), NSS Effectiveness: Mean (SD) reduction in PU area in (I) group was 9.1 (1.2) cm^2 vs. 6.2 (9.8) cm^2 in group (C), an area reduction of 44% & 28% respectively PU area decreased in 83% of (I) group vs. 74% in (C) group after 12 weeks (NSS) Complete PU heal 3 patients in each group, NSS Cost-effectiveness: Total cost/1 cm^2 reduction in PU was Pta 4,559 for (I) & Pta 5,310 for (C) If only pharmaceutical costs were considered, the cost/1cm^2 reduction in PU was Pta 2,290 for (I) and Pta 3,382 for (C), NSS. The cost per reduction in PU area was lower for (I) & on this basis (I) is the more cost-effective option, dominating (C). Uncertainty assessed: Appropriate statistical tests applied and variance reported. However no uncertainty around the cost-effectiveness estimate was presented. No sensitivity analyses were conducted.	Conclusions: NSS difference in costs or effects across treatments. However, there was a trend towards lower costs and better effects associated with (I) making it the more cost-effective option. Comment: Material costs very similar but total cost of (I) tended to be higher than (C) due to greater staff input. Cost per 1cm^2 reduction were lower for (I) but not NSS. No allowance for across site differences.

5
Authors: Capillas Perez et al, 2000*
Setting/Perspective of the analysis: District Health Authority, Spain
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I) Moist environment dressings (Hydrocolloid Comfeel), n=15 PU, (C) Traditional dressings (saline gauze), n=14 PU
Funding: None stated

METHOD	RESULTS	OVERVIEW
Design: Randomised clinical trial with study analysts blinded to allocation of patients to study groups. Analysis of treatment completers Sample: (I) n=15 PU, (C) n=14 PU Level of effectiveness analysis: Level 1/2 Inclusion: Grade 2 or 3 PU Exclusion: Patients with infected PU Outcome/s: Time required to cicatrise an initial 1cm^2 wound % of surface healed daily Resource use: Materials and nurse time Currency: Spanish pesetas (Pta), price year not reported Follow-up: Not stated explicitly Assessment: Not clear	Resource use: Median nurse time required to cicatrise an initial 1cm^2 PU: (I)= 67.5 (32.24 to 135) minutes Median nurse time required to cicatrise an initial 1cm^2 PU: (C)= 400 (129.9 to 2,041) minutes, p<0.018 (SS) Median number of treatments required to cicatrise an initial 1cm^2 PU: (I)=1.86 (0.71 to 2.29) Median number of treatments required to cicatrise an initial 1cm^2 PU: (C)=12.1 (5.71 to 29.86), P<0.05 (SS) Median frequency of treatments: (I)=every 5 (3.46 to 5.86) days Median frequency of treatments: (C)=every 1 (1.0 to 1.01) day, p<0.05 (SS) Effectiveness: Median nurse time required to cicatrise an initial 1cm^2 PU: (I)=7.12 (5.33 to 11) days Median nurse time required to cicatrise an initial 1cm^2 PU: (C)=12.18 (5.85 to 39.38) days, NSS Median % of surface healed daily: (I)=1.42% (0.56% to 2.5%) Median % of surface healed daily: (C)=1.19% (0.59% to 1.55%), NSS Cost-effectiveness: Median (1st and 3rd percentiles) cost of the cicatrisation of an initial 1cm^2 PU: (I)= Pta 4,388 (1,808 to 7,539) vs. (C)= Pta 17,983 (6,521 to 87,798), SS Nurses times for cicatrisation of an initial 1cm^2 PU cost: (I)= Pta 2,610 (1,247 to 5,221) vs. (C)= Pta 15,490 (5,027 to 78,971), SS Material cost for cicatrisation of an initial 1cm^2 PU: (I)= Pta 1,230 (338 to 2,754) vs. (C)= Pta 2,619 (1,351 to 12,086), SS Median % of surface area healed daily was faster for (I) and median cost of cicatrisation was lower, therefore (I) appears to be the more cost-effective option, dominating (C). Uncertainty assessed: Standard statistical analyses conducted	Conclusions: (I) was more cost-effective than (C). Comment: Sequential randomisation to groups not truly random. Reduced time to cicatrise PU with (I) may have beneficial quality of life impacts and benefits for caregivers too. Reported median costs that are difficult to interpret.

*NB Taken from an abstract written in English

6
Authors: Colwell et al. (1993)
Setting/Perspective of the analysis: Hospital, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Hydrocolloid wafer dressing, (C) Sterile moist gauze dressings
Funding: Convatec, division of Bristol-Myers Squibb Company

METHOD	RESULTS	OVERVIEW
Design: RCT, PU randomly assigned. More grade 2 PU randomised to (I) (SS) & more grade 3 PU in (C) (SS) Sample: 70 patients; (I): n=33, (C): n=37. 97 PU; (I): n=48 PU, (C): n=49 PU Level of effectiveness evidence: Level 1/2 Inclusion: Grade 2 & 3 PU Exclusion: Grade 1 or 4 PU, if factors present that could adversely influence wound healing e.g. uncontrolled diabetes mellitus, clinical infection, PU that could not be accurately graded, if left study within 8 days of initial enrolment, if patients receiving other therapies that could confound the results. Outcome/s: Number of PU completely healed. Decrease in PU size and area, total wound healing. Resource use: Nurse time and treatment supply (including tape, dressings, underpad, gauze pads). Activity data based on observation of dressing changes over a fortnight. Nurses completed supply usage forms for first 50 PU redressed. Currency: US$, no price date Follow-up: 17 days on average (range 6-56 days) Assessments: Assessed every 4 days	Resource use: (I) 0.42 dressing changes/ day (over 17 days), took 7.30 minutes/dressing change and spent 3.07 minutes/PU/day (C) 4.1 dressing changes/ day (over 17 days), 7.95 minutes/dressing change and spent 32.60 minutes/PU/day Cost: Average supply cost/dressing change= $6.15 for (I) & $0.47 for (C) Average labour cost/dressing change = $2.31 for (I) & $2.52 for (C) Total cost/dressing change = $8.46 for (I) vs. $2.99 for (C) Total daily cost of (I)=$3.55 vs. $12.26 for the (C) group Total average cost per case = $53.68 (I) vs. $176.90 (C) Effectiveness: 22% (n=11) PU healed n the (I) group vs. 2% (n=1) in the (C) group Cost-effectiveness: Not presented. Costs associated with (I) were lower and more PU healed and on this basis (I) is the more cost-effective option, dominating (C). Uncertainty assessed: Indication of variance and significance testing. Robustness of results tested using different wage costs.	Conclusions: (I) more cost-effective when all costs considered. Cost of (I) dressing was higher than cost of (C) though. Greater proportion of PU healed in group (I) vs. group (C). Comment: Authors randomised by PU instead of by patient and that can introduce bias. Variance around cost estimates not reported. Not clear what measure of central tendency was used. No statistical tests of costs undertaken. There were SS more grade 2 PU randomised to (I) than (C) and grade 2 PU tend to have better healing characteristics than grade 3 PU.

7
Authors: Gorse et al. (1987)
Setting/Perspective of the analysis: Hospital, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Hydrocolloid dressings. (C) Dakin's solution (chloramines-T)-soaked wet-to-dry dressings
Funding: Not stated

METHOD	RESULTS	OVERVIEW
Design: Prospective selection of patients. Allocation to intervention was determined on the basis of admission to a particular ward. Wards were chosen which included medical and surgical patients. Sample: (I) 27 patients & 76 PU. (C) 25 patients with 52 PU Level of effectiveness analysis: Level 2 Inclusion: grade 2 & 3 PU and grade 4 PU that extended only into the muscle Exclusion: Adjacent osteomyelitis or extension of PU into fascia, bone &/or a joint space, venous stasis, ischaemic ulcers of the extremities, rapidly fatal underlying disease, planned hospital discharge within 7 days of initiating treatment Outcome/s: Rate of healing for each healed PU (initial surface area divided by number of days until complete healing). If patients died/were discharged prior to complete healing, the surface area at the last examination was subtracted from the initial surface area and the results divided by the number of treatment days. Resource use: Nurse time & treatment supply but only the cost of supplies were calculated Currency: US$, no price date Follow-up: From initiation of conservative treatment until healing, hospital discharge or failure of the initial intervention Assessments: Nurses	Resource use: (I) was changed approximately every 4 days per week, five minutes per dressing change was assumed (C) was changed approximately every 8 hours or 3 times per day, 21 times per week. 20 minutes per dressing change was assumed Cost: Based on intervention costs only, a cost of $6.20 per week was estimated for (I) vs. $52.50 per week for (C) Effectiveness: (I) 86.8% of PU improved vs. (C) 69.2%. The number of days to complete heal for those PU that did heal was 10.0 (+/-10.5) for (I) vs. 8.7 (+/-6.2) for (C). The rate of decrease (cm2 per day) for PU that healed was 0.72 (+/-1.22) for (I) vs. 0.55 (+/-0.59) for (C). NSS Among incompletely healed PU the duration of follow-up was SS for (C) vs. (I) but the rate of decrease in surface area was not significantly different. Among PU that worsened, a SS higher rate of increase in surface area in (I) resulted compared to (C). Cost-effectiveness: Not presented. Costs associated with (I) were lower and more PU healed and on this basis (I) is the more cost-effective option, dominating (C). Uncertainty assessed: Appropriate statistical tests were applied to the effects. Cost differences across groups were not compared statistically.	Conclusions: (I) resulted in a large proportion of PU completely healed or healing vs. (C). The weekly cost of the interventions alone was lower for (I) vs. (C). Comment: The cost was not examined until time to heal or according to any other effectiveness measure. Some patients had more than one PU that was entered into the trial. Allocation of patients to interventions not random. The cost of nursing time was not assessed.

8
Authors: Graumlich et al (2003)
Setting/Perspective of the analysis: Nursing homes, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Topical collagen. (C) Hydrocolloid
Funding: Glaxo, Smith, Kline Inc, BioCore Medical Technologies, Retirement Research Foundation

METHOD	RESULTS	OVERVIEW
Design: Multi-centre, randomized (by computerized random number generator), allocation concealed, single (outcome assessor) blind, controlled trial. Stratified, blocked design with diabetes mellitus as the stratification variable. One PU per/patient. Analysis according to intention to treat. Sample: (I) n=35, (C) n=30, drop-out rate= 17% (n=6) for (I) and 17% (n=3) for (C), NSS Level of effectiveness evidence: Level 1 Inclusion: Grade 2 or 3 PU, 18+ years old Exclusion: Hypersensitivity to collagen or bovine products, concomitant investigational therapy, previous enrolment in the trial, osteomyelitis, cellulitis, malnutrition, PU covered by eschar or necrotic material, PU covered by orthopaedic casts, burn ulcers, diabetic foot ulcers distal to tarsals, life expectancy <8 weeks, anticipated transfer to acute care within 8 weeks. Outcome/s: % of PU completely healed within 8 weeks. Secondary outcomes, time to heal, ulcer area healed per day, linear healing of wound edge Resource use: Nurse time & treatment supply including ancillary supplies Currency: US$, no price date Follow-up: 8 weeks (median=5 weeks) Assessments: Weekly nurse assessments	Resource use: (I)=1/day, (C)=0.29/day or 2/week. Average time/dressing change=15 minutes Cost: Average cost/patient for grade 2 or 3 PU for 8 weeks = $627.56 for (I) & $222.36 for (C) Effectiveness: Complete PU healing within 8 weeks for 51% of (I) and 50% of (C) (95% CI: 26% to 29%), NSS Mean healing time (I)=5 weeks (95% CI: 4 to 6 weeks), (C)=6 weeks (95% CI: 5 to 7 weeks), NSS Mean area healed/day = 6mm^2 /day in both groups Mean linear healing of wound edge was 3mm both groups Cost-effectiveness: Not presented. Costs associated with (I) were higher and more PU healed but NSS Uncertainty assessed: Appropriate statistical tests were applied	Conclusions: NSS differences in healing outcome across groups. (I) was considerably more expensive and offered no major benefits to patients otherwise eligible for (C) Comment: The rationale for using an 8 week follow-up period was not provided. Little exploration of the uncertainty associated with the cost data was provided

9
Authors: Harding et al. (2000, 2001)
Setting/perspective of the analysis: Health care, UK
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I1) Saline moistened gauze, (I2) Hydrocolloid Comfeel dressing, (I3) Hydrocolloid Granuflex dressing
Funding: ConvaTec

METHOD	RESULTS	OVERVIEW
Design: Probability based decision model Sample: Initially (I1) PU n=102, (I2) PU n=136, (I3) PU=281. Total sample of PU, n=519. Hypothetical managed care plan with a population of 100,000 individuals. Level of effectiveness evidence: Not clear but use of evidence on levels 1 to 4 possible Inclusion: Effectiveness data derived from review of published studies and validated by expert panel. 15 studies of 3 PU protocols qualified for inclusion. Exclusion: Those studies that did not include information on patient demographics by treatment modality, wound healing assessments or methods of care, grade 1 PU, studies that did not report the % of PU healed between 4 and 12 weeks, and studies with a pooled total of <100 PU. Outcome/s: Average (weighted) proportions of PU completely healed at different time frames. Number of patients healed/not healed after 12 weeks. If no healing data was available, the % of PU healed was estimated based on available data and linear growth interpolation. Resource use: Dressing materials, ancillary supplies, nursing and doctor debridement. A PU care questionnaire was developed to validate resource use and treatment patterns, based on existing guidelines and the published literature. 4 European experts completed the questionnaire and the data from each used to obtain parameter estimates. Currency: UK sterling £, price date 1999 Follow-up: 12 weeks	Resource use: Frequency of doctor visits = 0. Nursing time to change dressing & assess PU = 20 minutes/PU. Dressing changes/week: (I1)=14, (I2) & (I3)=2. Surgical debridement by a doctor was estimated to be required in 25% of PU and subsequent debridement in 13% of PU. Non-surgical debridement by a nurse was assumed to be required in 50% of all PU. In case of PU infection, a course of antibiotics was assumed: 500mg Amoxycillin, 3/day for 10 days. Cost: Average cost for (12) weeks per healed PU were: (I1)=£115 for dressing materials, £2,548 for nursing (I2)= £189 for dressing materials, £453 for nursing (I3)= £124 for dressing materials, £298 for nursing Effectiveness: Proportion of PU healed at 12 weeks: (I1)=51%, (I2)=48%, (I3)=61% Cost-effectiveness: Not reported. Instead the average cost per effect (i.e.) total cost/patient healed after 12 weeks of treatment was calculated: (I1)=£2,663, (I2)=£642, (I3)=£422 Uncertainty assessed: No	Conclusions: (I3) was the most cost-effective option. The cost of (I2) & (I3) were lower per patient PU healed compared to (I1) Comment: (I1) dressings were cheaper than (I2) and (I3) dressings. However, due to increased nurse input associated with higher frequency of dressing changes, the total cost per healed PU at 12 weeks was lower for groups (I2) & (I3). Difficult to compare primary study samples in terms of % of PU healed according to ulcer grade and location. Testing for statistical significance not applied. To compare across treatments, the average cost-effectiveness ratio was calculated rather than the incremental cost-effectiveness ratio.

10
Authors: Kerstein et al. (2001)
Setting/Perspective of the analysis: Hypothetical managed care plan, US
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I1) Saline moistened gauze (I2) Hydrocolloid Comfeel dressing (I3): Hydrocolloid DuoDERM dressing
Funding: Convatec, division of Bristol-Myers Squibb Company

METHOD	RESULTS	OVERVIEW
Design: Probability based decision model Sample: Hypothetical managed-care plan with a population of 100,000 lives Level of effectiveness evidence: Not clear but use of evidence on levels 1 to 4 possible Inclusion: Effectiveness data derived from review of published studies and validated by expert panel. Exclusion: Those studies that did not include information on patient demographics by treatment modality, wound healing assessments or methods of care, grade 1 PU, studies that did not report the % of PU healed in at least one of a number of specific timeframes (4, 6, 8 and 12 weeks of PU) and studies with a pooled total of <100 PU. Outcome/s: Average (weighted) proportions of PU completely healed at different time frames. Number of patients healed/not healed after 12 weeks. If no healing data was available, the % of PU healed was estimated based on available data and linear growth interpolation and extrapolation. Resource use: Dressing materials, nursing and doctor debridement. A PU care questionnaire was developed to validate resource use and treatment patterns, based on existing guidelines and the published literature. 4 US experts completed the questionnaire and the data from each used to obtain parameter estimates Currency: US$ 2000 Follow-up: 12 weeks	Resource use: Frequency of doctor visits was 0.25/week (15 to 30 minutes for the first visit and 15 minutes for follow-up visits) Nursing time to change dressing and assess PU was 15 minutes/PU. Dressing changes/week were 14.41 (7 to 21) for I1, 2.47 (1.8 to 7) for I2, 2.19 (1.0 to 3.4) for I3 Cost: Average cost for 12 weeks were: (I1)=$92.43 for dressing materials, $996.05 for nursing, $338.87 for doctor debridement (I2)=$270.05 for dressing materials, $170.37 for nursing, $338.87 for doctor debridement (I3)=$260.06 for dressing materials, $151.63 for nursing, $338.87 for doctor debridement Effectiveness: After 12 weeks 511 patients with PU were healed with I1, 358 with I2, 696 with I3 Proportion of PU healed at 12 weeks: (I1)=51% (0-100), (I2)=48% (29-80), (I3)=61% (33-100) Cost-effectiveness: Not reported. Instead the average cost per effect (i.e.) total cost /patient healed after 12 weeks of treatment was calculated: (I1)=$2,179, (I2)=$1,267, (I3)=$910 Uncertainty assessed: No	Conclusions: (I3) was the most cost-effective option. The cost of (I2) and (I3) were lower per patient PU healed compared to (I1). Comment: (I1) dressings were cheaper than (I2) and (I3) dressings. However, due to increased nurse input associated with higher frequency of dressing changes, the total cost per healed PU at 12 weeks was lower for groups (I2) & (I3). It was difficult to compare primary study samples in terms of % of PU healed according to PU grade and location. Testing for statistical significance not applied. To compare across treatments, the average cost-effectiveness ratio was calculated rather than the incremental cost-effectiveness ratio.

11
Authors: Kim et al. (1996)
Setting/Perspective of the analysis: Health care system, Korea
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Hydrocolloid occlusive dressing. (C) Wet-to-dry gauze dressing
Funding: Not stated

METHOD	RESULTS	OVERVIEW
Design: RCT Sample: (I) 26 PU. (C) 18 PU Level of effectiveness evidence: Level 1 Inclusion: Grade 1 and 2 PU Exclusion: Patients with systemic infections, with endocrinological disorders, with difficulty in keeping pressure-relieving positions or with aggravated general conditions due to other factors. Outcome/s: Complete heal, time to heal, PU healing rate Resource use: Number of dressing changes per day and medical staff time Costs: Only costs of the interventions were considered Currency: Korean Won, price date not specified Follow-up: Not stated Assessment: Every 4 days	Resource use: (I) changed every 4 to 5 days (C) changed 3 times per day Medical staff time was 20.4 minutes per day for (I) vs. 201.7 minutes per day for (C) Cost: The average cost of the interventions was Won 8,204 (+/-2,664) for (I) vs. Won 14,571 (+/-6,700) for (C) (P<0.05). These costs did not take the cost of staff into account. Effectiveness: 80.8% of (I) and 77.8% of (C) healed completely (NSS). Time to complete heal was 18.9 days for (I) vs. 24.3 days for (C) PU healing speed was 9.1mm^2 per day for (I) vs. 7.9 mm^2/day for (C) 3 (11.5%) of PU in (I) developed hypergranulation and they were treated with povidine-iodine gauze until complete healing was achieved. Cost-effectiveness: Cost and outcomes not synthesised. More PU healed in (I) and the daily cost of treatment was lower, therefore (I) appears to be the more cost-effective option, dominating (C). However the difference in outcomes was NSS. Uncertainty assessed: Statistical analysis was undertaken to compare costs and outcomes across groups.	Conclusions: (I) may be more cost-effective than (C) Comment: The method of allocation to treatment was not described fully. The length of follow up was not stated.

12
Authors: Kraft et al. (1993)
Setting/Perspective of the analysis: Long-term hospital care at a spinal cord injury centre, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) semi-permeable polyurethane foam dressing, (C) Moist saline gauze dressings
Funding: Calgon Vestal Laboratories

METHOD	RESULTS	OVERVIEW
Design: RCT. Treatment completers Sample: Initial sample size: (I): n=24 PU, (C): n=14 PU. Final sample size: (I): n=11 PU, (C): n=6 PU Level of effectiveness evidence: Level 1 Exclusion: Grade 1 or 4 PU, clinically infected patients, patients on special beds, unstable insulin-dependent diabetes, serum albumin <2gm, haemoglobin<12gm, class 4 congestive heart failure, chronic renal insufficiency, documented severe peripheral vascular disease, documented severe COPD Outcome/s: Complete heal within 24 weeks Resource use: Nurse time and treatment supply. Nurses assumed to spend an average of 10 minutes per dressing. Currency: US$ 1990 Follow-up: 24 weeks Assessments: Nurse assessed at 6, 12 and 24 weeks	Resource use: (I) changed once per week or until leakage of exudates, an average of 2.5 dressings/week or 25 minutes nursing time (C) 3/day, an average of 21 dressing changes/week or 210 minutes of nursing time Cost: Average supply weekly cost of (I)=$12.18 vs. $5.25 for (C) group Average cost of nursing time/week (I)= $8.30, (C)=$69.72 Total average cost/week (I)=$20.48, (C)=$74.97 Effectiveness: At 24 weeks, in the (I) group 42% (n=10) of PU were healed vs. 21% (n=3) in the (C) group Cost-effectiveness: Cost and outcomes not synthesised. More PU healed in (I) and the daily cost of treatment was lower, therefore (I) appears to be the more cost-effective option, dominating (C). However the difference in outcomes was NSS. Uncertainty assessed: Indication of variance and significance testing. Robustness of results tested using different wage costs.	Conclusions: (I) more cost-effective when all costs considered. Cost of (I) dressing was higher than cost of (C) though. Greater proportion of PU healed in group (I) vs. group (C). Comment: Not clear what measure of central tendency average was. No statistical tests undertaken. 2/24 (I) patients withdrawn and the reason for this was not given.

13
Authors: Mosher et al. (1999)
Setting/Perspective of the analysis: Long-term care, Third party payer (Medicare), US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I1) Autolysis (autolytic debridement) (I2) Wet to dry saline (mechanical debridement) (I3) Collagenase (enzymatic debridement) (I4) Fibrinolysin (enzymatic debridement)
Funding: Knoll Pharmaceutical Company

METHOD	RESULTS	OVERVIEW
Design: Decision analytic model. Effectiveness evidence synthesised data from the literature and expert opinion. Initial surgical debridement of the wound was not entered into the model. Median values of experts gained were used as probabilities in the decision model. A modified Delphi approach was used to reach consensus on critical treatment choices and possible outcomes. Sample: Hypothetical 78-yr-old female in a long-term care facility who had not been hospitalised in the prior 12 months. She has a new full-thickness PU on her trochanter with 50% necrotic tissue (eschar) covering the PU, mild odour, minimal draining, no undermining and intact peri-ulcer skin. Level of effectiveness evidence: Not clear but use of evidence on levels 1 to 4 possible Outcome/s: Probability of obtaining a clean wound bed for each 28-day treatment of the hypothetical treatment Resource use: Drugs, dressing and irrigation supply, doctor visits, ancillary services (e.g. outpatient laboratory tests), hospitalisation and associated resource use, surgical debridement. Currency: US$ 1995 Follow-up: 28 day treatment	Cost: Total cost per patient for 28 days: (I3)=$610.96, (I1)=$920.73, (I4)=$986.38, (I2)=$1008.72 Effectiveness: Probability of a clean wound bed: (I3)=0.887, (I1)=0.641, (I2)=0.376, (I4)=0.449 Cost-effectiveness: (I3) dominant over all other alternatives Uncertainty assessed: Expected costs were probability weighted costs. Probabilistic sensitivity analysis conducted to investigate parameter uncertainty. All parameter inputs were varied by –5% and +5% and results remained robust.	Conclusions: (I3) was the most cost-effective treatment for the management of PU in elderly long-term care residents. (I) remained the most cost-effective option when probability estimates were varied between +/- 10%. Comment: The quality of the review process and the elicitation of expert opinion was not clear. The authors note that the probability data was non-normally distributed and non-random.

14
Authors: Motta et al. (1999)
Setting/Perspective of the analysis: Home healthcare patients, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Synthetic polymer dressing. (C) Hydrocolloid dressing
Funding: AcryMed educational grant, Portland

METHOD	RESULTS	OVERVIEW
Design: RCT Sample: (I) n=5 PU. (C) n=5 PU Level of effectiveness analysis: Level 1 Inclusion: Grade 2 and 3 PU Exclusion: Those with an underlying medical condition such as long-term use of steroids or uncontrolled diabetes Outcome/s: Healing rate, adverse reaction, product performance (based on exudate performance, whether dressing maintains moist environment, promotes autolytic debridement and its overall clinical performance marked out of 1 to 5 with 1 being most favourable and 5 being least favourable) Resource use: Treatment (dressings and ancillary supplies) and labour (nursing time) Currency: US$, price year not stated Follow-up: 8 week pilot study Assessment: Weekly	Resources: On average 3.38 dressings were used and labour time per dressing change was 9 minutes for (I) vs. 8 dressings and a labour time per dressing change of 13 minutes for (C) Cost: Total cost of treatment over 8 weeks was $57.76 for (I) and $9l.48 for (C) Effectiveness: 2 PU in each group completely healed and all other PU demonstrated substantial reductions in size. The overall healing rates were not SS different. No adverse reactions occurred. The overall performance of the interventions was assessed based on the average score obtained during dressing change for each parameter. No SS differences were noted. Cost-effectiveness: The same number of PU healed in (I) and (C). The daily cost of treatment using (I) was lower therefore it may be the more cost-effective option. Uncertainty assessed: Statistical analysis to compare costs and effects but tests used were not reported	Conclusions: (I) may be more cost-effective than (C) with a lower associated cost and similar effectiveness. The lower cost of treatment using (I) was due to the use of significantly fewer dressings by that group. Comment: Randomisation process was not described. This was a pilot study and the sample size was small.

15
Authors: Muller et al. (2001)
Setting/Perspective of the analysis: Hospital, The Netherlands
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I): Collagenese-containing ointment. (C): Hydrocolloid dressing (Duoderm)
Funding: Knoll AG

METHOD	RESULTS	OVERVIEW
Design: RCT. Following autolytic debridement patients were allocated to the interventions. Treatment completers since one patient in (C) failed to comply with the weekly PU inspection and was dropped from the study. Sample: (I) n=12 PU, (C) n=12 Level of effectiveness evidence: Level 1 Inclusion: Grade 4 PU on the heel following orthopaedic surgery due to hip fracture or total hip replacement Exclusion: Patients with a life expectancy < 6 months Outcome/s: Complete wound heal meant that the patient was successfully treated. Rate of complete wound healing. Average number of weeks required until PU healing was achieved Resource use: Materials and labour time Currency: Dutch Guilders NLG 1998 Follow-up: To complete heal Assessments: Once per week by the doctor	Resource use: (I) treated 1 /day (C) treated 0.29 /day Nurse time to change dressing = 15 minutes for both groups Doctor time per visit = 30 minutes for both groups Cost: Average cost / patient of (I) = NLG1,615.8 vs. (C) NLG1,692.7 Effectiveness: (I): 91.7% (11/12) patients successfully treated (C): 63.6% (7/11) patients successfully treated, SS (p<0.005) Time to PU heal was shorter for (I) at, on average, 10 weeks compared to 14 weeks for (C), P<0.005) Cost-effectiveness: Cost per successfully treated patient (i.e. complete wound heal): (I)=NLG1,762.0 vs. NLG2,661.4 for (C). (I) cost less and was associated with better effects and therefore dominated (C). Uncertainty assessed: Statistical tests were undertaken. A deterministic model and one-way sensitivity analysis and a probabilistic model using Monte Carlo simulation were conducted. In all scenarios, (I) remained the more cost-effective treatment. The independency of the model parameters was assumed.	Conclusions: (I) was more cost-effective and that the amount of time needed for wound healing was shorter. Comment: Average cost-effectiveness rather than incremental cost-effectiveness reported. Sensitivity analysis revealed that even under extreme conditions (I) remained more cost-effective than (C). Two patients, one in each group had two PU on the heel but it was not mentioned which PU was included in the study.

16
Authors: Nasar et al. (1982)
Setting/Perspective of the analysis: Hospital, UK
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I): Debrisan, n=10 PU. (C): Eusol and paraffin dressings, n=8. Total of 12 patients, 18 PU
Funding: Not stated

METHOD	RESULTS	OVERVIEW

Design: RCT
 	
Sample: (I) n=10 PU, (C) n=8 PU. Total of 12 patients, 18 PU.
 	
Level of effectiveness evidence: Level 1
 	
Inclusion: Grade 2 or 3 PU
 	
Exclusion: Those with urinary tract infections
 	
Outcome/s: Complete heal, time to heal
 	
Resource use: Materials and ancillary supplies and hospital stay
 	
Currency: UK Sterling £, price year not stated
 	
Follow-up: Endpoint was when the PU was clean and granulating and appeared to be less than 25% of its original surface area
 	
Assessment: Every three days by an independent observer
	Resource use:
	(I) was applied 2/day for the first 3 days and once per day thereafter.
	(C) were changed 3 times per day for the first 3 days and then twice daily until the PU was healed.
	
	Cost: Average cost for PU that healed was £1053.05 for (I) vs. £1667.00 for (C)
	
	Effectiveness:
	For (I), 6 out of 8 PU healed in approximately 39.3 days. One other patient died and one patient withdrew from treatment.
	For (C), 5 out of 8 PU healed in approximately 62 days. Three patients were switched to (I).
	
	Cost-effectiveness:
	(I) was lower cost and was associated with a higher number of PU healed compared to (C).
	
	Uncertainty assessed:
	No
		Conclusions: (I) appears to be more cost-effective than (C), costing less and time to heal was faster for those PU that healed.
		
		Comment: Some patients had more than one PU entered into the trial. Randomisation procedure to allocate patients to interventions was not described. Length of follow-up not clear. Costs only relate to those whose PU healed.

17
Authors: Ohura et al. (2004)
Setting/Perspective of the analysis: Hospital, Japan
Type of economic evaluation: Cost-effectiveness analysis
Interventions: (I1) Hydrocolloid DuoDERM dressing with a standardized wound management algorithm (I2) Traditional care of ointment and gauze with a standardized wound management algorithm (I3) Traditional care of ointment and gauze without a standardized wound management algorithm
Funding: ConvaTec, a division of ER Squibb & Co

METHOD	RESULTS	OVERVIEW
Design: Multi-centre, comparative, prospective study. Successive patients were assigned to one of the three groups. The dressings and ointments to be used for each PU grade were grouped for use in different grades of wound healing. Sample: Total number of patients enrolled = 91, 83 patient in final analysis (9% dropped out). (I1) 35% of patients (n=29), (I2) 41% of patients (n=34), (I3) 24% of patients (n=20) Level of effectiveness evidence: Level 2 Inclusion: Grade 2 or 3 PU Outcome/s: Change in Pressure Ulcer Status Tool (PSST) score calculated by subtracting end score by enrolment score Resource use: Materials and labour time of nurses, doctors, nurses, nurse assistants, care-workers. Wound management materials and time spent were recorded daily on an activity record form. Currency: Japanese Yen, 2001 Follow-up: Maximum period of 12 weeks Assessments: Not clear who did or when	Cost: (I1): Average total cost per patient = Yen 87,715 vs. Yen 131,283 for (I2) & Yen 200,584 for (I3). Difference in cost of (I1) vs. (I3) was SS as well as when materials and total labour costs were analysed separately. Similar trends existed but were NSS when comparisons made for patients with grade 2 PU only. For grade 3 PU, the total cost of care, the cost of labour and the cost of materials was SS different for (I1) vs. (I3) groups (p=0.003, 0.005, 0.005 respectively). Effectiveness: (I1)= 11.1 point reduction in PSST vs. 6.9 point reduction for I2 group & 9.0 for I3. Reduction in PSST was SS different for (I1) vs. (I2). If groups compared by grade of PU, (I1) was more effective than (I2) and (I3) but NSS. Cost-effectiveness: Across all PU, PSST units difference/Yen: (I1) = 0.127 was more cost-effective than (I3) = (0.045) and SS more cost-effective than (I2) = 0.052 (p=0.044). Average effect per unit of cost rather than incremental cost per effect was calculated. Uncertainty assessed: Statistical tests applied to compare costs across groups. No sensitivity analyses conducted.	Conclusions: (I1) was the most cost-effective option. The total costs were lower due to a higher success rate and less nursing time required. However, the unit cost of (I) treatment material was higher. Comment: Non-random allocation to groups. Statistical tests applied to compare costs across groups were not stated. Doctors were involved in wound management, a high cost input.

18
Authors: Robson et al. (1999)
Setting/Perspective of the analysis: Hospital, US
Type of economic evaluation: Cost-consequence analysis
Interventions: Recombinant human platelet-derived growth factor-BB. (I1) 100 µ g rhPDGF-BB per day. (I2) 300 µ g rhPDGF-BB per day. (I3) 100 µ grhPDGF-BB twice daily. (I4) Placebo.
Funding: The R.W Johnson Pharmaceutical Research Institute. Statistical support by Ortho-McNeil Pharmaceuticals Inc

METHOD	RESULTS	OVERVIEW
Design: Multi-centre (n=14) clinical trial sites. A double blind, randomised, placebo controlled trial. Sample: (I1) n=21 patients. (I2) n=22 patients. (I3) n=23 patients. (I4) n=17 patients. Total patients, n=124 and of these 83 had photographs of sufficient quality to rate for ease of closure. Level of effectiveness evidence: Level 1 Outcome/s: Wound volume decrease over time. Changes in ease of surgical closure on a scale from 0 (no need to close, healed) to 13 (not possible to close) based on photographs of PU at a set focal distance obtained weekly and as assessed by 4 rater blinded surgeons. Cost: The change in difficulty of wound closure was studied in relation to the composite cost including surgeon's fee, anaesthesia fee and operating room cost. Costs were arrived at from charges to patients at two university centres. The range of costs was $100 for a single-buttressed suture placed at the patient's bedside to $12,000 for a difficult musculocutaneous or free flap. Currency: US $, no price date Follow-up: 16-week treatment trial Assessments: From day 0 and weekly for 16 weeks by independent observers	Cost: At the beginning of the trial, the mean and median cost of closure was estimated at $8,000 per PU as they were rated as requiring a somewhat easy pedicle flap procedure to close the wound. At the end of the trial, (I) required (according to the raters) a difficult direct wound application costing $800 to $1,000 (a cost saving of $7,000 to $7,200), vs. an easy skin graft for (I2) and (I3) costing $1,200 (a cost saving of $6,800) and for (I4) a slightly more difficult procedure was required costing $1,700 (a cost saving of $6,300). The cost savings were SS even though 100% wound closure was not routinely achieved. Effectiveness: 94% of the possible maximum number of photographs were available for rating. At the end of the trial, (I1) patients PU improved 6 points on the scale from beginning to end of treatment. For (I2) and (I3) patients had a mean of 5 points on the scale and for (I4) the score was 4 points. All outcomes were SS improved from their respective starting ease of closure scores of 10 ($p<0.0001$). Cost-effectiveness: Not synthesised. It appears that (I) was more cost-effective than (I2) & (I3) which, in turn, were more cost-effective than (I4). Uncertainty assessed: Statistical tests regarding effectiveness and costs (but cost test results not reported)	Conclusions: (I1) was the dominant treatment being cheaper and showing signs of higher ease of wound closure compared to (I2), (I3) and I4). Comment: The analysis assumes that PU would have otherwise been closed via surgical techniques. The authors tested the correlation between the ease of closure scale and the wound area as photographs are only 2-dimensional. Results of clinical trial are provided in another paper.

19
Authors: Robson et al. (2000)
Setting/Perspective of the analysis: Hospital, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I1) Cytokine growth factors (2.0 µg/cm^2 GM-CSF) therapy topically applied daily for 35 days. (I2) 5.0 µg/cm^2 bFGF therapy applied daily for 35 days. (I3) 2.0 µg/cm^2 GM-CSF applied for 10 days followed sequentially by 25 days of topically applied 5.0 µg/cm^2 bFGF. (I4) Placebo applied daily for 35 days.
Funding: National Institutes of Health. Schering-Plough Research Institute and Scios Inc provided the cytokines

METHOD	RESULTS	OVERVIEW
Design: A double blind, randomised, placebo controlled trial Sample: (I1) n=15 patients. (I2) n=15 patients. (I3) n=16 patients. (I4) n=15 patients. Total patients, n=61 Level of effectiveness evidence: Level 1 Inclusion: Grade 3 and 4 PU. All patients were denervated in the area of ulceration because of acquired spinal cord pathology. PU measuring 10 to 200cm^3 for at least 8 weeks . Exclusion: Significant diabetes mellitus, renal insufficiency, vasculitis, or hepatic, immunologic, cardiac, or haemorrhagic disease, malignant or neoplastic disease (except for adequately treated skin cancers), significant malnutrition, systemic steroidal therapy, immunotherapy, or chemotherapy, cytokine therapy within 90 days or investigational drug study within 30 days. Outcome/s: Wound volume decrease over time. Changes in ease of surgical closure on a scale from 0 (no need to close, healed) to (13) (not possible to close) based on photographs of PU at a set focal distance. An arbitrary response rate of at least 85% wound closure during 35 days of follow-up was chosen as indicative of a responder. Resource use: The amount of topical substance each week of treatment was based on volumetrically determined surface area at baseline and on study days 7, 14, 21, 28 Cost: Change in difficulty of PU closure in relation to total cost (surgeon's fee, anaesthesia fee, operating room cost) Currency: US $, no price date Follow-up: 35 days (5 weeks) Assessments: From day 0 and weekly for 5 weeks as assessed by 2 blinded surgeons	Cost: At the beginning of the trial, the median cost of closure was estimated at $10,000 per PU. At the end of the trial, (I2) patients PU could be healed by a difficult wound approximation costing $800 to $1,000 (a cost saving of $9,000 to $9,200). For (I3) patients would require a somewhat easy skin graft costing $1,700 (cost saving of 8,300). For (I1) a somewhat difficult procedure was required costing $2,200 (cost saving of $7,800). For (I4) PU could be closed for $3,000 (cost-saving of $7,000). Effectiveness: No differences in mean % of initial PU volume remaining on day 36 across all interventions. However, (I2) had a trend toward greater PU closure. The % of patients responding was SS higher for all cytokine therapies compared to (I4) (p=0.03) with (I2) patients doing best. The median ease of closure for all 4 groups was 11 on day 0. (I2) patients PU improved 7 points on the ease of closure scale. (I3) patients improved 5 points, (I1) patients improved 4 points and (I4) patients improved 3 points. Cost-effectiveness: Not undertaken. It appears that (I) was more cost-effective than (I2) & (I3) which, in turn, were more cost-effective than (I4). Uncertainty assessed: Statistical tests regarding effectiveness estimates	Conclusions: (I2) was the dominant treatment being cheaper and showing signs of higher ease of wound closure compared to (I1), (I3) and I4). Delaying the onset of (I2) appeared to decrease its response. Comment: Little detail was provided on costs. The analysis assumes that PU would have otherwise been closed via surgical techniques. Inter-rater reliability using the ease of closure scale was not undertaken.

20
Authors: Sebern et al. (1986, 1989)
Setting/Perspective of the analysis: Home-care population served by a metropolitan visiting nurse association, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Transparent moisture vapour permeable (MVP) dressing. (C) Gauze and tape
Funding: Sigma Theta Tau research grant and 3M Medical Division, St Paul

METHOD	RESULTS	OVERVIEW
Design: RCT, PU randomly assigned using sequential list of 100 random numbers. Treatment completers. Sample: Initial sample size; (I) n=50 PU, (C): n=50 PU. Final sample size: 77 PU, 48 patients; (I): n=37 PU, (C): n=40 PU Level of effectiveness evidence: Level 1 Inclusion: Grade 2 and 3 PU using a visiting nurse association service Exclusion: PU contained eschar, grade 1 or 4 PU, patient was terminal, patient's white count <4,000 or patient had >3 existing PU Outcome/s: Healing status at 8 weeks: healed, progress toward healing, no change, discontinued or deteriorated. Healing rates. Comfort. Resource use: Nurse time and treatment supply (asepto syringe, hydrogen peroxide, physiologic saline, povidone iodine, sterile gloves, dressings) Currency: US$, no price date Follow up: 8 weeks Assessments: Nurse. Weekly	Resource use: (I) Change daily to 3 times per week, (C) 1/day Cost: Mean supply costs for grade 2 PU mean cost: I=$97, C=$99. Mean supply costs for grade 3 PU mean cost: I=$179, C=$140 (NSS, Wilcoxon) Mean 8 weeks cost per grade 2 PU: (I)=$845, (C)=$1359 (p<0.05) (Wilcoxon, non-parametric). The cost of treatments was NSS across groups. Mean 8 week treatment costs per grade 3 PU was $1470 for (I) group and $1412 for (C) group (NSS across groups). Effectiveness: Grade 2 PU, (I) 64% (n=14) healed, C: 0% (n=0) healed. Grade 3 PU not significantly different between the 2 groups and no further details were provided. Healing rates: grade 2 PU in the (I) group had a 52% median decrease in area of the wound vs. 100% median decrease in the (C) group (P<0.01, Wilcoxon). Grade 3 PU in the (I) group 67% median decrease in PU size vs. 44% in (C) group (not statistically significant). Subjects who had intact sensory input from their PU reported less pain when (I) (MVP or MVP and pouch) was used. Cost-effectiveness: Not undertaken. (I) cost slightly more per PU than (C). Effects differed depending on grade of PU. Uncertainty assessed: Significance testing to compare effects and costs across interventions	Conclusions: (I) more cost-effective for grade 2 PU. (C) less costly for grade 3 PU and NSS different effectiveness. Overall, (I) cheaper. Comment: No difference in outcome for grade 3 PU, however, possible type 2 error. Authors incorrectly re-graded PU at the end of the study. Authors randomised by PU rather than by patient and this can introduce bias. Variance around cost estimates not reported. Statistical tests applied to costs were non-parametric.

21
Authors: Xakellis et al. (1992)
Setting/Perspective of the analysis: Long-term care, US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Hydrocolloid dressings vs. (C) Non sterile saline gauze dressings
Funding: Family Heart Foundation of America & Convatec

METHOD	RESULTS	OVERVIEW
Design: RCT, only one PU included in the analysis. If >1 PU, PU chosen by toss of a coin. Intention to treat. Sample: (I) n=18 PU, (C): n=21 PU Level of effectiveness evidence: Level 1 Exclusion: Grade 1 or 4 PU, patient was terminal or an anticipated discharge within one week Outcome/s: Complete heal. Time to healing. Healing rates. Resource use: Nurse time and treatment supply (syringe, tape, dressings, gauze pads, saline) for 10 randomly chosen patients in each group. Two dressing change times measured and median used. Currency: US$ 1990 Follow up: Study period was 21 months. The study endpoints included PU heal, progression to grade IV, doubling in PU surface area, systemic infection from the PU, no decrease in PU size in 2 months or 6 months of treatment, subject death of subject discharge. Assessments: Nurse assessed twice weekly	Resource use: (I) changed daily to 2 times per week, (C) 3/day. Median nurse time for dressing change (I)= 4.4 minutes, (C)=3.3 minutes. (C) saline remoistening median time of 1.4 minutes. Total median nursing time for dressing changes/remoistening: (I)=15.4 minutes, (C) = 127 minutes Cost: Median total cost was $15.58 for (I) group and $22.65 for the (C) group (NSS) if local nurse wages used. If national nurse wages used, median total cost was $15.90 for (I) group and $25.31 for (C) group. (p=0.04). Effectiveness: Complete heal of PU in 89% (n=16) if (I) group and 86% of (C) group. Median time to healing after randomisation was 9 days for the (I) group and 11 days for (C) group (NSS). (I) 75% of PU healed within 14 days vs. 26 days for (C). After adjusting for exudates present at baseline, healing rates NSS different across groups although a trend towards slower healing for (C) group Cost-effectiveness: Not undertaken. (I) was a lower cost and was associated with a slightly higher number of PU healed compared to (C). Uncertainty assessed: Indication of variance and significance testing. Robustness of results tested using different wage costs.	Conclusions: (I) could be cost saving because, although materials significantly more expensive, nursing time cost was significantly lower. Comment: Healing rates appeared to be faster in the (I) group but this was not statistically significant. Reported median costs that are difficult to interpret. Statistical tests applied to costs were non-parametric.

DATA EXTRACTION TABLES: ADJUNCT THERAPIES

22
Authors: Macario et al. (2002)
Setting/Perspective of the analysis: Long-term medical care, health care payer perspective, USA
Type of economic evaluation: Cost-utility analysis
Interventions: (I) Noncontact normo-thermic wound therapy in combination with the use of pressure-reducing surfaces and repositioning vs. (C) Current standard care, that is moisture retentive dressings, a pressure-reducing surface, repositioning and debridement
Funding: Augustine Medical Inc

METHOD	RESULTS	OVERVIEW
Design: Markov model. Rates of healing, complications associated with healing and mortality rates were obtained from the literature. Incidences of progressing through health states were estimated, based on the literature and converted to bimonthly transition probabilities. Where no empirical data on base transition probabilities were available, estimates were based on available data. Age specific death rates were obtained from national statistics. The model comprised 6 mutually exclusive health states: grade 3 PU, grade 4 PU, healing wound, closed wound healed back to normal, complications requiring hospitalisation and death. Sample: The base case involved analysis of a hypothetical, 72 year old patient living in a nursing home with a 2-month-old grade 3 ischial PU. Secondary analysis involved a grade 4 PU. Monte Carlo simulation was undertaken to estimate results for 10,000 hypothetical patients for use in the probabilistic sensitivity analysis. Level of effectiveness evidence: Levels 1 to 4 Inclusion: Data from literature used to populate the model based on controlled trials of over 4 weeks duration and appropriate outcome measures Outcome/s: Quality-Adjusted Life Years (QALYs) were calculated based on author assumption using the Rosser Index to form quality of life weights (utilities) for each state in the model. Levels of distress and disability were assigned to each health state. The change in health status was combined with the life expectancy of patients to form QALYs.. Resource use: Nurse time, use of supplies and equipment, costs of complications and doctors. Currency: US $ 2000 Follow-up: Patient progression divided into 8-week cycles over 40 months. Discounting at 3% per year.	Effectiveness: RCT based evidence to suggest that (I) reduces the surface area of grade 3 and 4 PU by 2.5 fold (SD 9%) vs. (C) An RCT found that that the 8-week healing rate of grade 3 PU = 71% for (I) and 54% for (C). At these healing rates, for grade 3 PU the 40-month timeframe increases QALYs for (I) of 0.10 (SE=0.0005) life years relative to (C). For grade 4 PU there was an increase in QALYs for (I) of 0.14 (SE=0.001) relative to (C). Cost: Total expected cost of (C) for a grade 3 PU was $20,874. For grade 3 PU, there was a cost saving of $6,3340 (SE $98) for a 40-month time frame. For grade 4 PU (I) saved $15,216 (SE $186) relative to (C) Cost-effectiveness: (I) dominates for grade 3 and 4 PU. However this result was associated with substantial uncertainty. Uncertainty: Probabilistic sensitivity analysis. Triangular distributions were used for parameter values When the cost of (I) was increased to >$421, the use of (I) increased the overall cost to society. The variables that had the biggest impact on modelling were the daily treatment costs and the probability of healing to a normal closed PU.	Conclusions: (I) is less costly and more effective than (C) for 75% (SE=0.4%) of patients with grade 3 PU. (I) is less costly than (C) for 81% (SE 0.4%) of patients with grade 4 PU. Comment: More rapid reduction in PU area does not necessarily translate to a higher probability of complete PU healing. Quality of life assessments were gained indirectly.

23
Authors: Philbeck et al. (1999)
Setting/Perspective of the analysis: Medicare home health care (I), Nursing home residents (C), US
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) negative pressure wound therapy in patients who had failed previous interventions. Although PU n=566, for the purposes of comparison with (C), records of patients who were treated on a low air loss surface were observed, n=43 (i.e. 8% of PU all PU in the study. (C) Saline soaked gauze dressing applied to patients placed on a low air loss surface (based on data from Ferrell et al. 1993 (see Ferrell table)).
Funding: Kinetic Concepts Inc

METHOD	RESULTS	OVERVIEW
Design: Compared retrospective review of Medicare observational data for group (I) with a historical control (C) reported in Ferrell et al. (1993) (see Ferrell et al. 1993, 1995 table) Sample: There were 566 PU for (I) and 43 PU for (C) (i.e. 8% of all PU in the study (C)) Level of effectiveness evidence: Level 3 Inclusion: Grade 3 and 4 PU treated on the trochanter or trunk Exclusion: Patient whose notes were not eligible or that did not have the basic data set Outcome/s: Reduction in wound area and volume after 30 days of treatment (healing rates) Resource use: Nurse time and materials Currency: US$, price year not stated Follow-up: 180 days for (I). Median follow-up for (C) was 33 days	Cost: (I) = material costs and nursing visit costs/day = $107.46 and $42.50 (n=43 patients) respectively (C) = material costs and nursing visit costs/day = $10.00 and $85.00 Total cost / day, (I) = $149.96 vs. (C) = $95.00 Expected total cost to treat: (I)=$14,546 vs. $23,465 for (C) Effectiveness: Area reduction rate (cm^2 /day), (I) = 0.230 vs. (C) = 0.090 Time to heal based on wound healing reduction rates, (I) = 97 days expected to complete heal vs. (C) = 247 days to complete heal. Cost-effectiveness: (I) dominates (C) for grade 3 and 4 PU Uncertainty assessed: No	Conclusions: (I) more cost-effective due to faster healing time expected. However material costs higher for (I) per day. Comment: Data was taken from two different sources where the study designs and settings were different. The initial surface area of PU across groups was very different for (I) vs. (C) (22.2 cm^2 vs. 4.3cm^2.respectively) potentially favouring (C). It is not known what % of PU were grade 3 and 4 PU and (C) included grade 2 PU also. No assessment of uncertainty associated with the estimates.

DATA EXTRACTION TABLES: PRESSURE-RELIEVING SUPPORT SURFACES

24
Authors: Branom et al. (2001)
Setting/Perspective of the analysis: Hospital, USA
Type of economic evaluation: Cost-consequence analysis
Interventions: (I) Constant force technology mattress, (C) Low air loss mattress
Funding: Span-America Medical Systems Inc

METHOD	RESULTS	OVERVIEW
Design: Clinical trial, patients allocated alternately to either mattress. Treatment completers. Sample: (I) patients/PU n=10, (C) patients/PU n=8 Level of effectiveness evidence: Level 2 Inclusion: Grade 3 or 4 PU on the trunk or pelvis. For patients with >1 PU, only the deepest one was followed in the study. All patients had to be bedridden. Exclusion: Patients with infected PU Outcome/s: Goal for wound healing. The wound care team established a goal for wound healing from progressive closure, maintenance or preparation for flap surgery. At the end of the study patients were rated as having achieved their goal, not having achieved their goal, or having exceeded their goal. Average rate of PH closure/week Average % PU closed Resource use: Mattress Currency: US $, price year not stated Follow-up: Maximum of 8 weeks. Study exit criteria also included death, discharge from inpatient status, flap surgery.	Cost: Purchase price for mattress (I) = $1,080.00, 55% of cost of (C) over 8 weeks Daily rental cost for (C) mattress = $35.00/day or $1,960.00/8 weeks Effectiveness: The goals set for PU healing were achieved of exceeded for all 100% (n=10) patients in the (I) group vs. 63% (n=5) in the (C) group Average size at discharge from the study was 6.6cm^3 for group (I) vs. 24.6cm^3 for group (C) Average amount closed at discharge from study = 25.8cm^3 for group (I) & 22.2cm^3 for group (C) Average rate of closure/week at discharge from study = 3.5cm^3 for group (I) & 2.8cm^3 for group (C) Average % closed = 60.0% for group (I) & 39.6% for group (C) Average % closed/week = 9.0% (+/-4.8) for group (I) vs. 5.0% (+/-3.7) for group (C) Cost-effectiveness: (I) dominates (C) for grade 3 and 4 PU Uncertainty assessed: Limited statistical analysis undertaken comparing outcomes.	Conclusions: (I) was more cost-effective than (C) and further cost savings could be realised because the mattress (I) could be available for further use. Comment: Sequential randomisation to groups not truly random. A narrow cost focus was adopted. The cost savings achieved by the (I) mattress was heavily dependent on the prices of the two mattresses and the time to heal. Small sample size.

25
Authors: Ferrell et al. (1995)
Setting/Perspective of the analysis: Nursing home, US
Type of economic evaluation Cost-effectiveness analysis
Interventions: (I) Low air loss beds (C) Conventional foam mattress (four inch corrugated foam mattress overlying a conventional foam mattress)
Funding: UCLA Older American Independence Centre. Sepulveda VAMC GRECC, RAND. Jewish homes for the Aging of Greater Los Angeles, Kinetic Concepts International provided some support for data collection

METHOD	RESULTS	OVERVIEW
Design: Retrospective analysis of an RCT to describe the rate of healing as a function of patient and PU characteristics and to provide data on variation in healing across patients. The result of the statistical model of healing produced was used in a simulation model to calculate the expected days to cure, death or end of the first year for patients with particular characteristics for the two interventions. Sample: (I) n=43 (patients), (C) n=41 patients Level of effectiveness evidence: Level 1 Inclusion: Grade 2 or more PU on trunk or trochanter Outcome/s: Added day free of PU in one year. Change in diameter of PU over time to estimate number of additional days free of PU. Took number of days with (C) and subtracted number of days until cure with (I). Resource use: Based on two studies. Nurse time and treatment use and cost. Costs: Additional cost of (I) Currency: US $, price year 1992 Follow-up: Until complete heal, death or transfer to another faculty. Median days of care (I)=33, (C)=40 days (p=0.56) Assessments: Two per week by nurses	Effectiveness: SS decrease in surface area of PU for (I) for grade 3 and 4 PU. 9.9 mm^2/day vs. 0.7 mm^2/day, p<0.02 Grade 2 PU (I)=9.0mm^2/day vs. 3.2mm^2/day, p<0.004 resulted in a higher probability of cure using (I) The overall cure-probability ratio was 2.66, p<0.004. PU took an average of 75 days to cure for group (I) and 172 days for group (C) Cost-effectiveness: (I) = $26 per added day free of PU Uncertainty assessed: One-way sensitivity analysis was conducted and results were sensitive to the lease cost of (I) and patient and PU healing characteristics	Conclusions: On average, the cost-effectiveness of (I) was $26 per additional day without a PU in the first year. (I) was more cost-effective for patients with good healing characteristics and mild PU (i.e. smaller diameter, with pink granulating tissue present, no necrotic tissue and minimal drainage, sessing grade 3 and no contractures). Comment: No assessment of utility based on patient preferences

26

Authors: Strauss et al. (1991)

Setting/Perspective of the analysis: Health care sector and home funded by the patient or private insurer, Medicare programme, US

Type of economic evaluation Cost-consequence analysis

Interventions: (I) Home air fluidised bed *including* the services of a visiting nurse specialist so long as the patient had a grade 3 or 4 PU. (C) Conventional therapy on a patient specific basis including alternating pressure pads, air support mattresses, water mattresses, high density foam pads.

Funding: Support systems International

METHOD	**RESULTS**	**OVERVIEW**
Design: RCT. Randomisation was by a random-number generating system Sample: (I) n=58 patients or 47 when excluding patients who were completely dropped from the study. (C) n=54 patients or 50 when excluding patients who were completely dropped from the study Level of effectiveness evidence: Level 1 Inclusion: Grade 3 or 4 PU, had an attending doctor who believed the patient would probably require future hospitalisation for PU related care, had severely limited mobility, adequate social support to use (I), likely to comply with the care regimen, likely to live at least one year, 16+ years old, out of hospital for at least 3 weeks, had a personal doctor who was willing to closely manage care in the patient's home Exclusion: Febrile or septic or otherwise required immediate hospitalisation, radiated skin Outcome/s: Heal to grade 2 PU or better. Clinical reviews of interpretable photographs for patients who had completed the 36 week follow-up period. Reviews by two nurses blinded to intervention type. PU were categorised as improved (ulcer that progressed to a lower grade or if the grade was unchanged showed a smaller surface area, reduced inflammation or less eschar), unchanged (no obvious changes), worse (PU that progressed to a higher grade or covered a greater surface or showed more inflammation or more eschar) or not accessible. Resource use: Hospital and doctor visits, nursing home admissions, home visits by nurse or home health care aide and outpatient services Currency: US $, no price date Follow-up: 36 weeks Assessments: Weekly assessments for first four weeks then biweekly telephone calls for data on resource use for as long as patients remained on the bed for (I) or regarding resource use for (C). The health care co-ordinator (nurse) measured the PU at the beginning of the study, after each hospital discharge and during the final visit at the end of the 36-week study period.	Effectiveness: Compared to (C), a higher % of (I) PU were classified as improved, NSS for those patients who completed the 36-week regimen. Resource use: Days in hospital was 11.4 day (I) vs. 25.5 days for (C), ($p<0.05$) Cost: (I) use of inpatient and outpatient resources based on charges was $29,016 for (I) vs. $34,747 for (C), NSS For Medicare DRG & doctor payments (I) cost $16,415 vs. $16,800, NSS Cost-effectiveness: (I) dominates (C) but difference in outcomes NSS Uncertainty assessed: Statistical tests applied	Conclusions: (I) cost less and a higher % PU were improved but this was NSS. Comment: The drop out rate was high with only 50% of (I) patients completing the study and 56% of (C) completing the study.

KEY

PU = pressure ulcer
SS = statistically significant
NSS = not statistically significantly different
NS = not stated
NA = not applicable
CI = confidence interval
SD = standard deviation

Level of evidence – relates to questions of effectiveness only.

Eccles M and Mason J (2001) How to develop cost conscious guidelines. *Health Technology Assessment*,5,16

Appendix B: Search strategies

Clinical effectiveness search strategies for Question A

Medline & Medline In-Process Citations strategy (OVID interface)

1. Skin Ulcer/
2. decubitus ulcer/
3. (decubitus or decubital or skin breakdown$).tw.
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
7. or/1-6
8. limit 7 to english language
9. animal/
10. human/
11. 9 not (9 and 10)
12. 8 not 11 not (letter or editorial or comment).pt.
13. NUTRITION ASSESSMENT/ or Monitoring, Physiologic/
14. GERIATRIC ASSESSMENT/
15. (evaluat$ or assessment$).ti,ab.
16. (nutrition$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
17. (pain adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
18. (psychosocial$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
19. (psycho-social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
20. (mobile or mobility or exercis$ or mobilis$ or mobiliz$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
21. or/13-20
22. 12 and 21

Embase strategy (OVID interface)

1. Skin Ulcer/
2. Decubitus/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
7. or/1-6
8. limit 7 to english language

9. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
10. exp ANIMAL/
11. Animal Experiment/
12. Nonhuman/
13. Human/
14. Human Experiment/
15. or/9-12
16. 13 or 14
17. 15 not (15 and 16)
18. 8 not 17
19. 18 not (editorial or letter or note).pt.
20. Nutritional Status/
21. (geriatric assess$ or physiolog$ assess$ or physiologi$ exam$ or physiolog$ monitor$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
22. (evaluat$ or assessment$).ti,ab.
23. (nutrition$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
24. (pain$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
25. (psycho?social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
26. (psycho-social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
27. (mobile or mobility or exercis$ or mobilis$ or mobiliz$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
28. or/20-27
29. 19 and 28

Cinahl strategy (OVID interface)

1. skin ulcer/ or pressure ulcer/
2. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
3. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
4. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
6. or/1-5
7. limit 6 to english
8. 7 not (editorial or letter or anecdote or commentary).pt.
9. geriatric assessment/ or geriatric functional assessment/ or monitoring, physiologic/ or nursing assessment/ or nutritional assessment/ or patient assessment/
10. (evaluat$ or assessment$).ti,ab.
11. (nutrition$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
12. (pain$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
13. (psychosocial$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
14. (psycho-social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
15. (mobile or mobility or exercis$ or mobilis$ or mobiliz$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]

16. or/9-15
17. 8 and 16

SIGLE (SilverPlatter interface)

1. decubitus or decubital or skin breakdown*
2. bedulcer* or bed-ulcer*
3. (pressure or bed) adj ulcer*
4. pressure adj (ulcer* or wound* or damag* or injur*)
5. #1 or #2 or #3 or #4
6. evaluat* or assessment*
7. nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)
8. pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)
9. psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)
10. psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)
11. mobile or mobility or exercis* or mobilis* or mobiliz*
12. #6 or #7 or #8 or #9 or #10 or #11
13. #5 and #12
14. #13 and (LA = "ENGLISH")

British Nursing Index strategy (OVID interface)

1. pressure ulcers/
2. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
4. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
6. or/1-5
7. patient assessment/ or elderly screening/
8. physiologic$ monitoring.mp.
9. (evaluat$ or assessment$).ti,ab.
10. (nutrition$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=heading words, title]
11. (pain$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=heading words, title]
12. (psychosocial$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=heading words, title]
13. (psycho-social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=heading words, title]
14. (mobile or mobility or mobilz$ or mobilis$ or exercis$).mp. [mp=heading words, title]
15. or/7-14
16. 6 and 15

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. (evaluat*:ti or assessment*:ti or evaluat*:ab or assessment*:ab)
#9. ((nutrition* next exam*) or (nutrition next survey*) or (nutrition next assess*) or (nutrition next eval*) or (nutrition next status) or (nutrition next condition*) or (nutrition next situation*) or (nutrition next score*))

#10. ((pain* next exam*) or (pain* next survey*) or (pain* next assess*) or (pain* next eval*) or (pain* next status) or (pain* next condition*) or (pain* next situation*) or (pain* next score*))
#11. ((psychosocial* next eval*) or (psychosocial* next status) or (psychosocial* next condition*) or (psychosocial* next situation*) or (psychosocial* next score*))
#12. ((psycho-social* next eval*) or (psycho-social* next status) or (psycho-social* next condition*) or (psycho-social* next situation*) or (psycho-social* next score*))
#13. (mobile or mobility or exercis* or mobilis* or mobiliz*)
#14. (#8 or #9 or #10 or #11 or #12 or #13)
#15. (#7 and #14)

DARE & HTA strategy (internal CRD Cairs interface)

1. S decubitus or decubital or skin breakdown$
2. S (bedulcer$ or bed(w1)ulcer$)
3. S (pressure or bed)(w3)ulcer$
4. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
5. S s1 or s2 or s3 or s4
6. S (evaluat$ or assessment$)/til,abs
7. S (nutrition$)(w3)(exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)
8. S (pain$)(w3)(exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)
9. S (psychosocial$)(w3)(exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)
10. S psycho(w1)social$)(w3)(exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)
11. S (mobile or mobility or exercis$ or mobilis$ or mobiliz$)
12. S s6 or s7 or s8 or s9 or s10 or s11
13. S s5 and s12
14. s (French or spanish or italian or dutch or german or russian)/lan
15. s s13 andnot s14

PsycInfo strategy (SilverPlatter interface)

1. decubitus or decubital or skin breakdown*
2. (bedulcer* or bed-ulcer*)
3. (pressure adj (ulcer* or wound* or damag* or injur*))or((pressure or bed) adj ulcer*)
4. ((pressure adj (ulcer* or wound* or damag* or injur*))or((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)
5. (nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))
6. (((evaluat* or assessment*)) in AB)or(((evaluat* or assessment*)) in TI)
7. (psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))and((mobile or mobility or exercis* or mobilis* or mobiliz*))
8. ((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))and((mobile or mobility or exercis* or mobilis* or mobiliz*))) or ((((evaluat* or assessment*)) in AB)or(((evaluat* or assessment*)) in TI))
9. (((pressure adj (ulcer* or wound* or damag* or injur*))or((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))and((mobile or mobility or exercis* or mobilis* or mobiliz*))) or ((((evaluat* or assessment*)) in AB)or(((evaluat* or assessment*)) in TI)))
10. (((pressure adj (ulcer* or wound* or damag* or injur*))or((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(pain*

adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))or(psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))and((mobile or mobility or exercis* or mobilis* or mobiliz*))) or ((((evaluat* or assessment*)) in AB)or(((evaluat* or assessment*)) in TI))) and (LA:PY = ENGLISH)

AMED strategy (OVID interface)

1. skin ulcer/ or decubitus ulcer/
2. (decubitis or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
3. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
4. ((bed or pressure) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
6. or/1-5
7. limit 6 to english language
8. 7 not (commentary or editorial or notes or letter).pt.
9. patient assessment/ or geriatric assessment/ or pain measurement/
10. nutritional status/
11. physiologic$ monitoring.mp.
12. (evaluat$ or assessment$).ti,ab.
13. (nutrition$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
14. (pain$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
15. (psychosocial$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
16. (psycho-social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
17. (mobile or mobility or mobils$ or mobilz$ or exercis$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
18. or/9-17
19. 6 and 18

Health Management Information Consortium (up to 2003/07) (OVID)

1. pressure ulcers/
2. skin ulcers/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, other title, abstract, heading words]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, other title, abstract, heading words]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, other title, abstract, heading words]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, other title, abstract, heading words]
7. or/1-6
8. individual assessment/ or nursing assessment/ or psychological assessment/ or pain assessment/
9. (physiologic$ monitor$ or geriatric assess$).mp. [mp=title, other title, abstract, heading words]
10. (evaluat$ or assessment$).ti,ab.
11. (nutrition$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, other title, abstract, heading words]
12. (pain$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, other title, abstract, heading words]
13. (psychosocial$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, other title, abstract, heading words]
14. (psycho-social$ adj (exam$ or survey$ or assess$ or eval$ or status or condition$ or situation$ or score$)).mp. [mp=title, other title, abstract, heading words]
15. (mobile or mobility or exercis$ or mobilis$ or mobiliz$).mp. [mp=title, other title, abstract,

heading words]
16. or/8-15
17. 7 and 16

Cost-effectiveness search strategies for Question A

Economics terms used to search Endnote

Cost
Price
Pricing
Econom
Value
Pharmacoeconom
Pharmaco-econom
Budget
Exoen
Qualy
Utility
*Search was not limited to field and automatic truncation was used.

NHS EED strategy (internal CRD Cairs interface)

1. S decubitus or decubital or skin breakdown$
2. S (bedulcer$ or bed(w1)ulcer$)
3. S (pressure or bed)(w3)ulcer$
4. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
5. S s1 or s2 or s3 or s4
6. s (French or spanish or italian or dutch or german or russian)/xla
7. s s5 andnot s6

HEED strategy (cd-rom interface)

decubitus or decubital or skin breakdown or bedulcer or bedulcers or bed-ulcer or bed-ulcers
OR
pressure ulcer or pressure ulcers or bed ulcers or bed ulcer or pressure ulcer
OR
pressure ulcers or pressure wound or pressure wounds or pressure damage
OR
pressure damaging or pressure injury or pressure injuries

EconLit strategy (SilverPlatter interface)

1. (decubitus or decubital or skin breakdown*)or(bedulcer* or bed-ulcer*)or((pressure or bed) adj ulcer*)
2. pressure adj (ulcer* or wound* or damag* or injur*)
3. (pressure adj (ulcer* or wound* or damag* or injur*)) or ((decubitus or decubital or skin breakdown*)or(bedulcer* or bed-ulcer*)or((pressure or bed) adj ulcer*))

Clinical effectiveness search strategies for Question B

Medline & Medline In-Process Citations strategy (OVID interface)

1. Skin Ulcer/
2. decubitus ulcer/
3. (decubitus or decubital or skin breakdown$).tw.

4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
7. or/1-6
8. limit 7 to english language
9. animal/
10. human/
11. 9 not (9 and 10)
12. 8 not 11 not (letter or editorial or comment).pt.
13. Nursing Assessment/ or nurs$ assess$.tw.
14. Decubitus Ulcer/cl [Classification]
15. Skin Ulcer/cl [Classification]
16. Photography/du [Diagnostic Use]
17. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
18. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
19. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
20. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
21. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
22. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
23. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
24. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
25. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
26. (sonogra$ or echogra$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
27. Ultrasonography/
28. or/13-27
29. 12 and 28

Embase strategy (OVID interface)

1. Skin Ulcer/
2. Decubitus/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
7. or/1-6
8. limit 7 to english language

9. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
10. exp ANIMAL/
11. Animal Experiment/
12. Nonhuman/
13. Human/
14. Human Experiment/
15. or/9-12
16. 13 or 14
17. 15 not (15 and 16)
18. 8 not 17
19. 18 not (editorial or letter or note).pt.
20. examination/ or clinical examination/
21. nurs$ assess$.mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
22. photography/ or medical photography/
23. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ r quipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
24. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
25. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
26. (decubi$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
27. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
28. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
29. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
30. (probe$ or tape measure$ or measur tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
31. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
32. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
33. (sonogra$ or echogra$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
34. echography/
35. ULTRASOUND/
36. or/20-35
37. 19 and 36

Cinahl strategy (OVID interface)

1. skin ulcer/ or pressure ulcer/
2. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
3. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
4. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject

headings, abstract, instrumentation]
6. or/1-5
7. limit 6 to english
8. 7 not (editorial or letter or anecdote or commentary).pt.
9. Nursing Assessment/
10. nurs$ assess$.tw.
11. Pressure Ulcer/cl [Classification]
12. Skin Ulcer/cl [Classification]
13. Leg Ulcer/cl [Classification]
14. Photography/du [Diagnostic Use]
15. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
16. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
17. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
18. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
19. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
20. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
21. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
22. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
23. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
24. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
25. (sonogra$ or echogra$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
26. Ultrasonography/
27. or/9-26
28. 8 and 27

SIGLE (SilverPlatter interface)

1. decubitus or decubital or skin breakdown*
2. bedulcer* or bed-ulcer*
3. (pressure or bed) adj ulcer*
4. pressure adj (ulcer* or wound* or damag* or injur*)
5. #1 or #2 or #3 or #4
6. #5 and (LA = "ENGLISH")
7. nurs* assess*
8. wound* assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)
9. pressure ulcer* near assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)
10. pressure ulcer* near assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)
11. decubit* near assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)
12. (bedulcer* or bed-ulcer*) near assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)

13. pressure wound* near assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)
14. pressure injur* near assess* near (tool* or score* or scoring or scale* or instrument* or equipment* or support surface*)
15. probe* or tape measure* or measur* tape* or rule or ruler or rulers or trace or traced or tracing*
16. photograph* or ultrasound* or ultra-sound* or ultrasonog* or ultra-sonog*
17. sonogra* or echogra*
18. #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17
19. #6 and #18

British Nursing Index strategy (OVID interface)

1. pressure ulcers/
2. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
4. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
6. or/1-5
7. patient assessment/
8. nurs$ assess$.mp. [mp=heading words, title]
9. photography.mp.
10. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
11. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
12. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
13. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
14. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
15. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
16. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
17. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=heading words, title]
18. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=heading words, title]
19. (sonogra$ or echogra$).mp. [mp=heading words, title]
20. ULTRASOUND/
21. or/7-20
22. 6 and 21

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. DECUBITUS ULCER [cl] single term (MeSH)
#9. SKIN ULCER [cl] single term (MeSH)
#10. PHOTOGRAPHY [du] single term (MeSH)
#11. ULTRASONOGRAPHY single term (MeSH)
#12. (wound* next assess*)
#13. ((pressure next ulcer*) near assess*)

#14. ((pressure next ulcer*) near assess*)
#15. (decubit* near assess*)
#16. (bedulcer* near assess*)
#17. (bed-ulcer* near assess*)
#18. ((pressure next wound*) near assess*)
#19. ((pressure next injur*) near assess*)
#20. (probe* or rule or ruler or rulers or trace or traced or tracing*)
#21. (photograph* or ultrasound* or ultra-sound* or ultrasonog* or ultra-sonog* or sonogra* or echogra*)
#22. ((tape next measure*) or (measur* next tape*))
#23. (#8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22)
#24. (#7 and #23)

DARE strategy (internal CRD Cairs interface)

1. S decubitus or decubital or skin breakdown$
2. S (bedulcer$ or bed(w1)ulcer$)
3. S (pressure or bed)(w3)ulcer$
4. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
5. S s1 or s2 or s3 or s4
6. s nurs$(w)assess$
7. s wound$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
8. s pressure(w)ulcer$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
9. s pressure(w)ulcer$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
10. s decubit$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
11. s bedulcer$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
12. s bed(w)ulcer$(w)assess$(w)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
13. s pressure(w)wound$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
14. s pressure(w)injur$(w)assess$(w3)(tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)
15. s probe$ or tape(w)measure$ or measur$(w)tape$ or rule or ruler or rulers or trace or traced or tracing$
16. s photograph$ or ultrasound$ or ultra(w)sound$ or ultrasonog$ or ultra(w)sonog$
17. s sonogra$ or echogra$
18. S s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13 or s14 or s15 or s16 or s17
19. S s5 and s18
20. s (French or spanish or italian or dutch or german or russian)/lan
21. s s19 andnot s20

PsycInfo strategy (SilverPlatter interface)

1. decubitus or decubital or skin breakdown*
2. bedulcer* or bed-ulcer*
3. (pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*))
4. ((pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)
5. (nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))
6. (((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI)
7. (psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))
8. ((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation*

or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))) or ((((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI))

9. (((pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))) or ((((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI)))
10. (((pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))) or ((((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI))) and (LA:PY = ENGLISH)

AMED strategy (OVID interface)

1. skin ulcer/ or decubitus ulcer/
2. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
4. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
6. or/1-5
7. limit 6 to english language
8. 7 not (commentary or editorial or notes or letter).pt.
9. nurs$ assess$.mp. [mp=abstract, heading words, title]
10. Photography/
11. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
12. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
13. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
14. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
15. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
16. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
17. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=abstract, heading words, title]
18. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=abstract, heading words, title]
19. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=abstract, heading words, title]
20. (sonogra$ or echogra$).mp. [mp=abstract, heading words, title]
21. Ultrasonography/
22. or/9-21
23. 8 and 22

Health Management Information Consortium (OVID)

1. pressure ulcers/
2. skin ulcers/

3. (decubitus or decubital or skin breakdown$).mp. [mp=title, other title, abstract, heading words]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, other title, abstract, heading words]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, other title, abstract, heading words]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, other title, abstract, heading words]
7. or/1-6
8. exp NURSING ASSESSMENT/
9. nurs$ assess$.mp.
10. exp MEDICAL PHOTOGRAPHY/ or exp PHOTOGRAPHY/
11. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
12. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
13. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
14. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
15. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
16. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
17. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
18. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, other title, abstract, heading words]
19. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, other title, abstract, heading words]
20. (sonogra$ or echogra$).mp. [mp=title, other title, abstract, heading words]
21. exp ULTRASONICS/
22. or/8-21
23. 7 and 22

Cost-effectiveness search strategies for Question B

NHS EED strategy (internal CRD Cairs interface)

8. S decubitus or decubital or skin breakdown$
9. S (bedulcer$ or bed(w1)ulcer$)
10. S (pressure or bed)(w3)ulcer$
11. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
12. S s1 or s2 or s3 or s4
13. s (French or spanish or italian or dutch or german or russian)/xla
14. s s5 andnot s6

HEED strategy (cd-rom interface)

decubitus or decubital or skin breakdown or bedulcer or bedulcers or bed-ulcer or bed-ulcers
OR
pressure ulcer or pressure ulcers or bed ulcers or bed ulcer or pressure ulcer
OR
pressure ulcers or pressure wound or pressure wounds or pressure damage
OR
pressure damaging or pressure injury or pressure injuries

EconLit strategy (SilverPlatter interface)

4. (decubitus or decubital or skin breakdown*)or(bedulcer* or bed-ulcer*)or((pressure or bed) adj ulcer*)
5. pressure adj (ulcer* or wound* or damag* or injur*)

6. (pressure adj (ulcer* or wound* or damag* or injur*)) or ((decubitus or decubital or skin breakdown*)or(bedulcer* or bed-ulcer*)or((pressure or bed) adj ulcer*))

Medline & Medline In-Process Citations strategy (OVID interface)

1. outcome$ measur$.mp. [mp=ti, ab, rw, sh]
2. cost minimi?ation.ti,ab.
3. quality-adjusted life years/
4. cost utility.mp.
5. cost consequence$.mp.
6. cost saving$.mp.
7. cost-effective$.mp.
8. (cba or cma or cca or cua or cca or cea).ti,ab.
9. ECONOMICS/
10. exp "Costs and Cost Analysis"/
11. VALUE OF LIFE/ec [Economics]
12. exp ECONOMICS, HOSPITAL/
13. exp ECONOMICS, nursing/
14. exp ECONOMICS, pharmaceutical/
15. exp budgets/
16. (cost or costs or costly or costed or costing or budget$).mp.
17. (econom$ or pharmacoeconom$ or pharmaco-econom$ or price$ or pricing).mp.
18. (value adj5 money).mp.
19. (expenditure$ not energy).mp.
20. (utilit$ approach$ or health gain or (hui or hui2 or hui-2 or hui3 or hui-3)).ti,ab.
21. exp Quality-of-Life/
22. Health-Status/
23. (health measurement$ scor$ or health measurement$ scale$ or health measurement$ questionnaire$).ti,ab.
24. (time-trade-off$ or hrqol).ti,ab.
25. (time trade-off$ or index of wellbeing or index of well-being).ti,ab.
26. (time trade off$ or quality of wellbeing or quality of well-being or qwb).ti,ab.
27. (rating scale$ or multiattribute$ health ind$ or multi-attribute$ health ind$ or multi attribute$ health ind$).ti,ab.
28. (health utilit$ index or multiattribute$ theor$ or multi-attribute$ theor$ or multi attribute$ theor$).ti,ab.
29. (health utilit$ indices or multiattribute$ analys$ or multi-attribute$ analys$ or multi attribute$ analys$).ti,ab.
30. (health utilit$ scale$ or classification of illness state$ or (15d or 15-d) or 15 dimension or 15-dimension).ti,ab.
31. (health state$ utilit$ or (12d or 12-d) or 12 dimension or 12-dimension).ti,ab.
32. (health-state$ utilit$ or euroqol).ti,ab.
33. (health-utilit$ index or well year$ or well-year$).ti,ab.
34. (health-utilit$ indices or multiattribute$ utilit$ or multi-attribute$ utilit$ or multi attribute$ utilit$).ti,ab.
35. health-utilit$ scale$.ti,ab.
36. (qol or (5d or 5-d) or 5 dimension or 5-dimension).ti,ab.
37. (quality of life or eq-5d or eq5d).ti,ab.
38. quality-of-life.ti,ab.
39. (qualy or qaly or qualys or qalys).ti,ab.
40. (quality-adjusted-life-year$ or quality adjusted life year$ or quality-adjusted life-year$ or quality adjusted life-year$ or quality-adjusted life year$).ti,ab.
41. (life-year$ gain$ or life year$ gain$ or life-year$-gain$).ti,ab.
42. (willingness to pay or willingness-to-pay).ti,ab.
43. (person trade off$ or person-trade-off$ or person trade-off$ or person tradeoff$ or time tradeoff$).ti,ab.
44. (Hye or hyes).ti,ab.
45. (health$ year$ equivalent$ or health$-year$-equivalent$ or health$-year$ equivalent$ or theory utilit$).ti,ab.
46. (health state$ or health-state$).ti,ab.
47. (Qale or Quality-adjusted life expectanc$ or Quality-adjusted life-expectanc$ or Quality adjusted life expectanc$).ti,ab.

48. (daly or disability adjusted life year$ or disability-adjusted life-year$ or disability adjusted life-year$ or disability-adjusted life year$).ti,ab.
49. (Conjoint analys$ or Contingent valuat$ or Discrete choice model$).mp.
50. healing rate$.ti,ab.
51. healing time$.ti,ab.
52. healing timing$.ti,ab.
53. pain reduc$.mp.
54. (pain ceas$ or pain cessat$).mp.
55. animal/
56. human/
57. 55 not (55 and 56)
58. Skin Ulcer/
59. decubitus ulcer/
60. (decubitus or decubital or skin breakdown$).tw.
61. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
62. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
63. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=ti, ab, rw, sh]
64. or/58-63
65. Nursing Assessment/ or nurs$ assess$.tw.
66. Decubitus Ulcer/cl [Classification]
67. Skin Ulcer/cl [Classification]
68. Photography/du [Diagnostic Use]
69. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
70. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
71. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
72. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
73. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
74. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
75. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=ti, ab, rw, sh]
76. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=ti, ab, rw, sh]
77. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=ti, ab, rw, sh]
78. (sonogra$ or echogra$).mp. [mp=ti, ab, rw, sh]
79. Ultrasonography/
80. or/65-79
81. or/1-54
82. 81 not 57
83. limit 82 to english language
84. 83 not (letter or editorial or comment).pt.
85. 84 and 64 and 80

Embase strategy (OVID interface)

1. outcome$ measur$.mp.
2. cost minimi?ation.ti,ab.
3. Quality Adjusted Life Year/
4. quality of life/
5. exp economic evaluation/
6. cost utility.mp.
7. cost consequence$.mp.
8. cost saving$.mp.
9. cost-effective$.mp.
10. (cba or cma or cca or cua or cea).ti,ab.

11. economics/
12. health economics/ or exp fee/ or exp health care cost/ or exp health insurance/ or exp pharmacoeconomics/ or health care organization/ or exp health care quality/ or exp disease management/
13. health economics/ or exp fee/ or exp health care cost/ or exp health insurance/ or exp pharmacoeconomics/ or health care organization/ or exp health care quality/ or exp disease management/
14. economic aspect/ or cost/
15. budget/
16. (cost or costs or costly or costing or costed or budget$).mp.
17. (econom$ or pharmacoeconom$ or pharmaco-econom$ or price$ or pricing).mp.
18. (value adj5 money).mp.
19. (expenditure$ not energy).mp.
20. (utilit$ approach$ or health gain or (hui or hui2 or hui-2 or hui3 or hui-3)).ti,ab.
21. health status/
22. (health measurement$ scor$ or health measurement$ scale$ or health measurement$ questionnaire$).ti,ab.
23. (time trade-off$ or hrqol).ti,ab.
24. (time trade-off$ or index of wellbeing or index of well-being).ti,ab.
25. (time trade off$ or quality of wellbeing or quality of well-being or qwb).ti,ab.
26. (rating scale$ or multiattribute$ health ind$ or multi-attribute$ health ind$ or multi attribute$ health ind$).ti,ab.
27. (health utilit$ index or multiattribute$ theor$ or multi-attribute$ theor$ or multi attribute$ theor$).ti,ab.
28. (health utilit$ indices or multiattribute$ analys$ or multi-attribute$ analys$ or multi attribute$ analys$).ti,ab.
29. (health utilit$ scale$ or classification of illness state$ or (15d or 15-d) or 15 dimension or 15-dimension).ti,ab.
30. (health state$ utilit$ or (12d or 12-d) or 12 dimension or 12-dimension).ti,ab.
31. (health-state$ utilit$ or euroqol).ti,ab.
32. (health-utilit$ index or well year$ or well-year$).ti,ab.
33. (health-utilit$ indices or multiattribute$ utilit$ or multi-attribute$ utilit$ or multi attribute$ utilit$).ti,ab.
34. health-utilit$ scale$.ti,ab.
35. (qol or (5d or 5-d) or 5 dimension or 5-dimension).ti,ab.
36. (quality of life or eq-5d or eq5d).ti,ab.
37. quality-of-life.ti,ab.
38. (qualy or qaly or qualys or qalys).ti,ab.
39. (quality-adjusted-life-year$ or quality adjusted life year$ or quality-adjusted life-year$ or quality adjusted life-year$ or quality-adjusted life year$).ti,ab.
40. (life-year$ gain$ or life year$ gain$ or life-year$-gain$).ti,ab.
41. (willingness to pay or willingness-to-pay).ti,ab.
42. (person trade off$ or person-trade-off$ or person trade-off$ or person tradeoff$ or time tradeoff$).ti,ab.
43. (Hye or hyes).ti,ab.
44. (health$ year$ equivalent$ or health$-year$-equivalent$ or health$-year$ equivalent$ or theory utilit$).ti,ab.
45. (health state$ or health-state$).ti,ab.
46. (daly or disability adjusted life year$ or disability-adjusted life-year$ or disability adjusted life-year$ or disability-adjusted life year$).ti,ab.
47. (Conjoint analys$ or Contingent valuat$ or Discrete choice model$).mp.
48. healing rate$.ti,ab.
49. healing time$.ti,ab.
50. healing timing$.ti,ab.
51. pain reduc$.mp.
52. (pain ceas$ or pain cessat$).mp.
53. or/1-52
54. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
55. exp ANIMAL/ or Animal Experiment/ or Nonhuman/
56. or/54-55
57. Human/ or Human Experiment/

58. 56 not (57 and 56)
59. 53 not 58
60. limit 59 to english language
61. 60 not (editorial or letter or note).pt.
62. Skin Ulcer/
63. Decubitus/
64. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
65. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
66. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
67. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
68. or/62-67
69. 61 and 68
70. examination/ or clinical examination/
71. nurs$ assess$.mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
72. photography/ or medical photography/
73. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ r quipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
74. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
75. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
76. (decubi$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
77. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
78. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
79. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
80. (probe$ or tape measure$ or measur tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
81. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
82. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
83. (sonogra$ or echogra$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
84. echography/
85. ULTRASOUND/
86. or/70-85
87. 69 and 86

Cinahl strategy (OVID interface)

1. outcome$ measur$.mp.
2. cost minimi?ation.ti,ab.

3. cost utility.mp.
4. cost consequence$.mp.
5. cost saving$.mp.
6. cost-effective$.mp.
7. (cba or cma or cca or cua or cea).ti,ab.
8. (cost or costs or costly or costing or costed or budget$).mp.
9. (econom$ or pharmacoeconom$ or pharmaco-econom$ or price$ or pricing).mp.
10. (value adj5 money).mp.
11. (expenditure$ not energy).mp.
12. (utilit$ approach$ or health gain or (hui or hui2 or hui-2 or hui3 or hui-3)).ti,ab.
13. (health measurement$ scor$ or health measurement$ scale$ or health measurement$ questionnaire$).ti,ab.
14. (time trade-off$ or hrqol).ti,ab.
15. (time trade-off$ or index of wellbeing or index of well-being).ti,ab.
16. (time trade off$ or quality of wellbeing or quality of well-being or qwb).ti,ab.
17. (rating scale$ or multiattribute$ health ind$ or multi-attribute$ health ind$ or multi attribute$ health ind$).ti,ab.
18. (health utilit$ index or multiattribute$ theor$ or multi-attribute$ theor$ or multi attribute$ theor$).ti,ab.
19. (health utilit$ indices or multiattribute$ analys$ or multi-attribute$ analys$ or multi attribute$ analys$).ti,ab.
20. (health utilit$ scale$ or classification of illness state$ or (15d or 15-d) or 15 dimension or 15-dimension).ti,ab.
21. (health state$ utilit$ or (12d or 12-d) or 12 dimension or 12-dimension).ti,ab.
22. (health-state$ utilit$ or euroqol).ti,ab.
23. (health-utilit$ index or well year$ or well-year$).ti,ab.
24. (health-utilit$ indices or multiattribute$ utilit$ or multi-attribute$ utilit$ or multi attribute$ utilit$).ti,ab.
25. health-utilit$ scale$.ti,ab.
26. (qol or (5d or 5-d) or 5 dimension or 5-dimension).ti,ab.
27. (quality of life or eq-5d or eq5d).ti,ab.
28. quality-of-life.ti,ab.
29. (qualy or qaly or qualys or qalys).ti,ab.
30. (quality-adjusted-life-year$ or quality adjusted life year$ or quality-adjusted life-year$ or quality adjusted life-year$ or quality-adjusted life year$).ti,ab.
31. (life-year$ gain$ or life year$ gain$ or life-year$-gain$).ti,ab.
32. (willingness to pay or willingness-to-pay).ti,ab.
33. (person trade off$ or person-trade-off$ or person trade-off$ or person tradeoff$ or time tradeoff$).ti,ab.
34. (Hye or hyes).ti,ab.
35. (health$ year$ equivalent$ or health$-year$-equivalent$ or health$-year$ equivalent$ or theory utilit$).ti,ab.
36. (health state$ or health-state$).ti,ab.
37. (daly or disability adjusted life year$ or disability-adjusted life-year$ or disability adjusted life-year$ or disability-adjusted life year$).ti,ab.
38. (Conjoint analys$ or Contingent valuat$ or Discrete choice model$).mp.
39. healing rate$.ti,ab.
40. healing time$.ti,ab.
41. healing timing$.ti,ab.
42. pain reduc$.mp.
43. (pain ceas$ or pain cessat$).mp.
44. "costs and cost analysis"/ or cost benefit analysis/ or cost control/ or health care costs/ or health facility costs/ or nursing costs/ or economic aspects of illness/ or economic value of life/ or economics, pharmaceutical/ or "fees and charges"/ or capitation fee/ or fee for service plans/ or health facility charges/ or "rate setting and review"/ or financial management/ or budgets/
45. economics/
46. "acceptance: health status (iowa noc)"/ or health status/ or "status (omaha)"/ or health status indicators/
47. Quality of Life/
48. or/1-47
49. skin ulcer/ or pressure ulcer/

50. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
51. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
52. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
53. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
54. or/49-53
55. limit 54 to english
56. 55 not (editorial or letter or anecdote or commentary).pt.
57. 48 and 56
58. Nursing Assessment/
59. nurs$ assess$.tw.
60. Pressure Ulcer/cl [Classification]
61. Skin Ulcer/cl [Classification]
62. Leg Ulcer/cl [Classification]
63. Photography/du [Diagnostic Use]
64. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
65. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
66. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
67. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
68. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
69. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
70. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
71. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
72. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
73. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
74. (sonogra$ or echogra$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
75. Ultrasonography/
76. or/58-75
77. 57 and 76

SIGLE (SilverPlatter interface)

1. ((bedulcer* or bed-ulcer*)or(pressure adj (ulcer* or wound* or damag* or injur*))or((Pressure or bed)adj ulcer*)) or (decubitus or decubital or skin breakdown*)
2. ((outcome* measur*) or (cost or costs or costly or costed or costing or budget*))or((econom* or pharmacoeconom* or pharmaco-econom* or price* or pricing) or (value adj money))or((expenditure* not energy))
3. utilit* approach* or health gain
4. (utilit* approach* or health gain)or(((hui or hui2 or hui-2 or hui3 or hui-3 or cba or cma or cca or cua or cca or cea).) in AB)or(((hui or hui2 or hui-2 or hui3 or hui-3 or cba or cma or cca or cua or cca or cea).) in TI)
5. (health stat* or hrqol or qol or hye or hyes or qualy or qaly or qualys or qalys or Qale)or(quality of life or quality adjusted life year*)or(health utilit* or Quality adjusted life expectanc*)

6. (daly or disability adjusted life year*)or(healing rate* or healing time* or healing timing*)or(pain reduc* or (pain ceas* or pain cessat*))
7. ((health stat* or hrqol or qol or hye or hyes or qualy or qaly or qualys or qalys or Qale)or(quality of life or quality adjusted life year*)or(health utilit* or Quality adjusted life expectanc*)) or ((utilit* approach* or health gain)or(((hui or hui2 or hui-2 or hui3 or hui-3 or cba or cma or cca or cua or cca or cea).) in AB)or(((hui or hui2 or hui-2 or hui3 or hui-3 or cba or cma or cca or cua or cca or cea).) in TI)) or (utilit* approach* or health gain) or (((outcome* measur*) or (cost or costs or costly or costed or costing or budget*))or((econom* or pharmacoeconom* or pharmaco-econom* or price* or pricing) or (value adj money))or((expenditure* not energy))) or ((daly or disability adjusted life year*)or(healing rate* or healing time* or healing timing*)or(pain reduc* or (pain ceas* or pain cessat*)))
8. (((bedulcer* or bed-ulcer*)or(pressure adj (ulcer* or wound* or damag* or injur*))or((Pressure or bed)adj ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((health stat* or hrqol or qol or hye or hyes or qualy or qaly or qualys or qalys or Qale)or(quality of life or quality adjusted life year*)or(health utilit* or Quality adjusted life expectanc*)) or ((utilit* approach* or health gain)or(((hui or hui2 or hui-2 or hui3 or hui-3 or cba or cma or cca or cua or cca or cea).) in AB)or(((hui or hui2 or hui-2 or hui3 or hui-3 or cba or cma or cca or cua or cca or cea).) in TI)) or (utilit* approach* or health gain) or (((outcome* measur*) or (cost or costs or costly or costed or costing or budget*))or((econom* or pharmacoeconom* or pharmaco-econom* or price* or pricing) or (value adj money))or((expenditure* not energy))) or ((daly or disability adjusted life year*)or(healing rate* or healing time* or healing timing*)or(pain reduc* or (pain ceas* or pain cessat*))))

British Nursing Index strategy (OVID interface)

1. outcome$ measur$.mp.
2. cost minimi?ation.ti,ab.
3. cost utility.mp.
4. cost consequence$.mp.
5. cost saving$.mp.
6. cost-effective$.mp.
7. (cba or cma or cca or cua or cea).ti,ab.
8. (cost or costs or costly or costing or costed or budget$).mp.
9. (econom$ or pharmacoeconom$ or pharmaco-econom$ or price$ or pricing).mp.
10. (value adj5 money).mp.
11. (expenditure$ not energy).mp.
12. (utilit$ approach$ or health gain or (hui or hui2 or hui-2 or hui3 or hui-3)).ti,ab.
13. (health measurement$ scor$ or health measurement$ scale$ or health measurement$ questionnaire$).ti,ab.
14. (time trade-off$ or hrqol).ti,ab.
15. (time trade-off$ or index of wellbeing or index of well-being).ti,ab.
16. (time trade off$ or quality of wellbeing or quality of well-being or qwb).ti,ab.
17. (rating scale$ or multiattribute$ health ind$ or multi-attribute$ health ind$ or multi attribute$ health ind$).ti,ab.
18. (health utilit$ index or multiattribute$ theor$ or multi-attribute$ theor$ or multi attribute$ theor$).ti,ab.
19. (health utilit$ indices or multiattribute$ analys$ or multi-attribute$ analys$ or multi attribute$ analys$).ti,ab.
20. (health utilit$ scale$ or classification of illness state$ or (15d or 15-d) or 15 dimension or 15-dimension).ti,ab.
21. (health state$ utilit$ or (12d or 12-d) or 12 dimension or 12-dimension).ti,ab.
22. (health-state$ utilit$ or euroqol).ti,ab.
23. (health-utilit$ index or well year$ or well-year$).ti,ab.
24. (health-utilit$ indices or multiattribute$ utilit$ or multi-attribute$ utilit$ or multi attribute$ utilit$).ti,ab.
25. health-utilit$ scale$.ti,ab.
26. (qol or (5d or 5-d) or 5 dimension or 5-dimension).ti,ab.
27. (quality of life or eq-5d or eq5d).ti,ab.
28. quality-of-life.ti,ab.
29. (qualy or qaly or qualys or qalys).ti,ab.
30. (quality-adjusted-life-year$ or quality adjusted life year$ or quality-adjusted life-year$ or quality adjusted life-year$ or quality-adjusted life year$).ti,ab.

31. (life-year$ gain$ or life year$ gain$ or life-year$-gain$).ti,ab.
32. (willingness to pay or willingness-to-pay).ti,ab.
33. (person trade off$ or person-trade-off$ or person trade-off$ or person tradeoff$ or time tradeoff$).ti,ab.
34. (Hye or hyes).ti,ab.
35. (health$ year$ equivalent$ or health$-year$-equivalent$ or health$-year$ equivalent$ or theory utilit$).ti,ab.
36. (health state$ or health-state$).ti,ab.
37. (daly or disability adjusted life year$ or disability-adjusted life-year$ or disability adjusted life-year$ or disability-adjusted life year$).ti,ab.
38. (Conjoint analys$ or Contingent valuat$ or Discrete choice model$).mp.
39. healing rate$.ti,ab.
40. healing time$.ti,ab.
41. healing timing$.ti,ab.
42. pain reduc$.mp.
43. (pain ceas$ or pain cessat$).mp.
44. health economics/
45. "CONTRACTS AND MARKETING"/
46. "health and quality of life"/
47. or/1-46
48. pressure ulcers/
49. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
50. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
51. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
52. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
53. or/48-52
54. 47 and 53
55. patient assessment/
56. nurs$ assess$.mp. [mp=heading words, title]
57. photography.mp.
58. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
59. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
60. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
61. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
62. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
63. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
64. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=heading words, title]
65. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=heading words, title]
66. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=heading words, title]
67. (sonogra$ or echogra$).mp. [mp=heading words, title]
68. ULTRASOUND/
69. or/55-68
70. 54 and 69

PsycInfo strategy (SilverPlatter interface)

1. decubitus or decubital or skin breakdown*
2. bedulcer* or bed-ulcer*
3. (pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*))
4. ((pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)
5. (nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation*

or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))

6. (((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI)
7. (psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))
8. ((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))) or ((((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI))
9. (((pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))) or ((((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI)))
10. (((pressure adj (ulcer* or wound* or damag* or injur*)) or ((pressure or bed) adj ulcer*)) or ((bedulcer* or bed-ulcer*)) or (decubitus or decubital or skin breakdown*)) and (((nutrition* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (pain* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) or (psychosocial* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*))) or ((psycho-social* adj (exam* or survey* or assess* or eval* or status or condition* or situation* or score*)) and ((mobile or mobility or exercise* or mobilis* or mobilz*))) or ((((evaluat* or assessment*)) in AB) or (((evaluat* or assessment*)) in TI))) and (LA:PY = ENGLISH)

AMED strategy (OVID interface)

1. outcome$ measur$.mp.
2. cost minimi?ation.ti,ab.
3. cost utility.mp.
4. cost consequence$.mp.
5. cost saving$.mp.
6. cost-effective$.mp.
7. (cba or cma or cca or cua or cea).ti,ab.
8. (cost or costs or costly or costing or costed or budget$).mp.
9. (econom$ or pharmacoeconom$ or pharmaco-econom$ or price$ or pricing).mp.
10. (value adj5 money).mp.
11. (expenditure$ not energy).mp.
12. (utilit$ approach$ or health gain or (hui or hui2 or hui-2 or hui3 or hui-3)).ti,ab.
13. (health measurement$ scor$ or health measurement$ scale$ or health measurement$ questionnaire$).ti,ab.
14. (time trade-off$ or hrqol).ti,ab.
15. (time trade-off$ or index of wellbeing or index of well-being).ti,ab.
16. (time trade off$ or quality of wellbeing or quality of well-being or qwb).ti,ab.
17. (rating scale$ or multiattribute$ health ind$ or multi-attribute$ health ind$ or multi attribute$ health ind$).ti,ab.
18. (health utilit$ index or multiattribute$ theor$ or multi-attribute$ theor$ or multi attribute$ theor$).ti,ab.
19. (health utilit$ indices or multiattribute$ analys$ or multi-attribute$ analys$ or multi attribute$ analys$).ti,ab.
20. (health utilit$ scale$ or classification of illness state$ or (15d or 15-d) or 15 dimension or 15-dimension).ti,ab.
21. (health state$ utilit$ or (12d or 12-d) or 12 dimension or 12-dimension).ti,ab.
22. (health-state$ utilit$ or euroqol).ti,ab.
23. (health-utilit$ index or well year$ or well-year$).ti,ab.
24. (health-utilit$ indices or multiattribute$ utilit$ or multi-attribute$ utilit$ or multi attribute$ utilit$).ti,ab.
25. health-utilit$ scale$.ti,ab.

26. (qol or (5d or 5-d) or 5 dimension or 5-dimension).ti,ab.
27. (quality of life or eq-5d or eq5d).ti,ab.
28. quality-of-life.ti,ab.
29. (qualy or qaly or qualys or qalys).ti,ab.
30. (quality-adjusted-life-year$ or quality adjusted life year$ or quality-adjusted life-year$ or quality adjusted life-year$ or quality-adjusted life year$).ti,ab.
31. (life-year$ gain$ or life year$ gain$ or life-year$-gain$).ti,ab.
32. (willingness to pay or willingness-to-pay).ti,ab.
33. (person trade off$ or person-trade-off$ or person trade-off$ or person tradeoff$ or time tradeoff$).ti,ab.
34. (Hye or hyes).ti,ab.
35. (health$ year$ equivalent$ or health$-year$-equivalent$ or health$-year$ equivalent$ or theory utilit$).ti,ab.
36. (health state$ or health-state$).ti,ab.
37. (daly or disability adjusted life year$ or disability-adjusted life-year$ or disability adjusted life-year$ or disability-adjusted life year$).ti,ab.
38. (Conjoint analys$ or Contingent valuat$ or Discrete choice model$).mp.
39. healing rate$.ti,ab.
40. healing time$.ti,ab.
41. healing timing$.ti,ab.
42. pain reduc$.mp.
43. (pain ceas$ or pain cessat$).mp.
44. health economics/
45. "CONTRACTS AND MARKETING"/
46. "health and quality of life"/
47. or/1-46
48. pressure ulcers/
49. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
50. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
51. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
52. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
53. or/48-52
54. 47 and 53

Health Management Information Consortium (OVID interface)

1. outcome$ measur$.mp.
2. cost minimi?ation.ti,ab.
3. cost utility.mp.
4. cost consequence$.mp.
5. cost saving$.mp.
6. cost-effective$.mp.
7. (cba or cma or cca or cua or cea).ti,ab.
8. (cost or costs or costly or costing or costed or budget$).mp.
9. (econom$ or pharmacoeconom$ or pharmaco-econom$ or price$ or pricing).mp.
10. (value adj5 money).mp.
11. (expenditure$ not energy).mp.
12. (utilit$ approach$ or health gain or (hui or hui2 or hui-2 or hui3 or hui-3)).ti,ab.
13. (health measurement$ scor$ or health measurement$ scale$ or health measurement$ questionnaire$).ti,ab.
14. (time trade-off$ or hrqol).ti,ab.
15. (time trade-off$ or index of wellbeing or index of well-being).ti,ab.
16. (time trade off$ or quality of wellbeing or quality of well-being or qwb).ti,ab.
17. (rating scale$ or multiattribute$ health ind$ or multi-attribute$ health ind$ or multi attribute$ health ind$).ti,ab.
18. (health utilit$ index or multiattribute$ theor$ or multi-attribute$ theor$ or multi attribute$ theor$).ti,ab.
19. (health utilit$ indices or multiattribute$ analys$ or multi-attribute$ analys$ or multi attribute$ analys$).ti,ab.
20. (health utilit$ scale$ or classification of illness state$ or (15d or 15-d) or 15 dimension or 15-dimension).ti,ab.
21. (health state$ utilit$ or (12d or 12-d) or 12 dimension or 12-dimension).ti,ab.

22. (health-state$ utilit$ or euroqol).ti,ab.
23. (health-utilit$ index or well year$ or well-year$).ti,ab.
24. (health-utilit$ indices or multiattribute$ utilit$ or multi-attribute$ utilit$ or multi attribute$ utilit$).ti,ab.
25. health-utilit$ scale$.ti,ab.
26. (qol or (5d or 5-d) or 5 dimension or 5-dimension).ti,ab.
27. (quality of life or eq-5d or eq5d).ti,ab.
28. quality-of-life.ti,ab.
29. (qualy or qaly or qualys or qalys).ti,ab.
30. (quality-adjusted-life-year$ or quality adjusted life year$ or quality-adjusted life-year$ or quality adjusted life-year$ or quality-adjusted life year$).ti,ab.
31. (life-year$ gain$ or life year$ gain$ or life-year$-gain$).ti,ab.
32. (willingness to pay or willingness-to-pay).ti,ab.
33. (person trade off$ or person-trade-off$ or person trade-off$ or person tradeoff$ or time tradeoff$).ti,ab.
34. (Hye or hyes).ti,ab.
35. (health$ year$ equivalent$ or health$-year$-equivalent$ or health$-year$ equivalent$ or theory utilit$).ti,ab.
36. (health state$ or health-state$).ti,ab.
37. (daly or disability adjusted life year$ or disability-adjusted life-year$ or disability adjusted life-year$ or disability-adjusted life year$).ti,ab.
38. (Conjoint analys$ or Contingent valuat$ or Discrete choice model$).mp.
39. healing rate$.ti,ab.
40. healing time$.ti,ab.
41. healing timing$.ti,ab.
42. pain reduc$.mp.
43. (pain ceas$ or pain cessat$).mp.
44. exp economic analysis/ or economic evaluation/ or costs/ or economic research/ or economic models/ or economic value/ or prices/
45. health economics/
46. quality of life/ or quality adjusted life years/
47. health status/ or health status measures/ or health outcomes/ or health measurement/ or health status measurement/
48. or/1-47
49. pressure ulcers/
50. skin ulcers/
51. (decubitus or decubital or skin breakdown$).mp. [mp=title, other title, abstract, heading words]
52. (bedulcer$ or bed-ulcer$).mp. [mp=title, other title, abstract, heading words]
53. ((pressure or bed) adj ulcer$).mp. [mp=title, other title, abstract, heading words]
54. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, other title, abstract, heading words]
55. or/49-54
56. 48 and 55
57. exp NURSING ASSESSMENT/
58. nurs$ assess$.mp.
59. exp MEDICAL PHOTOGRAPHY/ or exp PHOTOGRAPHY/
60. (wound$ assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
61. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
62. (pressure ulcer$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
63. (decubit$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
64. ((bedulcer$ or bed-ulcer$) adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
65. (pressure wound$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]
66. (pressure injur$ adj assess$ adj (tool$ or score$ or scoring or scale$ or instrument$ or equipment$ or support surface$)).mp. [mp=title, other title, abstract, heading words]

67. (probe$ or tape measure$ or measur$ tape$ or rule or ruler or rulers or trace or traced or tracing$).mp. [mp=title, other title, abstract, heading words]
68. (photograph$ or ultrasound$ or ultra-sound$ or ultrasonog$ or ultra-sonog$).mp. [mp=title, other title, abstract, heading words]
69. (sonogra$ or echogra$).mp. [mp=title, other title, abstract, heading words]
70. exp ULTRASONICS/
71. or/57-70
72. 56 and 71

Clinical effectiveness search strategies for Question C

Medline & Medline In-Process Citations strategy (OVID interface)

1 Skin Ulcer/
2. decubitus ulcer/
3. (decubitus or decubital or skin breakdown$).tw.
4. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
5. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=ti, ab, rw, sh]
7. or/1-6
8. limit 7 to english language
9. animal/
10. human/
11. 9 not (9 and 10)
12. 8 not 11 not (letter or editorial or comment).pt.
13. BEDS/is, nu [Instrumentation, Nursing]
14. "Bedding and Linens"/
15. Protective Support surfaces/ or posture/ or head-down tilt/ or prone position/ or supine position/
16. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=ti, ab, rw, sh]
17. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=ti, ab, rw, sh]
18. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=ti, ab, rw, sh]
19. (support$ pillow$ or film$).mp. [mp=ti, ab, rw, sh]
20. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=ti, ab, rw, sh]
21. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=ti, ab, rw, sh]
22. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=ti, ab, rw, sh]
23. (turning adj1 (bed$ or frame$)).mp. [mp=ti, ab, rw, sh]
24. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=ti, ab, rw, sh]
25. or/13-24
26. 12 and 25
27. limit 26 to yr=2002-2004

Embase strategy (OVID interface)

1. Skin Ulcer/
2. Decubitus/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]

7. or/1-6
8. limit 7 to english language
9. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
10. exp ANIMAL/
11. Animal Experiment/
12. Nonhuman/
13. Human/
14. Human Experiment/
15. or/9-12
16. 13 or 14
17. 15 not (15 and 16)
18. 8 not 17
19. 18 not (editorial or letter or note).pt.
20. limit 19 to yr=2002-2004
21. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
22. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
23. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
24. (support$ pillow$ or film$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
25. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
26. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
27. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
28. (turning adj1 (bed$ or frame$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
29. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
30. bed/ or fluidized bed/ or hospital bed/
31. protective equipment/ or body position/ or body posture/ or recumbency/ or sitting/ or standing/ or supine position/ or head position/
32. or/21-31
33. 20 and 32

Cinahl strategy (OVID interface)

1 . skin ulcer/ or pressure ulcer/
2. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
3. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
4. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
6. or/1-5
7. limit 6 to english
8. 7 not (editorial or letter or anecdote or commentary).pt.
9. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
10. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or

cradles or bolster$ or cushion$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
11. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
12. (support$ pillow$ or film$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
13. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
14. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
15. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
16. (turning adj1 (bed$ or frame$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
17. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
18. "bedding and linens"/ or "beds and mattresses"/ or cribs/ or flotation beds/ or "pillows and cushions"/
19. Protective Support surfaces/ or patient positioning/ or prone position/ or supine position/
20. or/9-19
21. 8 and 20
22. limit 21 to yr=2002-2003

British Nursing Index strategy (OVID interface)

1. pressure ulcers/
2. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
4. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
6. or/1-5
7. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=heading words, title]
8. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=heading words, title]
9. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=heading words, title]
10. patients positioning/ or (support$ pillow$ or film$).mp. [mp=heading words, title]
11. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=heading words, title]
12. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=heading words, title]
13. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=heading words, title]
14. (turning adj1 (bed$ or frame$)).mp. [mp=heading words, title]
15. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=heading words, title]
16. or/7-15
17. 6 and 16
18. limit 17 to yr=2002-2003

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. BEDS single term (MeSH)
#9. BEDDING AND LINENS single term (MeSH)

#10. PROTECTIVE SUPPORT SURFACES single term (MeSH)
#11. posture
#12. POSTURE single term (MeSH)
#13. HEAD-DOWN TILT single term (MeSH)
#14. PRONE POSITION single term (MeSH)
#15. SUPINE POSITION single term (MeSH)
#16. ((pressure next relie*) or pressure-relie* or (pressure next reduc*) or pressure-reduc*)
#17. (bed or beds or bedding or mattress* or couch* or cot or cots or crib or cribs or cradle or cradles or bolster* or cushion*)
#18. ((pressure near overlay*) or (pressure near over-lay*) or (decubit* near overlay*) or (decubit* near over-lay*) or (bedulcer* near overlay*) or (bedulcer* near over-lay*))
#19. ((support* next pillow*) or film*)
#20. (pillow* or (foam next wedge*) or (foam next block*) or gelpad* or (gel next pad*) or gel-pad* or (gell next pad*) or gellpad* or gell-pad*)
#21. ((air next support*) or air-support* or air-fluidised or air-fluidised or (air next fluidized) or air-fluidized or (support next surface*) or support-surface*)
#22. (sheepskin* or sheep-skin* or (alternat* next pressure*))
#23. ((turning next bed*) or (turning next frame*))
#24. ((limb* next protect*) or (limb* next guard*) or (limb* next defend*) or (limb* next defenc*) or (limb* next shield*) or (limb* next rest*))
#25. (#8 or #9 or #10 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24)
#26. (#7 and #25)
#27. (#7 and #25) (2002 to current date)

DARE strategy (internal CRD Cairs interface)

1. S decubitus or decubital or skin breakdown$
2. S (bedulcer$ or bed(w1)ulcer$)
3. S (pressure or bed)(w3)ulcer$
4. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
5. S s1 or s2 or s3 or s4
6. s pressure(w)relie$ or pressure(w)reduc$
7. s (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$)
8. s (pressure or decubit$ or bedulcer$ or bed(w1)ulcer$)(w10)(overlay$ or over(w1)lay$) s support$(w)pillow$ or film$ or pillow$ or foam(w)wedge$ or foam(w)block$ or gelpad$ or gel(w)pad$ or gell(w)pad$ or gellpad$
9. s air(w)support$ or air(w)fluidised or air(w)fluidized or support(w)surface$
10. s sheepskin$ or sheep(w)skin$ or alternat$(w)pressure$
11. s turning(w1)(bed$ or frame$)
12. s limb$(w1)(protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)
13. s s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13
14. s s5 and s14
15. s (French or spanish or italian or dutch or german or russian)/lan
16. s s15 andnot s16
17. s 2002:2003/dat
18. s s17 and s18

AMED strategy (OVID interface)

1 . skin ulcer/ or decubitus ulcer/
2. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
4. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
6. or/1-5
7. limit 6 to english language
8. 7 not (commentary or editorial or notes or letter).pt.
9. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=abstract, heading words, title]

10. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=abstract, heading words, title]
11. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=abstract, heading words, title]
12. (support$ pillow$ or film$).mp. [mp=abstract, heading words, title]
13. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=abstract, heading words, title]
14. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=abstract, heading words, title]
15. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=abstract, heading words, title]
16. (turning adj1 (bed$ or frame$)).mp. [mp=abstract, heading words, title]
17. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=abstract, heading words, title]
18. protective support surfaces/ or pronation/ or range of motion/ or rotation/ or posture/ or head down tilt/ or prone position/ or supine position/ or sitting/
19. or/9-18
20. limit 19 to yr=2002-2003
21. 8 and 20

Health Management Information Consortium (OVID interface)

1. pressure ulcers/
2. skin ulcers/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, other title, abstract, heading words]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, other title, abstract, heading words]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, other title, abstract, heading words]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, other title, abstract, heading words]
7. or/1-6
8. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=title, other title, abstract, heading words]
9. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=title, other title, abstract, heading words]
10. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=title, other title, abstract, heading words]
11. (support$ pillow$ or film$).mp. [mp=title, other title, abstract, heading words]
12. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=title, other title, abstract, heading words]
13. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=title, other title, abstract, heading words]
14. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=title, other title, abstract, heading words]
15. (turning adj1 (bed$ or frame$)).mp. [mp=title, other title, abstract, heading words]
16. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=title, other title, abstract, heading words]
17. beds/ or adjustable beds/ or bed cradles/ or cots/ or fluidised beds/ or hospital beds/ or light duty beds/ or non adjustable beds/ or roto rest beds/ or water beds/ or back rests/ or bed aids/ or bed blocks/ or bed centres/ or bed frames/ or bed lifts/ or bed rails/ or bed spaces/ or bedding/ or bedside fittings/ or couches/ or hospital equipment/
18. turning frames/ or patient handling/ or pressure ulcer underpads/ or fleeces/ or bedding/ or pressure area care.mp. [mp=title, other title, abstract, heading words]
19. patient positioning equipment/ or mattresses/ or bedding/ or foam mattresses/ or ripple mattresses/ or sheepskin mattresses/ or water mattresses/
20. or/8-19
21. 7 and 20
22. limit 21 to yr=2002-2005

National Research Register (Issue 3:2003) (cd-rom)

1. (SKIN-ULCER:ME or DECUBITUS-ULCER:ME)
2. ((DECUBITUS or DECUBITAL) OR (SKIN next BREAKDOWN*))

3. (BEDULCER* or BED-ULCER*)
4. ((PRESSURE near ULCER*) or (BED near ULCER*))
5. ((((PRESSURE next ULCER*) or (PRESSURE next WOUND*)) OR (PRESSURE NEXT DAMAG*)) OR (PRESSURE NEXT INJUR*))
6. ((((#1 or #2) or #3) or #4) or #5)
7. ((BEDS:ME or BEDS-AND-LINENS:ME) or PROTECTIVE-SUPPORT SURFACES:ME)
8. ((POSTURE or POSTURE:ME) or HEAD-DOWN-TILT:ME)
9. (PRONE-POSITION:ME or SUPINE-POSITION:ME)
10. ((((PRESSURE next RELIE*) or PRESSURE-RELIE*) OR (PRESSURE NEXT REDUC*)) OR PRESSURE-REDUC*)
11. ((((((((((BED or BEDS) or BEDDING) or MATTRESS*) or COUCH*) or COT) or COTS) or CRIB) or CRIBS) or CRADLE) or CRADLES) or BOLSTER*) or CUSHION*)
12. ((((((PRESSURE next OVERLAY*) OR (PRESSURE near OVER-LAY*)) OR (DECUBIT* NEAR OVERLAY*)) OR (DECUBIT* NEAR OVER-LAY*)) OR (BEDULCER* NEAR OVERLAY*)) OR (BEDULCER NEAR OVER-LAY*))
13. ((SUPPORT* next PILLOW*) or FILM*)
14. (((((((PILLOW* or (FOAM next WEDGE*)) OR (FOAM NEXT BLOCK*)) OR GELPAD*) OR (GEL NEXT PAD*)) OR GEL-PAD*) OR (GELL NEXT PAD*)) OR GELLPAD*) OR GELL-PAD*)
15. (((((((AIR next SUPPORT*) or AIR-SUPPORT*) OR AIR-FLUIDISED) OR (AIR NEXT FLUIDIZED)) OR AIR-FLUIDIZED) OR (SUPPORT NEXT SURFACE*)) OR SUPPORT-SURFACE*)
16. ((SHEEPSKIN* or SHEEP-SKIN*) OR (ALTERNAT* next PRESSURE*)) ((TURNING next BED*) or (TURNING next FRAME*))
17. ((((((LIMB* next PROTECT*) or (LIMB* next GUARD*)) OR (LIMB* NEXT DEFEND*)) OR (LIMB NEXT DEFENC*)) OR (LIMB* NEXT SHIELD*)) OR (LIMB NEXT REST*))
18. (((((((((#8 or #9) or #10) or #11) or #12) or #13) or #14) or #15) or #16) or #17)
19. ((#18 or #19) or #21)
20. (#7 and #22)

Clinical effectiveness search strategies for Question D

Medline & Medline In-Process Citations strategy (OVID interface)

1. randomized controlled trial.pt.
2. exp randomized controlled trials/
3. random allocation/
4. double blind method/
5. single blind method/
6. clinical trial.pt.
7. exp clinical trials/
8. controlled clinical trials/
9. clin$ trial$.ti,ab.
10. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
11. placebo$.ti,ab.
12. placebos/
13. random$.ti,ab.
14. exp evaluation studies/
15. follow up studies/
16. exp research design/
17. prospective studies/
18. (control$ or prospectiv$ or volunteer$).ti,ab.
19. or/1-18
20. animal/
21. human/
22. 20 not (20 and 21)
23. 19 not 22
24. limit 23 to english language
25. 24 not (comment or letter or editorial).pt.
26. Skin Ulcer/
27. decubitus ulcer/

28. (decubitus or decubital or skin breakdown$).tw.
29. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
30. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
31. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=ti, ab, rw, sh]
32. or/26-31
33. biological dressings/
34. bandages/
35. occlusive dressings/
36. wound healing/
37. clothing/
38. growth substances/
39. platelet derived growth factor/
40. fibroblast growth factor/
41. iloprost/
42. alginates/
43. zinc/
44. zinc oxide/
45. ointments/
46. ointment bases/
47. dermatologic agents/
48. colloids/
49. Cellulose, Oxidized/ad, tu [Administration & Dosage, Therapeutic Use]
50. collagen/ad, tu
51. (bandag$ or stocking$ or gauze$ or tulle$ or bind$ or wrap$ or paste$ or ointment$).tw.
52. (dressing$ or compress$ or cream$ or salve$ or ointment$ or lotion$ or unguent$ or balm$ or unction$ or emollient$).tw.
53. ((growth adj factor$) or (Pressure adj relie$) or (recombinant adj protein$) or iloprost or alginate$ or zinc or hydrocolloid$ or hydro-colloid$).tw.
54. ((compress$ adj bandag$) or vitamin$ or hydrogel$ or hydro-gel$ or hydropolymer$ or hydro-polymer$).tw.
55. (low adheren$ layer$ or vapo?r permeable film$ or hydrofiber$ or hydro-fiber$ or hydrofibre$ or hydro-fibre$).tw.
56. (non adheren$ layer$ or no-sting barrier$ or barrier$ film$ or cavilon or ribbon gauze$).mp. or skin substitute$.tw. [mp=ti, ab, rw, sh]
57. (polysaccharide$ or poly-saccharide$ or foam$ or odo?r$ absorb$ or malodo?r$ absorb$).tw.
58. (odo?r$ reduc$ or malodo?r$ reduc$ or odo?r$ minimiz$ or malodo?r$ minimiz$ or odo?r$ minimis$ or malodo?r$ minimis$).tw.
59. (tissue engineer$ or biologically active$ or cellulose matrix or matrix dressing$ or protease modulating matrix or regenerated cellulose dressing$).tw.
60. (promogran or promogram).mp. [mp=ti, ab, rw, sh]
61. (nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).mp.
62. povidone/ or povidone-iodine/ or iodine/ or (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or cadexomer iodine or betadine or iodoflex).tw.
63. (silicon$ adj1 (dressing $ or film$ or barrier$ or foam$ or layer$ or bandag$ or compress$ or bind$ or wrap$)).mp.
64. (mepitel or mepilex or NA ultra).tw.
65. (acticoat or aquacell or contreet).tw.
66. (skin substitute$ or apligraft$).tw.
67. (semi occlusive or non occlusive).tw.
68. becaplermin.tw.
69. dermagraft$.tw.
70. surgical pad$.tw.
71. xerogel$.tw.
72. (debrisan or vacutex or silicone or silastic foam$ or activated charcoal or knitted viscose$ or saline soak).tw.
73. or/33-72
74. 25 and 32 and 73
75. limit 74 to yr=1997-2004

Embase strategy (OVID interface)

1. randomized controlled trial/
2. randomization/
3. double blind procedure/ or single blind procedure/
4. exp clinical trial/
5. controlled study/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. Placebo/
10. random$.ti,ab.
11. evaluation/
12. follow up/
13. exp methodology/
14. prospective study/
15. (control$ or prospectiv$ or volunteer$).ti,ab.
16. or/1-15
17. limit 16 to english language
18. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
19. exp ANIMAL/
20. Animal Experiment/
21. Nonhuman/
22. Human/
23. Human Experiment/
24. or/18-21
25. 22 or 23
26. 24 not (24 and 25)
27. 17 not 26
28. 27 not (editorial or letter or note).pt.
29. limit 28 to yr=1997-2004
30. Skin Ulcer/
31. Decubitus/
32. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
33. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
34. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
35. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
36. or/30-35
37. (bandag$ or stocking$ or gauze$ or tulle$ or bind$ or wrap$ or paste$ or ointment$).tw.
38. (dressing$ or compress$ or cream$ or salve$ or ointment$ or lotion$ or unguent$ or balm$ or unction$ or emollient$).tw.
39. ((growth adj factor$) or (Pressure adj relie$) or (recombinant adj protein$) or iloprost or alginate$ or zinc or hydrocolloid$ or hydro-colloid$).tw.
40. ((compress$ adj bandag$) or vitamin$ or hydrogel$ or hydro-gel$ or hydropolymer$ or hydro-polymer$).tw.
41. (low adheren$ layer$ or vapo?r permeable film$ or hydrofiber$ or hydro-fiber$ or hydrofibre$ or hydro-fibre$).tw.
42. (non adheren$ layer$ or no-sting barrier$ or barrier$ film$ or cavilon or ribbon gauze$ or skin substitute$).tw.
43. (polysaccharide$ or poly-saccharide$ or foam$ or odo?r$ absorb$ or malodo?r$ absorb$).tw.
44. (odo?r$ reduc$ or malodo?r$ reduc$ or odo?r$ minimiz$ or malodo?r$ minimiz$ or odo?r$ minimis$ or malodo?r$ minimis$).tw.
45. (tissue engineer$ or biologically active$ or cellulose matrix or matrix dressing$ or protease modulating matrix or regenerated cellulose dressing$).tw.
46. (promogran or promogram).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
47. (nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or

aquacel or avance or silver sulfadiazine or flamazine or silver based).mp.
48. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or cadexomer iodine or betadine or iodoflex).tw.
49. (silicon$ adj1 (dressing $ or film$ or barrier$ or foam$ or layer$ or bandag$ or compress$ or bind$ or wrap$)).mp.
50. (mepitel or mepilex or NA ultra).tw.
51. (acticoat or aquacell or contreet).tw.
52. (skin substitute$ or apligraft$).tw.
53. (semi occlusive or non occlusive).tw.
54. becaplermin.tw.
55. dermagraft$.tw.
56. surgical pad$.tw.
57. xerogel$.tw.
58. (debrisan or vacutex or silicone or silastic foam$ or activated charcoal or knitted viscose$ or saline soak).tw.
59. "bandages and dressings"/ or bandage/ or wound dressing/
60. protective clothing/
61. Wound Healing/
62. clothing/
63. growth factor/ or growth promotor/
64. platelet derived growth factor/ or platelet derived growth factor a/ or platelet derived growth factor aa/ or platelet derived growth factor ab/ or platelet derived growth factor b/ or platelet derived growth factor bb/
65. fibroblast growth factor/ or fibroblast growth factor 1/ or fibroblast growth factor 10/ or fibroblast growth factor 2/ or fibroblast growth factor 3/ or fibroblast growth factor 4/ or fibroblast growth factor 5/ or fibroblast growth factor 8/ or fibroblast growth factor 9/
66. Iloprost/
67. Alginic Acid/
68. Zinc/
69. Zinc Oxide/
70. ointment/
71. exp Ointment Base/
72. dermatological agent/ or topical agent/
73. exp colloid/
74. Collagen/dl, ad, cm, dt, tp, td [Intradermal Drug Administration, Drug Administration, Drug Comparison, Drug Therapy, Topical Drug Administration, Transdermal Drug Administration]
75. Oxidized Cellulose/ad, dt, cm, tp
76. or/37-75
77. 29 and 36 and 76

Cinahl strategy (OVID interface)

1. clinical trial.pt.
2. Random Assignment/
3. double-blind studies/
4. single-blind studies/
5. exp clinical trials/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. placebos/ or placebo effect/
10. random$.ti,ab.
11. Evaluation Research/
12. Prospective Studies/
13. exp Study Design/
14. (control$ or prospectiv$ or volunteer$).ti,ab.
15. or/1-14
16. limit 15 to english
17. limit 16 to yr=1997-2004
18. skin ulcer/ or pressure ulcer/
19. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]

20. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
21. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
22. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
23. or/18-22
24. 23 not (editorial or letter or anecdote or commentary).pt.
25. (bandag$ or stocking$ or gauze$ or tulle$ or bind$ or wrap$ or paste$ or ointment$).tw.
26. (dressing$ or compress$ or cream$ or salve$ or ointment$ or lotion$ or unguent$ or balm$ or unction$ or emollient$).tw.
27. ((growth adj factor$) or (Pressure adj relie$) or (recombinant adj protein$) or iloprost or alginate$ or zinc or hydrocolloid$ or hydro-colloid$).tw.
28. ((compress$ adj bandag$) or vitamin$ or hydrogel$ or hydro-gel$ or hydropolymer$ or hydro-polymer$).tw.
29. (low adheren$ layer$ or vapo?r permeable film$ or hydrofiber$ or hydro-fiber$ or hydrofibre$ or hydro-fibre$).tw.
30. (non adheren$ layer$ or no-sting barrier$ or barrier$ film$ or cavilon or ribbon gauze$ or skin substitute$).tw.
31. (polysaccharide$ or poly-saccharide$ or foam$ or odo?r$ absorb$ or malodo?r$ absorb$).tw.
32. (odo?r$ reduc$ or malodo?r$ reduc$ or odo?r$ minimiz$ or malodo?r$ minimiz$ or odo?r$ minimis$ or malodo?r$ minimis$).tw.
33. (tissue engineer$ or biologically active$ or cellulose matrix or matrix dressing$ or protease modulating matrix or regenerated cellulose dressing$).tw.
34. (promogran or promogram).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
35. (nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).mp.
36. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or cadexomer iodine or betadine or iodoflex).tw.
37. (silicon$ adj1 (dressing $ or film$ or barrier$ or foam$ or layer$ or bandag$ or compress$ or bind$ or wrap$)).mp.
38. (mepitel or mepilex or NA ultra).tw.
39. (acticoat or aquacell or contreet).tw.
40. (skin substitute$ or apligraft$).tw.
41. (semi occlusive or non occlusive).tw.
42. becaplermin.tw.
43. dermagraft$.tw.
44. surgical pad$.tw.
45. xerogel$.tw.
46. (debrisan or vacutex or silicone or silastic foam$ or activated charcoal or knitted viscose$ or saline soak).tw.
47. exp "Bandages and Dressings"/
48. Wound Healing/
49. clothing/ or protective clothing/
50. growth substances/ or platelet-derived growth factor/
51. Iloprost/
52. Alginates/
53. zinc oxide/ or zinc/
54. colloids/ or emulsions/ or gels/ or creams/ or ointments/
55. Dermatologic Agents/
56. Cellulose/ad, tu [Administration and Dosage, Therapeutic use]
57. Collagen/ad, tu [Administration and Dosage, Therapeutic use]
58. or/25-57
59. 17 and 24 and 58

British Nursing Index strategy (OVID interface)

1. exp research methods/
2. clin$ trial$.tw.
3. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
4. placebo$.tw.

5. random$.tw.
6. (control$ or prospectiv$ or volunteer$).tw.
7. ((study or studies) adj1 design$).tw.
8. or/1-7
9. limit 8 to yr=1997-2004
10. pressure ulcers/
11. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
12. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
13. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
14. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
15. or/10-14
16. (bandag$ or stocking$ or gauze$ or tulle$ or bind$ or wrap$ or paste$ or ointment$).tw.
17. (dressing$ or compress$ or cream$ or salve$ or ointment$ or lotion$ or unguent$ or balm$ or unction$ or emollient$).tw.
18. ((growth adj factor$) or (Pressure adj relie$) or (recombinant adj protein$) or iloprost or alginate$ or zinc or hydrocolloid$ or hydro-colloid$).tw.
19. ((compress$ adj bandag$) or vitamin$ or hydrogel$ or hydro-gel$ or hydropolymer$ or hydro-polymer$).tw.
20. (low adheren$ layer$ or vapo?r permeable film$ or hydrofiber$ or hydro-fiber$ or hydrofibre$ or hydro-fibre$).tw.
21. (non adheren$ layer$ or no-sting barrier$ or barrier$ film$ or cavilon or ribbon gauze$ or skin substitute$).tw.
22. (polysaccharide$ or poly-saccharide$ or foam$ or odo?r$ absorb$ or malodo?r$ absorb$).tw.
23. (odo?r$ reduc$ or malodo?r$ reduc$ or odo?r$ minimiz$ or malodo?r$ minimiz$ or odo?r$ minimis$ or malodo?r$ minimis$).tw.
24. (tissue engineer$ or biologically active$ or cellulose matrix or matrix dressing$ or protease modulating matrix or regenerated cellulose dressing$).tw.
25. (promogran or promogram).mp. [mp=heading words, title]
26. (nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).mp.
27. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or cadexomer iodine or betadine or iodoflex).tw.
28. (silicon$ adj1 (dressing $ or film$ or barrier$ or foam$ or layer$ or bandag$ or compress$ or bind$ or wrap$)).mp.
29. (mepitel or mepilex or NA ultra).tw.
30. (acticoat or aquacell or contreet).tw.
31. (skin substitute$ or apligraft$).tw.
32. (semi occlusive or non occlusive).tw.
33. becaplermin.tw.
34. dermagraft$.tw.
35. surgical pad$.tw.
36. xerogel$.tw.
37. (debrisan or vacutex or silicone or silastic foam$ or activated charcoal or knitted viscose$ or saline soak).tw.
38. dressings/
39. wounds/
40. or/16-39
41. 9 and 15 and 40

AMED strategy (OVID interface)

1. exp clinical trials/
2. exp research design/ or double blind method/ or random allocation/
3. clinical trial.pt.
4. clin$ trial$.tw.
5. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
6. placebo$.tw.
7. placebos/
8. random$.tw.
9. (control$ or prospectiv$ or volunteer$).tw.
10. ((study or studies) adj1 design$).tw.

11. or/1-10
12. limit 11 to english language
13. limit 12 to yr=1997-2004
14. skin ulcer/ or decubitus ulcer/
15. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
16. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
17. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
18. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
19. or/14-18
20. (bandag$ or stocking$ or gauze$ or tulle$ or bind$ or wrap$ or paste$ or ointment$).tw.
21. (dressing$ or compress$ or cream$ or salve$ or ointment$ or lotion$ or unguent$ or balm$ or unction$ or emollient$).tw.
22. ((growth adj factor$) or (Pressure adj relie$) or (recombinant adj protein$) or iloprost or alginate$ or zinc or hydrocolloid$ or hydro-colloid$).tw.
23. ((compress$ adj bandag$) or vitamin$ or hydrogel$ or hydro-gel$ or hydropolymer$ or hydro-polymer$).tw.
24. (low adheren$ layer$ or vapo?r permeable film$ or hydrofiber$ or hydro-fiber$ or hydrofibre$ or hydro-fibre$).tw.
25. (non adheren$ layer$ or no-sting barrier$ or barrier$ film$ or cavilon or ribbon gauze$ or skin substitute$).tw.
26. (polysaccharide$ or poly-saccharide$ or foam$ or odo?r$ absorb$ or malodo?r$ absorb$).tw.
27. (odo?r$ reduc$ or malodo?r$ reduc$ or odo?r$ minimiz$ or malodo?r$ minimiz$ or odo?r$ minimis$ or malodo?r$ minimis$).tw.
28. (tissue engineer$ or biologically active$ or cellulose matrix or matrix dressing$ or protease modulating matrix or regenerated cellulose dressing$).tw.
29. (promogran or promogram).mp. [mp=abstract, heading words, title]
30. (nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).mp.
31. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or cadexomer iodine or betadine or iodoflex).tw.
32. (silicon$ adj1 (dressing $ or film$ or barrier$ or foam$ or layer$ or bandag$ or compress$ or bind$ or wrap$)).mp.
33. (mepitel or mepilex or NA ultra).tw.
34. (acticoat or aquacell or contreet).tw.
35. (skin substitute$ or apligraft$).tw.
36. (semi occlusive or non occlusive).tw.
37. becaplermin.tw.
38. dermagraft$.tw.
39. surgical pad$.tw.
40. xerogel$.tw.
41. (debrisan or vacutex or silicone or silastic foam$ or activated charcoal or knitted viscose$ or saline soak).tw.
42. wound healing/
43. bandages/
44. clothing/ or protective clothing/
45. growth substances/
46. zinc/
47. dermatologic agents/
48. collagen/
49. or/20-48
50. 13 and 19 and 49

Health Management Information Consortium strategy (OVID interface)

#12 #1 and #2 and #10 and ((PY:HMIC = 1997-2099) or (PY:HQ = 1997-2010))
#11 #1 and #2 and #10
#10 #3 or #4 or #5 or #6 or #7 or #8 or #9
#9 (skin near substitute*) or apligraft* or occlusive or becaplermin or dermagraft* or (surgical near pad*) or xerogel* or debrisan or vacutex or silicone or silastic or charcoal or viscose* or saline

#8 (silver or sulphadiazine or actisorb or aquacel or avance or sulfadiazine or flamazine)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or betadine or iodoflex)or(silicon* or mepitel or mepilex or (NA near ultra) or acticoat or aquacell or contreet)
#7 ((odor* near reduc*) or (odour* near reduc*) or (malodor* near reduc*) or (malodour* near reduce*) or (odor* near minimi*) or (malodor* near minimi*) or (odour* near minimis*) or (malodour* near minimis*))or((tissue near engineer*) or (biologically near active*) or (cellulose near matrix) or (matrix near dressing*) or (protease near modulating near matrix) or (regenerated near cellulose near dressing*))or((promogran or promogram))
#6 ((non near adheren* near layer*) or (no-sting near barrier*) or (barrier* near film*) or cavilon or (ribbon near gauze*) or (skin near substitute*))or(polysaccharide* or poly-saccharide* or foam* or (odor* near absorb*) or (odour* near absorb*) or (malodor* near absorb*) or (malodour* near absorb*))
#5 (low near adheren* near layer*) or (permeable near film*) or hydrofiber* or hydro-fiber* or hydrofibre* or hydro-fibre*
#4 (compress* near bandag*) or vitamin* or hydrogel* or hydro-gel* or hydropolymer* or hydro-polymer*
#3 (bandag* or stocking* or gauze* or tulle* or bind* or wrap* or paste* or ointment*)or(dressing* or compress* or cream* or salve* or ointment* or lotion* or unguent* or balm* or unction* or emollient*)or((growth near2 factor*) or (Pressure near relie*) or (recombinant near protein*) or iloprost or alginate* or zinc or hydrocolloid* or hydro-colloid*)
#2 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)
#1 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)

Cochrane Controlled Trials Register strategy: Issue 1:2004 (WWW interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. IODINE single term (MeSH)
#9. POVIDONE single term (MeSH)
#10. POVIDONE-IODINE single term (MeSH)
#11. BANDAGES explode tree 1 (MeSH)
#12. WOUND HEALING single term (MeSH)
#13. CLOTHING single term (MeSH)
#14. GROWTH SUBSTANCES single term (MeSH)
#15. FIBROBLAST GROWTH FACTORS single term (MeSH)
#16. PLATELET-DERIVED GROWTH FACTOR single term (MeSH)
#17. ILOPROST single term (MeSH)
#18. ALGINATES single term (MeSH)
#19. ZINC single term (MeSH)
#20. ZINC OXIDE single term (MeSH)
#21. OINTMENTS single term (MeSH)
#22. OINTMENT BASES single term (MeSH)
#23. DERMATOLOGIC AGENTS single term (MeSH)
#24. COLLOIDS single term (MeSH)
#25. CELLULOSE OXIDIZED [ad] single term (MeSH)
#26. CELLULOSE OXIDIZED [tu] single term (MeSH)
#27. COLLAGEN [ad] single term (MeSH)
#28. COLLAGEN [tu] single term (MeSH)
#29. (bandag* or stocking* or gauze* or tulle* or bind* or wrap* or paste* or ointment*)
#30. ((growth next factor*) or (pressure next relie*) or (recombinant next protein*) or iloprost or alginate* or zinc or hydrocolloid* or hydro-colloid*)
#31. ((compress* next bandag*) or vitamin* or hydrogel* or hydro-gel* or hydropolymer* or hydro-polymer*)

#32. ((adheren* next layer*) or (permeable next film*) or hydrofiber* or hydro-fiber* or hydrofibre* or hydro-fibre*)
#33. ((no-sting next barrier*) or (barrier* next film*) or cavilon or (ribbon next gauze*) or (skin next substitute*))
#34. (polysaccharide* or poly-saccharide* or foam* or (odor* near absorb*) or (odour* near absorb*))
#35. ((malodor* near absorb*) or (malodour* near absorb*) or (odor* near reduc*) or (odour* near reduce*) or (malodor* near reduc*) or (malodour* near reduce*))
#36. ((odor* near minimi*) or (malodor* near minimi*) or (odour* near minimi*) or (malodour* near minimi*))
#37. ((tissue near engineer*) or (biologically near active*) or (cellulose near matrix) or (matrix near dressing*) or (modulating near matrix) or (cellulose near dressing*))
#38. (promogran or promogram or silver or sulphadiazine or actisorb or aquacel or avance or sulfadiazine or flamazine)
#39. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or betadine or iodoflex or silicon*)
#40. (mepitel or mepilex or (na near ultra) or acticoat or aquacell or contreet) 18
#41. ((skin near substitute*) or apligraft* or occlusive or becaplermin or dermagraft* or (surgical near pad*) or xerogel*)
#42. (debrisan or vacutex or silicone or silastic or charcoal or viscose* or saline)
#43. (#8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20)
#44. (#21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30)
#45. (#31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44)
#46. (#7 and #45)
#47. (#7 and #45) (1997 to current date)

SIGLE strategy (SilverPlatter interface)

#11 #1 and #2 and #10
#10 #3 or #4 or #5 or #6 or #7 or #8 or #9
#9 (skin near substitute*) or apligraft* or occlusive or becaplermin or dermagraft* or (surgical near pad*) or xerogel* or debrisan or vacutex or silicone or silastic or charcoal or viscose* or saline
#8 (silver or sulphadiazine or actisorb or aquacel or avance or sulfadiazine or flamazine)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or betadine or iodoflex)or(silicon* or mepitel or mepilex or (NA near ultra) or acticoat or aquacell or contreet)
#7 ((odor* near reduc*) or (odour* near reduc*) or (malodor* near reduc*) or (malodour* near reduce*) or (odor* near minimi*) or (malodor* near minimi*) or (odour* near minimis*) or (malodour* near minimis*))or((tissue near engineer*) or (biologically near active*) or (cellulose near matrix) or (matrix near dressing*) or (protease near modulating near matrix) or (regenerated near cellulose near dressing*))or((promogran or promogram))
#6 ((non near adheren* near layer*) or (no-sting near barrier*) or (barrier* near film*) or cavilon or (ribbon near gauze*) or (skin near substitute*))or(polysaccharide* or poly-saccharide* or foam* or (odor* near absorb*) or (odour* near absorb*) or (malodor* near absorb*) or (malodour* near absorb*))
#5 (low near adheren* near layer*) or (permeable near film*) or hydrofiber* or hydro-fiber* or hydrofibre* or hydro-fibre*
#4 (compress* near bandag*) or vitamin* or hydrogel* or hydro-gel* or hydropolymer* or hydro-polymer*
#3 (bandag* or stocking* or gauze* or tulle* or bind* or wrap* or paste* or ointment*)or(dressing* or compress* or cream* or salve* or ointment* or lotion* or unguent* or balm* or unction* or emollient*)or((growth near2 factor*) or (Pressure near relie*) or (recombinant near protein*) or iloprost or alginate* or zinc or hydrocolloid* or hydro-colloid*)
#2 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)
#1 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)

Clinical effectiveness search strategies for Question E

Medline & Medline In-Process Citations strategy (OVID interface)

1. Skin Ulcer/
2. decubitus ulcer/
3. (decubitus or decubital or skin breakdown$).tw.
4. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
5. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=ti, ab, rw, sh]
7. or/1-6
8. limit 7 to english language
9. animal/
10. human/
11. 9 not (9 and 10)
12. 8 not 11
13. letter.pt.
14. editorial.pt.
15. comment.pt.
16. 12 not (13 or 14 or 15)
17. Debridement/
18. Debrid$.ti,ab.
19. Larva/
20. Larva$.ti,ab.
21. (maggot or maggots).ti,ab.
22. (biosurg$ or bio surg$ or bio-surg$).ti,ab.
23. (trypsin or collagenase or streptokinase or streptodornase).ti,ab.
24. (varidase adj topical).ti,ab.
25. (wet adj dry adj dress$).ti,ab.
26. (polysaccharide$ or dextranomer$ or xerogel or cadexomer iodine).ti,ab.
27. (iodoflex or iodosorb or hydrogel$ or gel$).ti,ab.
28. (intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin).ti,ab.
29. pressur$ wound$ irrigat$.ti,ab.
30. whirlpool.ti,ab.
31. hypochlorite solution.ti,ab.
32. sodium hypochlorite.ti,ab.
33. dakin$ solution.ti,ab.
34. eusol.ti,ab.
35. (malic acid or benzoic acid or salicylic acid or propylene glycol).ti,ab.
36. (proteolytic$ or fibrinolytic$ or collagenase$).ti,ab.
37. (hydrocholloid$ or hydrocolloid$ or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm).ti,ab.
38. (hydrofibre or debrisan).ti,ab.
39. (bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm).ti,ab.
40. (polyurethane foam or allevyn or lyfoam or tielle or lyofoam).ti,ab.
41. (alginate$ or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity).ti,ab.
42. (tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle).ti,ab.
43. (vapour permeable membrane$ or vapor permeable membrane$ or spyrosorb or flexipore or omiderm or surfasoft or tegapore).ti,ab.
44. (enzymes or enzymatic).ti,ab.
45. (secondary dressing$ or film or films or gauze or gauzes or fibre or fiber or occlusive dressing$).ti,ab.
46. (aquacel or aloe vera or wound gel$ or polynoxylin).ti,ab.
47. (melolin or emsol or silastic foam$ or hydrofibre$ or hydrofiber$).ti,ab.
48. (polyurethane or hydrocellular or foam elastomer or cellulose).ti,ab.
49. (medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles).ti,ab.
50. (aserbine or paratulle or unitulle or skintact or mepore).ti,ab.

51. Zinc/
52. Zinc oxide/
53. Ointments/
54. Dermatologic agents/
55. Colloids/
56. Alginates/
57. Biological dressings/
58. Occlusive dressings/
59. Papain/tu [Therapeutic Use]
60. UREA/tu [Therapeutic Use]
61. Collagenases/tu [Therapeutic Use]
62. Hydrotherapy/
63. WATER/tu [Therapeutic Use]
64. IRRIGATION/
65. Acetic Acid/tu [Therapeutic Use]
66. Potassium Permanganate/tu [Therapeutic Use]
67. IODINE/tu [Therapeutic Use]
68. POVIDONE-IODINE/tu [Therapeutic Use]
69. PROFLAVINE/tu [Therapeutic Use]
70. CHLORHEXIDINE/tu [Therapeutic Use]
71. (papain or panafil or collagenase santyl or elase or fibrinolysin).ti,ab.
72. (desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme).ti,ab.
73. (tap water or hydrotherap$ or hydro-therap$ or lavage or irrigat$).ti,ab.
74. edinburgh university solution of lime.ti,ab.
75. (acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver sulfadiazine).ti,ab.
76. (flamazine or hydrogen peroxide or hioxyl).ti,ab.
77. (semipermeable membrane$ or semi-permeable membrane$).ti,ab.
78. (semipermeable dressing$ or semi-permeable dressinge$).ti,ab.
79. (semipermeable dressing$ or semi-permeable dressing$).ti,ab.
80. (pvp iodine or iodine or proflavine or chlorhexdine or cetrimede).ti,ab.
81. or/17-80
82. 16 and 81
83. limit 82 to yr=2000-2004

Embase strategy (OVID interface)

1. Skin Ulcer/
2. Decubitus/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
7. or/1-6
8. limit 7 to english language
9. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
10. exp ANIMAL/
11. Animal Experiment/
12. Nonhuman/
13. Human/
14. Human Experiment/
15. or/9-12
16. 13 or 14
17. 15 not (15 and 16)
18. 8 not 17
19. 18 not (editorial or letter or note).pt.

20. Debrid$.ti,ab.
21. Larva$.ti,ab.
22. (maggot or maggots).ti,ab.
23. (biosurg$ or bio surg$ or bio-surg$).ti,ab.
24. (trypsin or collagenase or streptokinase or streptodornase).ti,ab.
25. (varidase adj topical).ti,ab.
26. (wet adj dry adj dress$).ti,ab.
27. (polysaccharide$ or dextranomer$ or xerogel or cadexomer iodine).ti,ab.
28. (iodoflex or iodosorb or hydrogel$ or gel$).ti,ab.
29. (intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin).ti,ab.
30. pressur$ wound$ irrigat$.ti,ab.
31. whirlpool.ti,ab.
32. hypochlorite solution.ti,ab.
33. sodium hypochlorite.ti,ab.
34. dakin$ solution.ti,ab.
35. eusol.ti,ab.
36. (malic acid or benzoic acid or salicylic acid or propylene glycol).ti,ab.
37. (proteolytic$ or fibrinolytic$ or collagenase$).ti,ab.
38. (hydrocholloid$ or hydrocolloid$ or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm).ti,ab.
39. (hydrofibre or debrisan).ti,ab.
40. (bioclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm).ti,ab.
41. (polyurethane foam or allevyn or lyfoam or tielle or lyofoam).ti,ab.
42. (alginate$ or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity).ti,ab.
43. (tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle).ti,ab.
44. (vapour permeable membrane$ or vapor permeable membrane$ or spyrosorb or flexipore or omiderm or surfasoft or tegapore).ti,ab.
45. (enzymes or enzymatic).ti,ab.
46. (secondary dressing$ or film or films or gauze or gauzes or fibre or fiber or occlusive dressing$).ti,ab.
47. (aquacel or aloe vera or wound gel$ or polynoxylin).ti,ab.
48. (melolin or emsol or silastic foam$ or hydrofibre$ or hydrofiber$).ti,ab.
49. (polyurethane or hydrocellular or foam elastomer or cellulose).ti,ab.
50. (medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles).ti,ab.
51. (aserbine or paratulle or unitulle or skintact or mepore).ti,ab.
52. (papain or panafil or collagenase santyl or elase or fibrinolysin).ti,ab.
53. (desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme).ti,ab.
54. (tap water or hydrotherap$ or hydro-therap$ or lavage or irrigat$).ti,ab.
55. edinburgh university solution of lime.ti,ab.
56. (acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver sulfadiazine).ti,ab.
57. (flamazine or hydrogen peroxide or hioxyl).ti,ab.
58. (semipermeable membrane$ or semi-permeable membrane$).ti,ab.
59. (semipermeable dressing$ or semi-permeable dressinge$).ti,ab.
60. (semipermeable dressing$ or semi-permeable dressing$).ti,ab.
61. (pvp iodine or iodine or proflavine or chlorhexdine or cetrimede).ti,ab.
62. debridement/ or wound irrigation/
63. larva/
64. Trypsin/
65. Collagenase/
66. Streptokinase/
67. STREPTODORNASE PLUS STREPTOKINASE/ or STREPTODORNASE/
68. Streptodornase Plus Streptokinase/
69. Polysaccharide/
70. Dextranomer/
71. CADEXOMER IODINE/
72. HYDROGEL/
73. gel/

74. wound irrigation/
75. lavage/
76. Hypochlorite Sodium/
77. Eusol/
78. Malic Acid/
79. Benzoic Acid/
80. Salicylic Acid/
81. Propylene Glycol/
82. hydrocolloid/
83. Enzyme/ae, ct, ad, an, cb, cm, cr, pe, dv, do, pd, it, dt, sc, tp [Adverse Drug Reaction, Clinical Trial, Drug Administration, Drug Analysis, Drug Combination, Drug Comparison, Drug Concentration, Pharmacoeconomics, Drug Development, Drug Dose, Pharmacology, Drug Interaction, Drug Therapy, Subcutaneous Drug Administration, Topical Drug Administration]
84. ZINC OXIDE/ or ZINC/
85. gel/ or hydrogel/ or ointment/
86. dermatological agent/ or topical agent/
87. colloid/ or hydrocolloid/
88. "bandages and dressings"/ or bandage/
89. UREA/ae, ct, ad, an, cb, cm, cr, pe, dv, pk, do, pd, it, tp, dt, td, to [Adverse Drug Reaction, Clinical Trial, Drug Administration, Drug Analysis, Drug Combination, Drug Comparison, Drug Concentration, Pharmacoeconomics, Drug Development, Pharmacokinetics, Drug Dose, Pharmacology, Drug Interaction, Topical Drug Administration, Drug Therapy, Transdermal Drug Administration, Drug Toxicity]
90. PAPAIN/ae, ct, ad, an, cb, cm, cr, pe, dv, pk, do, pd, it, tp, dt, td, to
91. HYDROTHERAPY/
92. water/ or fresh water/ or mineral water/ or tap water/
93. wound irrigation/
94. Wound Dressing/
95. Acetic Acid/
96. Permanganate Potassium/
97. IODINE/ or CADEXOMER IODINE/
98. POVIDONE IODINE/
99. PROFLAVINE/
100. CHLORHEXIDINE/
101. or/20-100
102. 19 and 101
103. "200000".em.
104. "2001$".em.
105. "2002$".em.
106. "2003$".em.
107. "2004$".em.
108. or/103-107
109. 102 and 108

Cinahl strategy (OVID interface)

1. skin ulcer/ or pressure ulcer/
2. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
3. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
4. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
6. or/1-5
7. limit 6 to english
8. 7 not (editorial or letter or anecdote or commentary).pt.
9. Debrid$.ti,ab.
10. Larva$.ti,ab.
11. (maggot or maggots).ti,ab.
12. (biosurg$ or bio surg$ or bio-surg$).ti,ab.
13. (trypsin or collagenase or streptokinase or streptodornase).ti,ab.

14. (varidase adj topical).ti,ab.
15. (wet adj dry adj dress$).ti,ab.
16. (polysaccharide$ or dextranomer$ or xerogel or cadexomer iodine).ti,ab.
17. (iodoflex or iodosorb or hydrogel$ or gel$).ti,ab.
18. (intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin).ti,ab.
19. pressur$ wound$ irrigat$.ti,ab.
20. whirlpool.ti,ab.
21. hypochlorite solution.ti,ab.
22. sodium hypochlorite.ti,ab.
23. dakin$ solution.ti,ab.
24. eusol.ti,ab.
25. (malic acid or benzoic acid or salicylic acid or propylene glycol).ti,ab.
26. (proteolytic$ or fibrinolytic$ or collagenase$).ti,ab.
27. (hydrocholloid$ or hydrocolloid$ or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm).ti,ab.
28. (hydrofibre or debrisan).ti,ab.
29. (bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm).ti,ab.
30. (polyurethane foam or allevyn or lyfoam or tielle or lyofoam).ti,ab.
31. (alginate$ or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity).ti,ab.
32. (tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle).ti,ab.
33. (vapour permeable membrane$ or vapor permeable membrane$ or spyrosorb or flexipore or omiderm or surfasoft or tegapore).ti,ab.
34. (enzymes or enzymatic).ti,ab.
35. (secondary dressing$ or film or films or gauze or gauzes or fibre or fiber or occlusive dressing$).ti,ab.
36. (aquacel or aloe vera or wound gel$ or polynoxylin).ti,ab.
37. (melolin or emsol or silastic foam$ or hydrofibre$ or hydrofiber$).ti,ab.
38. (polyurethane or hydrocellular or foam elastomer or cellulose).ti,ab.
39. (medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles).ti,ab.
40. (aserbine or paratulle or unitulle or skintact or mepore).ti,ab.
41. (papain or panafil or collagenase santyl or elase or fibrinolysin).ti,ab.
42. (desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme).ti,ab.
43. (tap water or hydrotherap$ or hydro-therap$ or lavage or irrigat$).ti,ab.
44. edinburgh university solution of lime.ti,ab.
45. (acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver sulfadiazine).ti,ab.
46. (flamazine or hydrogen peroxide or hioxyl).ti,ab.
47. (semipermeable membrane$ or semi-permeable membrane$).ti,ab.
48. (semipermeable dressing$ or semi-permeable dressinge$).ti,ab.
49. (semipermeable dressing$ or semi-permeable dressing$).ti,ab.
50. (pvp iodine or iodine or proflavine or chlorhexdine or cetrimede).ti,ab.
51. Debridement/
52. Larva/
53. Ointments/
54. zinc/
55. zinc oxide/
56. Dermatologic Agents/
57. colloids/ or gels/ or suspensions/
58. Alginates/
59. biological dressings/ or hydrocolloid dressings/ or hydrogel dressings/ or occlusive dressings/ or transparent dressings/
60. Urea/tu [Therapeutic use]
61. Hydrotherapy/
62. Water/tu [Therapeutic use]
63. Irrigation/
64. "wound irrigation (iowa nic)"/
65. Acetic Acid/tu [Therapeutic use]

66. IODINE/tu [Therapeutic use]
67. POVIDONE-IODINE/tu [Therapeutic use]
68. CHLORHEXIDINE/tu [Therapeutic use]
69. or/9-68
70. 8 and 69
71. ("200006" or "200007" or "200008" or "200009" or "200010" or "200011" or "200012").ew.
72. ("2001$" or "2002$" or "2003$" or "2004$").ew.
73. 71 or 72
74. 70 and 73

British Nursing Index strategy (OVID interface)

1. pressure ulcers/
2. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
4. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
6. or/1-5
7. Debrid$.ti,ab.
8. Larva$.ti,ab.
9. (maggot or maggots).ti,ab.
10. (biosurg$ or bio surg$ or bio-surg$).ti,ab.
11. (trypsin or collagenase or streptokinase or streptodornase).ti,ab.
12. (varidase adj topical).ti,ab.
13. (wet adj dry adj dress$).ti,ab.
14. (polysaccharide$ or dextranomer$ or xerogel or cadexomer iodine).ti,ab.
15. (iodoflex or iodosorb or hydrogel$ or gel$).ti,ab.
16. (intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin).ti,ab.
17. pressur$ wound$ irrigat$.ti,ab.
18. whirlpool.ti,ab.
19. hypochlorite solution.ti,ab.
20. sodium hypochlorite.ti,ab.
21. dakin$ solution.ti,ab.
22. eusol.ti,ab.
23. (malic acid or benzoic acid or salicylic acid or propylene glycol).ti,ab.
24. (proteolytic$ or fibrinolytic$ or collagenase$).ti,ab.
25. (hydrocholloid$ or hydrocolloid$ or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm).ti,ab.
26. (hydrofibre or debrisan).ti,ab.
27. (bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm).ti,ab.
28. (polyurethane foam or allevyn or lyfoam or tielle or lyofoam).ti,ab.
29. (alginate$ or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity).ti,ab.
30. (tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle).ti,ab.
31. (vapour permeable membrane$ or vapor permeable membrane$ or spyrosorb or flexipore or omiderm or surfasoft or tegapore).ti,ab.
32. (enzymes or enzymatic).ti,ab.
33. (secondary dressing$ or film or films or gauze or gauzes or fibre or fiber or occlusive dressing$).ti,ab.
34. (aquacel or aloe vera or wound gel$ or polynoxylin).ti,ab.
35. (melolin or emsol or silastic foam$ or hydrofibre$ or hydrofiber$).ti,ab.
36. (polyurethane or hydrocellular or foam elastomer or cellulose).ti,ab.
37. (medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles).ti,ab.
38. (aserbine or paratulle or unitulle or skintact or mepore).ti,ab.
39. (papain or panafil or collagenase santyl or elase or fibrinolysin).ti,ab.
40. (desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme).ti,ab.
41. (tap water or hydrotherap$ or hydro-therap$ or lavage or irrigat$).ti,ab.
42. (acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver

sulfadiazine).ti,ab.
43. (flamazine or hydrogen peroxide or hioxyl).ti,ab.
44. (semipermeable membrane$ or semi-permeable membrane$).ti,ab.
45. (semipermeable dressing$ or semi-permeable dressinge$).ti,ab.
46. (semipermeable dressing$ or semi-permeable dressing$).ti,ab.
47. (pvp iodine or iodine or proflavine or chlorhexdine or cetrimede).ti,ab.
48. or/7-47
49. 6 and 48

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. DEBRIDEMENT single term (MeSH)
#9. LARVA single term (MeSH)
#10. ZINC single term (MeSH)
#11. zinc
#12. OINTMENTS single term (MeSH)
#13. DERMATOLOGIC AGENTS single term (MeSH)
#14. COLLOIDS single term (MeSH)
#15. ALGINATES single term (MeSH)
#16. BIOLOGICAL DRESSINGS single term (MeSH)
#17. OCCLUSIVE DRESSINGS single term (MeSH)
#18. PAPAIN [tu] single term (MeSH)
#19. UREA [tu] single term (MeSH)
#20. COLLAGENASES [tu] single term (MeSH)
#21. HYDROTHERAPY single term (MeSH)
#22. WATER [tu] single term (MeSH)
#23. IRRIGATION single term (MeSH)
#24. ACETIC ACID [tu] single term (MeSH)
#25. POTASSIUM PERMANGANATE [tu] single term (MeSH)
#26. IODINE [tu] single term (MeSH)
#27. POVIDONE-IODINE [tu] single term (MeSH)
#28. PROFLAVINE [tu] single term (MeSH)
#29. CHLORHEXIDINE [tu] single term (MeSH)
#30. (debrid* or larva* or maggot or maggots or biosurg* or (bio next surg*) or bio-surg* or trypsin or collagenase or streptokinase or streptodornase or (semipermeable next dressing*) or (semi-permeable next dressing*) or (pvp next iodine) or iodine or proflavine or chlorhexdine or cetrimede)
#31. ((varidase next topical) or (wet next dry next dress*) or polysaccharide* or dextranomer* or xerogel or iodoflex or iodosorb or hydrogel* or gel*)
#32. (intrasite or intrasitegel or sterigel or granugel or hydrogel* or nu-gel or (nu next gel) or nugel or vigilon or (2nd next skin) or (second next skin) or irrigat* or whirlpool)
#33. ((hypochlorite next solution) or (sodium next hypochlorite) or (dakin* next solution) or eusol or (malic next acid) or (benzoic next acid) or (salicylic next acid) or (propylene next glycol) or proteolytic* or fibrinolytic* or collagenase*)
#34. (hydrocholloid* or hydrocolloid* or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm or hydrofibre or debrisan or bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or polyurethane or allevyn or lyfoam or tielle or lyofoam)
#35. (alginate* or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or (cutinova next cavity) or tulle or tulles or jelonet or bactigras or chlorhexitulle or serotulle or intertulle or (vapour next permeable next membrane*) or (vapor next permeable next membrane*) or spyrosorb or flexipore or omiderm or surfasoft or tegapore)

#36. (enzymes or enzymatic or (secondary next dressing*) or film or films or gauze or gauzes or fibre or fiber or (occlusive next dressing*) or aquacel or (aloe next vera) or polynoxylin or melolin or emsol or (silastic next foam*) or hydrofibre* or hydrofiber* or polyurethane or hydrocellular or (foam next elastomer) or cellulose)
#37. (aserbine or paratulle or unitulle or skintact or mepore or papain or panafil or (collagenase next santyl) or elase or fibrinolysin or desoxyribonuclease or dnase or (antarctic next krill) or bromelain or iruxol or accuzyme)
#38. ((tap next water) or hydrotherap* or hydro-therap* or lavage or irrigat* or (acetic next acid) or chloramine or chlorasol or milton or (potassium next permanganate) or (silver next sulfadiazine) or flamazine or (hydrogen next peroxide) or hioxyl or (semipermeable next membrane*) or (semi-permeable next membrane*) or (semipermeable next dressing*) or (semi-permeable next dressing*))
#39. (#8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20)
#40. (#21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30)
#41. (#31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40)
#42. (#7 and #41)

DARE strategy (internal CRD Cairs interface)

1. S decubitus or decubital or skin breakdown$
2. S (bedulcer$ or bed(w1)ulcer$)
3. S (pressure or bed)(w3)ulcer$
4. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
5. S s1 or s2 or s3 or s4
6. S Debrid$ or Larva$ or maggot or maggots or biosurg$ or (bio(w)surg$) or trypsin or collagenase or streptokinase or streptodornase
7. S (semipermeable(w)dressing$) or (semi(w1)permeable(w)dressing$) or pvp(w)iodine or iodine or proflavine or chlorhexdine or cetrimede
8. S (varidase(w)topical) or (wet(w)dry(w)dress$) or polysaccharide$ or dextranomer$ or xerogel or cadexomer(w)iodine or iodoflex or iodosorb or hydrogel$ or gel$
9. S intrasite(w)gel or intrasitegel or sterigel or granugel or aquaform(w)hydrogel or nu(w)gel or nugel or purilon(w)gel or vigilon or 2nd(w)skin or second(w)skin or
10. S irrigat$ or whirlpool or hypochlorite(w)solution or sodium(w)hypochlorite or dakin$(w)solution or eusol or malic(w)acid or benzoic(w)acid or salicylic(w)acid or propylene(w)glycol or proteolytic$ or fibrinolytic$ or collagenase$
11. S hydrocholloid$ or hydrocolloid$ or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm or hydrofibre or debrisan or bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or tegaderm or polyurethane foam or allevyn or lyfoam or tielle or lyofoam
12. S alginate$ or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova or tulle or jelonet or bactigras or chlorhexitulle or serotulle or fucidin
13. S (vapour(w)permeable(w)membrane$) or (vapor(w)permeable(w)membrane$) or spyrosorb or flexipore or omiderm or surfasoft or tegapore
14. S enzymes or enzymatic or (secondary(w)dressing$) or film or films or gauze or gauzes or fibre or fiber or (occlusive(w)dressing$) or aquacel or (aloe(w)vera) or wound(w)gel$ or polynoxylin or melolin or emsol or silastic(w)foam$ or hydrofibre$ or hydrofiber$ or polyurethane or hydrocellular or foam(w)elastomer or cellulose
15. S tulles or aserbine or paratulle or unitulle or skintact or mepore or papain or panafil or elase or fibrinolysin or desoxyribonuclease or dnase or antarctic(w)krill or bromelain or iruxol or accuzyme
16. S water or hydrotherap$ or hydro(w)therap$ or lavage or irrigat$ or acetic(w)acid or chloramine or chlorasol or milton or potassium(w)permanganate or silver(w)sulfadiazine or flamazine or hydrogen(w)peroxide or hioxyl or semipermeable(w)membrane$ or semi(w)permeable(w)membrane$ or semipermeable(w)dressing$ or semi(w)permeable(w)dressing$
17. s s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13 or s14 or s15 or s16
18. s s5 and s17
19. s (French or spanish or italian or dutch or german or russian)/lan
20. s s18 andnot s19

AMED strategy (OVID interface)

1. skin ulcer/ or decubitus ulcer/
2. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
4. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
6. or/1-5
7. limit 6 to english language
8. 7 not (commentary or editorial or notes or letter).pt.
9. Debrid$.ti,ab.
10. Larva$.ti,ab.
11. (maggot or maggots).ti,ab.
12. (biosurg$ or bio surg$ or bio-surg$).ti,ab.
13. (trypsin or collagenase or streptokinase or streptodornase).ti,ab.
14. (varidase adj topical).ti,ab.
15. (wet adj dry adj dress$).ti,ab.
16. (polysaccharide$ or dextranomer$ or xerogel or cadexomer iodine).ti,ab.
17. (iodoflex or iodosorb or hydrogel$ or gel$).ti,ab.
18. (intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin).ti,ab.
19. pressur$ wound$ irrigat$.ti,ab.
20. whirlpool.ti,ab.
21. hypochlorite solution.ti,ab.
22. sodium hypochlorite.ti,ab.
23. dakin$ solution.ti,ab.
24. eusol.ti,ab.
25. (malic acid or benzoic acid or salicylic acid or propylene glycol).ti,ab.
26. (proteolytic$ or fibrinolytic$ or collagenase$).ti,ab.
27. (hydrocholloid$ or hydrocolloid$ or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm).ti,ab.
28. (hydrofibre or debrisan).ti,ab.
29. (bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm).ti,ab.
30. (polyurethane foam or allevyn or lyfoam or tielle or lyofoam).ti,ab.
31. (alginate$ or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity).ti,ab.
32. (tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle).ti,ab.
33. (vapour permeable membrane$ or vapor permeable membrane$ or spyrosorb or flexipore or omiderm or surfasoft or tegapore).ti,ab.
34. (enzymes or enzymatic).ti,ab.
35. (secondary dressing$ or film or films or gauze or gauzes or fibre or fiber or occlusive dressing$).ti,ab.
36. (aquacel or aloe vera or wound gel$ or polynoxylin).ti,ab.
37. (melolin or emsol or silastic foam$ or hydrofibre$ or hydrofiber$).ti,ab.
38. (polyurethane or hydrocellular or foam elastomer or cellulose).ti,ab.
39. (medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles).ti,ab.
40. (aserbine or paratulle or unitulle or skintact or mepore).ti,ab.
41. (papain or panafil or collagenase santyl or elase or fibrinolysin).ti,ab.
42. (desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme).ti,ab.
43. (tap water or hydrotherap$ or hydro-therap$ or lavage or irrigat$).ti,ab.
44. (acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver sulfadiazine).ti,ab.
45. (flamazine or hydrogen peroxide or hioxyl).ti,ab.
46. (semipermeable membrane$ or semi-permeable membrane$).ti,ab.
47. (semipermeable dressing$ or semi-permeable dressinge$).ti,ab.
48. (semipermeable dressing$ or semi-permeable dressing$).ti,ab.
49. (pvp iodine or iodine or proflavine or chlorhexdine or cetrimede).ti,ab.

50. zinc/
51. urea/
52. hydrotherapy/
53. water/
54. irrigation/
55. acetic acid/
56. iodine/
57. or/9-56
58. 8 and 57

Health Management Information Consortium (OVID interface)

#7 #1 and #6
#6 #4 or #5
#5 ((hypochlorite solution or sodium hypochlorite or dakin* solution or eusol or malic acid or benzoic acid or salicylic acid or propylene glycol or proteolytic* or fibrinolytic* or collagenase*)or(hydrocholloid* or hydrocolloid* or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm or hydrofibre or debrisan or bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm or polyurethane foam or allevyn or lyfoam or tielle or lyofoam)or(alginate* or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity or tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle or vapour permeable membrane* or vapor permeable membrane* or spyrosorb or flexipore or omiderm or surfasoft or tegapore)) or ((Debrid* or Larva* or maggot or maggots or biosurg* or bio surg* or bio-surg* or trypsin or collagenase or streptokinase or streptodornase or semipermeable dressing* or semi-permeable dressing* or pvp iodine or iodine or proflavine or chlorhexdine or cetrimede)or((varidase near topical) or (wet near dry near dress*) or polysaccharide* or dextranomer* or xerogel or cadexomer iodine or iodoflex or iodosorb or hydrogel* or gel*)or(intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin or pressur* wound* irrigat* or whirlpool))
#4 (enzymes or enzymatic or secondary dressing* or film or films or gauze or gauzes or fibre or fiber or occlusive dressing* or aquacel or aloe vera or wound gel* or polynoxylin or melolin or emsol or silastic foam* or hydrofibre* or hydrofiber* or polyurethane or hydrocellular or foam elastomer or cellulose)or(medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles or aserbine or paratulle or unitulle or skintact or mepore or papain or panafil or collagenase santyl or elase or fibrinolysin or desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme)or(tap water or hydrotherap* or hydro-therap* or lavage or irrigat* or acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver sulfadiazine or flamazine or hydrogen peroxide or hioxyl or semipermeable membrane* or semi-permeable membrane* or semipermeable dressing* or semi-permeable dressing*)
#3 (hypochlorite solution or sodium hypochlorite or dakin* solution or eusol or malic acid or benzoic acid or salicylic acid or propylene glycol or proteolytic* or fibrinolytic* or collagenase*)or(hydrocholloid* or hydrocolloid* or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm or hydrofibre or debrisan or bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm or polyurethane foam or allevyn or lyfoam or tielle or lyofoam)or(alginate* or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity or tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle or vapour permeable membrane* or vapor permeable membrane* or spyrosorb or flexipore or omiderm or surfasoft or tegapore)
#2 (Debrid* or Larva* or maggot or maggots or biosurg* or bio surg* or bio-surg* or trypsin or collagenase or streptokinase or streptodornase or semipermeable dressing* or semi-permeable dressing* or pvp iodine or iodine or proflavine or chlorhexdine or cetrimede)or((varidase near topical) or (wet near dry near dress*) or polysaccharide* or dextranomer* or xerogel or cadexomer iodine or iodoflex or iodosorb or hydrogel* or gel*)or(intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin or pressur* wound* irrigat* or whirlpool)
#1 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)

SIGLE strategy (SilverPlatter interface)

#6 #1 and #5
#5 #2 or #3 or #4
#4 (enzymes or enzymatic or secondary dressing* or film or films or gauze or gauzes or fibre or fiber or occlusive dressing* or aquacel or aloe vera or wound gel* or polynoxylin or melolin or emsol or silastic foam* or hydrofibre* or hydrofiber* or polyurethane or hydrocellular or foam elastomer or cellulose)or(medicated tulle or medicated tulles or nonmedicated tulle or non-medicated tulle or nonmedicated tulle or non-medicated tulles or aserbine or paratulle or unitulle or skintact or mepore or papain or panafil or collagenase santyl or elase or fibrinolysin or desoxyribonuclease or dnase or antarctic krill or bromelain or iruxol or accuzyme)or(tap water or hydrotherap* or hydro-therap* or lavage or irrigat* or acetic acid or chloramine or chlorasol or milton or potassium permanganate or silver sulfadiazine or flamazine or hydrogen peroxide or hioxyl or semipermeable membrane* or semi-permeable membrane* or semipermeable dressing* or semi-permeable dressing*)
#3 (hypochlorite solution or sodium hypochlorite or dakin* solution or eusol or malic acid or benzoic acid or salicylic acid or propylene glycol or proteolytic* or fibrinolytic* or collagenase*)or(hydrocholloid* or hydrocolloid* or granuflex or comfeel or tegasorb or aquacel or combiderm or duoderm or hydrofibre or debrisan or bioclusive or biocclusive or cutifilm or opsite or epiview or mefilm or opsite flexigrid or tegaderm or polyurethane foam or allevyn or lyfoam or tielle or lyofoam)or(alginate* or sorbsan or tegagel or kaltostat or kaltogel or seasorb or algisite or algosteril or megisorb or cutinova cavity or tulle gras or jelonet or bactigras or chlorhexitulle or serotulle or fucidin intertulle or sofra tulle or vapour permeable membrane* or vapor permeable membrane* or spyrosorb or flexipore or omiderm or surfasoft or tegapore)
#2 (Debrid* or Larva* or maggot or maggots or biosurg* or bio surg* or bio-surg* or trypsin or collagenase or streptokinase or streptodornase or semipermeable dressing* or semi-permeable dressing* or pvp iodine or iodine or proflavine or chlorhexdine or cetrimede)or((varidase near topical) or (wet near dry near dress*) or polysaccharide* or dextranomer* or xerogel or cadexomer iodine or iodoflex or iodosorb or hydrogel* or gel*)or(intrasite gel or intrasitegel or sterigel or granugel or aquaform hydrogel or nu-gel or nu gel or nugel or purilon gel or vigilon or 2nd skin or second skin or pressur* wound* irrigat* or whirlpool) #1 (pressure adj (ulcer* or wound* or damag* or injur*)) or ((decubitus or decubital or skin breakdown*)or(bedulcer* or bed-ulcer*)or((pressure or bed) adj ulcer*))

Clinical effectiveness search strategies for Question G

Medline & Medline In-Process Citations strategy (OVID interface)

1. randomized controlled trial.pt.
2. exp randomized controlled trials/
3. random allocation/
4. double blind method/
5. single blind method/
6. clinical trial.pt.
7. exp clinical trials/
8. controlled clinical trials/
9. clin$ trial$.ti,ab.
10. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
11. placebo$.ti,ab.
12. placebos/
13. random$.ti,ab.
14. exp evaluation studies/
15. follow up studies/
16. exp research design/
17. prospective studies/
18. (control$ or prospectiv$ or volunteer$).ti,ab.
19. or/1-18
20. animal/
21. human/
22. 20 not (20 and 21)
23. 19 not 22

24. Skin Ulcer/
25. decubitus ulcer/
26. (decubitus or decubital or skin breakdown$).tw.
27. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
28. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
29. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
30. or/24-29
31. limit 30 to english language
32. animal/
33. human/
34. 32 not (32 and 33)
35. 31 not 34
36. letter.pt.
37. editorial.pt.
38. comment.pt.
39. 35 not (36 or 37 or 38)
40. Electric Stimulation Therapy/
41. (electro-therap$ or electrotherap$).mp.
42. electrical stimulat$.mp.
43. ELECTROMAGNETICS/tu [Therapeutic Use]
44. Electromagnetic Fields/tu [Therapeutic Use]
45. (pulsed electromagnetic field$ or electromagnetic therap$ or electro-magnetic therap$).mp.
46. pemf.ti,ab.
47. Ultrasonography/
48. (therap$ ultrasound$ or therap$ ultra-sound$).mp.
49. (therap$ echograph$ or therap$ ultra-sonog$ or therap$ ultrasonog$).mp.
50. low frequency stimulat$.mp.
51. Laser Therapy, Low-Level/
52. low level laser$.mp.
53. hene laser$.mp.
54. gaas laser$.mp.
55. helium neon laser$.mp.
56. gallium arsenide laser$.mp.
57. topical negative pressure.mp.
58. SUCTION/
59. vacuum/
60. (adjunct adj3 (therap$ or treatment$ or intervention$ or regime$)).mp.
61. or/40-60
62. 23 and 39 and 61
63. limit 62 to yr=2000-2004

Embase strategy (OVID interface)

1. randomized controlled trial/
2. randomization/
3. double blind procedure/ or single blind procedure/
4. exp clinical trial/
5. controlled study/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. Placebo/
10. random$.ti,ab.
11. evaluation/
12. follow up/
13. exp methodology/
14. prospective study/

15. (control$ or prospectiv$ or volunteer$).ti,ab.
16. or/1-15
17. limit 16 to english language
18. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
19. exp ANIMAL/
20. Animal Experiment/
21. Nonhuman/
22. Human/
23. Human Experiment/
24. or/18-21
25. 22 or 23
26. 24 not (24 and 25)
27. 17 not 26
28. 27 not (editorial or letter or note).pt.
29. Skin Ulcer/
30. Decubitus/
31. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
32. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
33. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
34. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
35. or/29-34
36. electrostimulation/
37. electrostimulation therapy/
38. (electro-therap$ or electrotherap$).mp.
39. electrical stimulat$.mp.
40. electromagnetic field/
41. (pulsed electromagnetic field$ or electromagnetic therap$ or electro-magnetic therap$).mp.
42. pemf.ti,ab.
43. pulsed electric field/
44. ultrasound/
45. echography/
46. (therap$ ultrasound$ or therap$ ultra-sound$).mp.
47. (therap$ ultra-sonog$ or therap$ ultrasonog$).mp.
48. therap$ echograph$.mp.
49. low frequency stimulat$.mp.
50. low level laser therapy/
51. low level laser$.mp.
52. hene laser$.mp.
53. gaas laser$.mp.
54. helium neon laser$.mp.
55. gallium arsenide laser$.mp.
56. topical negative pressure.mp.
57. pressure/
58. suction/
59. vacuum/
60. (adjunct adj3 (therap$ or treatment$ or intervention$ or regime$)).mp.
61. or/36-60
62. 28 and 35 and 61
63. limit 62 to yr=1997-2004

Cinahl strategy (OVID interface)

1. clinical trial.pt.
2. Random Assignment/
3. double-blind studies/

4. single-blind studies/
5. exp clinical trials/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. placebos/ or placebo effect/
10. random$.ti,ab.
11. Evaluation Research/
12. Prospective Studies/
13. exp Study Design/
14. (control$ or prospectiv$ or volunteer$).ti,ab.
15. or/1-14
16. limit 15 to english
17. skin ulcer/ or pressure ulcer/
18. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
19. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
20. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
21. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
22. or/17-21
23. electrotherapy/ or electric stimulation/
24. (electro-therap$ or electrotherap$).mp.
25. electric$ stimulat$.mp.
26. ELECTROMAGNETICS/tu [Therapeutic use]
27. ELECTROMAGNETIC FIELDS/tu [Therapeutic use]
28. (pulsed electromagnetic field$ or electromagnetic therap$ or electro-magnetic therap$).mp.
29. pemf.ti,ab.
30. Ultrasonography/
31. (therap$ ultrasound$ or therap$ ultra-sound$).mp.
32. (therap$ echograph$ or therap$ ultra-sonog$ or therap$ ultrasonog$).mp.
33. low frequency stimulat$.mp.
34. Lasers/tu [Therapeutic use]
35. low level laser$.mp.
36. hene laser$.mp.
37. gaas laser$.mp.
38. helium neon laser$.mp.
39. gallium arsenide laser$.mp.
40. topical negative pressure.mp.
41. Suction/
42. (adjunct adj3 (therap$ or treatment$ or intervention$ or regime$)).mp.
43. or/23-42
44. 16 and 22 and 43
45. 44 not (editorial or letter or anecdote or commentary).pt.
46. limit 45 to yr=1999-2003

British Nursing Index strategy (OVID interface)

1. exp research methods/
2. clin$ trial$.tw.
3. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
4. placebo$.tw.
5. random$.tw.
6. (control$ or prospectiv$ or volunteer$).tw.
7. ((study or studies) adj1 design$).tw.
8. or/1-7
9. pressure ulcers/
10. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
11. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]

12. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
13. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
14. or/9-13
15. (electro-therap$ or electrotherap$).mp.
16. electric$ stimulat$.mp.
17. (ELECTROMAGNETIC$ or ELECTRO MAGNETIC).mp. [mp=heading words, title]
18. (pulsed electromagnetic field$ or electromagnetic therap$ or electro-magnetic therap$).mp.
19. pemf.tw.
20. (therap$ ultrasound$ or therap$ ultra-sound$).mp.
21. ultrasound/
22. (therap$ echograph$ or therap$ ultra-sonog$ or therap$ ultrasonog$).mp.
23. low frequency stimulat$.mp.
24. low level laser$.mp.
25. lasers/
26. hene laser$.mp.
27. gaas laser$.mp.
28. helium neon laser$.mp.
29. gallium arsenide laser$.mp.
30. topical negative pressure.mp.
31. (adjunct adj3 (therap$ or treatment$ or intervention$ or regime$)).mp.
32. (suction$ or vacuum$).mp. [mp=heading words, title]
33. or/15-32
34. 8 and 14 and 33

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. ELECTRIC STIMULATION THERAPY single term (MeSH)
#9. ELECTROMAGNETICS [tu] single term (MeSH)
#10. ELECTROMAGNETIC FIELDS [tu] single term (MeSH)
#11. ULTRASONOGRAPHY single term (MeSH)
#12. LASER THERAPY LOW-LEVEL single term (MeSH)
#13. SUCTION single term (MeSH)
#14. VACUUM single term (MeSH)
#15. (electro-therap* or electrotherap*)
#16. (electrical next stimulat*)
#17. ((pulsed next electromagnetic next field*) or (electromagnetic next therapy) or (electromagnetic next therapies))
#18. ((electro-magnetic next therapy) or (electro-magnetic next therapies))
#19. pemf:ti
#20. ((therapy next ultrasound*) or (therapies next ultra-sound*))
#21. ((therapy next ultrasound*) or (therapies next ultra-sound*))
#22. ((therapy next echograph*) or (therapy next ultra-sonog*) or (therapy next ultrasonog*))
#23. ((therapies next echograph*) or (therapies next ultra-sonog*) or (therapies next ultrasonog*))
#24. (low next frequency next stimulat*)
#25. (low next level next laser*)
#26. (hene next laser*)
#27. (gaas next laser*)
#28. (helium next neon next laser*)
#29. (gallium next arsenide next laser*)
#30. (topical next negative next pressure)
#31. ((adjunct next therapy) or (adjunct next therapies))

#32. ((adjunct next treatment) or (adjunct next treatments) or (adjunct next intervention*) or (adjunct next regime*))
#33. (#8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20)
#34. (#21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33)
#35. (#7 and #34)
#36. (#7 and #34) (2000 to current date)

AMED strategy (OVID interface)

1. exp clinical trials/
2. exp research design/ or double blind method/ or random allocation/
3. clinical trial.pt.
4. clin$ trial$.tw.
5. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
6. placebo$.tw.
7. placebos/
8. random$.tw.
9. (control$ or prospectiv$ or volunteer$).tw.
10. ((study or studies) adj1 design$).tw.
11. or/1-10
12. limit 11 to english language
13. skin ulcer/ or decubitus ulcer/
14. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
15. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
16. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
17. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
18. or/13-17
19. electric stimulation/
20. electrotherapy/
21. electromagnetic fields/
22. electromagnetics/
23. ultrasonography/
24. lasers/
25. (electro-therap$ or electrotherap$).mp.
26. electric$ stimulat$.mp.
27. (pulsed electromagnetic field$ or electromagnetic therap$ or electro-magnetic therap$).mp.
28. pemf.tw.
29. (therap$ ultrasound$ or therap$ ultra-sound$).mp.
30. (therap$ echograph$ or therap$ ultra-sonog$ or therap$ ultrasonog$).mp.
31. low frequency stimulat$.mp.
32. low level laser$.mp.
33. hene laser$.mp.
34. gaas laser$.mp.
35. helium neon laser$.mp.
36. gallium arsenide laser$.mp.
37. topical negative pressure.mp.
38. (adjunct adj3 (therap$ or treatment$ or intervention$ or regime$)).mp.
39. (suction$ or vacuum$).mp. [mp=abstract, heading words, title]
40. or/19-39
41. 12 and 18 and 40
42. 41 not (commentary or editorial or notes or letter).pt.

Health Management Information Consortium (OVID interface)

#6 (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((topical negative pressure) or (adjunct near3 (therap* or treatment* or intervention* or regime*))) or ((

electro-therap* or electrotherap* or (electric* stimulat*) or suction* or vacuum* or ultrasound* or echograph* or ultrasonog* or ultra-sound or echo-graph* or ultra-sonog*)or((therap* echograph* or therap* ultra-sonog* or therap* ultrasonog*) or (low frequency stimulat*) or (low level laser*) or laser*)or((pulsed electromagnetic field*) or (electromagnetic therap*) or (electro-magnetic therap*) or pemf or (therap* ultrasound* or therap* ultra-sound*))))
#5 ((topical negative pressure) or (adjunct near3 (therap* or treatment* or intervention* or regime*))) or ((electro-therap* or electrotherap* or (electric* stimulat*) or suction* or vacuum* or ultrasound* or echograph* or ultrasonog* or ultra-sound or echo-graph* or ultra-sonog*)or((therap* echograph* or therap* ultra-sonog* or therap* ultrasonog*) or (low frequency stimulat*) or (low level laser*) or laser*)or((pulsed electromagnetic field*) or (electromagnetic therap*) or (electro-magnetic therap*) or pemf or (therap* ultrasound* or therap* ultra-sound*)))
#4 (topical negative pressure) or (adjunct near3 (therap* or treatment* or intervention* or regime*))
#3 (electro-therap* or electrotherap* or (electric* stimulat*) or suction* or vacuum* or ultrasound* or echograph* or ultrasonog* or ultra-sound or echo-graph* or ultra-sonog*)or((therap* echograph* or therap* ultra-sonog* or therap* ultrasonog*) or (low frequency stimulat*) or (low level laser*) or laser*)or((pulsed electromagnetic field*) or (electromagnetic therap*) or (electro-magnetic therap*) or pemf or (therap* ultrasound* or therap* ultra-sound*))
#2 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)
#1 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)

SIGLE strategy (SilverPlatter interface)

#6 (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((topical negative pressure) or (adjunct near3 (therap* or treatment* or intervention* or regime*))) or ((electro-therap* or electrotherap* or (electric* stimulat*) or suction* or vacuum* or ultrasound* or echograph* or ultrasonog* or ultra-sound or echo-graph* or ultra-sonog*)or((therap* echograph* or therap* ultra-sonog* or therap* ultrasonog*) or (low frequency stimulat*) or (low level laser*) or laser*)or((pulsed electromagnetic field*) or (electromagnetic therap*) or (electro-magnetic therap*) or pemf or (therap* ultrasound* or therap* ultra-sound*))))
#5 ((topical negative pressure) or (adjunct near3 (therap* or treatment* or intervention* or regime*))) or ((electro-therap* or electrotherap* or (electric* stimulat*) or suction* or vacuum* or ultrasound* or echograph* or ultrasonog* or ultra-sound or echo-graph* or ultra-sonog*)or((therap* echograph* or therap* ultra-sonog* or therap* ultrasonog*) or (low frequency stimulat*) or (low level laser*) or laser*)or((pulsed electromagnetic field*) or (electromagnetic therap*) or (electro-magnetic therap*) or pemf or (therap* ultrasound* or therap* ultra-sound*)))
#4 (topical negative pressure) or (adjunct near3 (therap* or treatment* or intervention* or regime*))
#3 (electro-therap* or electrotherap* or (electric* stimulat*) or suction* or vacuum* or ultrasound* or echograph* or ultrasonog* or ultra-sound or echo-graph* or ultra-sonog*)or((therap* echograph* or therap* ultra-sonog* or therap* ultrasonog*) or (low frequency stimulat*) or (low level laser*) or laser*)or((pulsed electromagnetic field*) or (electromagnetic therap*) or (electro-magnetic therap*) or pemf or (therap* ultrasound* or therap* ultra-sound*))
#2 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)
#1 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)

Clinical effectiveness search strategies for Question H

Medline & Medline In-Process Citations strategy (OVID interface)

1. randomized controlled trial.pt.
2. exp randomized controlled trials/
3. random allocation/
4. double blind method/
5. single blind method/
6. clinical trial.pt.
7. exp clinical trials/
8. controlled clinical trials/
9. clin$ trial$.ti,ab.
10. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
11. placebo$.ti,ab.
12. placebos/
13. random$.ti,ab.
14. exp evaluation studies/
15. follow up studies/
16. exp research design/
17. prospective studies/
18. (control$ or prospectiv$ or volunteer$).ti,ab.
19. or/1-18
20. animal/
21. human/
22. 20 not (20 and 21)
23. 19 not 22
24. limit 23 to english language
25. 24 not (comment or letter or editorial).pt.
26. Skin Ulcer/
27. decubitus ulcer/
28. (decubitus or decubital or skin breakdown$).tw.
29. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
30. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
31. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp.
32. or/26-31
33. anti-infective agents/ or anti-bacterial agents/ or antifungal agents/ or exp anti-infective agents, local/
34. (antiseptic$ or anti-septic$ or antibiotic$ or anti-biotic$ or antimicrobial$ or anti-microbial$ or antibacterial$ or anti-bacterial$).tw.
35. povidone/ or povidone-iodine/
36. Iodine/
37. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex).tw.
38. SODIUM HYPOCHLORITE/ad, tu [Administration & Dosage, Therapeutic Use]
39. (eusol or dakins solution$ or edinburgh university solution of lime or hypochlorite$ or hydrogen peroxide$ or mafenide or dermablend or oxyquinoline or A&D ointment$).tw.
40. Hydrogen Peroxide/
41. Mafenide/
42. Oxyquinoline/ or (skin substitute$ or apligraft$).tw.
43. (acticoat or aquacell or contreet or nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).mp. [mp=ti, ab, rw, sh]
44. or/33-43
45. 25 and 32 and 44
46. limit 45 to yr=2000-2004

Embase strategy (OVID interface)

1. randomized controlled trial/
2. randomization/
3. double blind procedure/ or single blind procedure/
4. exp clinical trial/

5. controlled study/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. Placebo/
10. random$.ti,ab.
11. evaluation/
12. follow up/
13. exp methodology/
14. prospective study/
15. (control$ or prospectiv$ or volunteer$).ti,ab.
16. or/1-15
17. limit 16 to english language
18. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
19. exp ANIMAL/
20. Animal Experiment/
21. Nonhuman/
22. Human/
23. Human Experiment/
24. or/18-21
25. 22 or 23
26. 24 not (24 and 25)
27. 17 not 26
28. 27 not (editorial or letter or note).pt.
29. Skin Ulcer/
30. Decubitus/
31. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
32. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
33. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
34. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
35. or/29-34
36. (antiseptic$ or anti-septic$ or antibiotic$ or anti-biotic$ or antimicrobial$ or anti-microbial$ or antibacterial$ or anti-bacterial$).tw.
37. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidrine or cadexomer iodine or betadine or iodoflex).tw.
38. (eusol or dakins solution$ or edinburgh university solution of lime or hypochlorite$ or hydrogen peroxide$ or mafenide or dermablend or oxyquinoline or A&D ointment$).tw.
39. (skin substitute$ or apligraft$).tw.
40. (acticoat or aquacell or contreet or nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).tw.
41. antiinfective agent/ or antifungal agent/ or fungicide/ or exp topical antiinfective agent/ or exp disinfectant agent/
42. Povidone/
43. Povidone Iodine/
44. Iodine/
45. Hypochlorite Sodium/dt, ad, tp [Drug Therapy, Drug Administration, Topical Drug Administration]
46. Hydrogen Peroxide/
47. Mafenide/
48. 8 Quinolinol/
49. Sulfadiazine Silver/
50. Silver Nitrate/
51. Eusol/
52. Chlorhexidine/
53. Cadexomer Iodine/

54. Antibiotic Agent/
55. or/36-54
56. 28 and 35 and 55
57. limit 56 to yr=2000-2004

Cinahl strategy (OVID interface)

1. clinical trial.pt.
2. Random Assignment/
3. double-blind studies/
4. single-blind studies/
5. exp clinical trials/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. placebos/ or placebo effect/
10. random$.ti,ab.
11. Evaluation Research/
12. Prospective Studies/
13. exp Study Design/
14. (control$ or prospectiv$ or volunteer$).ti,ab.
15. or/1-14
16. limit 15 to english
17. skin ulcer/ or pressure ulcer/
18. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
19. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
20. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
21. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
22. or/17-21
23. 22 not (editorial or letter or anecdote or commentary).pt.
24. (antiseptic$ or anti-septic$ or antibiotic$ or anti-biotic$ or antimicrobial$ or anti-microbial$ or antibacterial$ or anti-bacterial$).tw.
25. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex).tw.
26. (eusol or dakins solution$ or edinburgh university solution of lime or hypochlorite$ or hydrogen peroxide$ or mafenide or dermablend or oxyquinoline or A&D ointment$).tw.
27. (skin substitute$ or apligraft$).tw.
28. (acticoat or aquacell or contreet or nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).tw.
29. Antibiotic Prophylaxis/
30. exp Antiinfective Agents, Local/
31. antibiotics, antifungal/ or antifungal agents/ or chlorhexidine/ or hydrogen peroxide/ or povidone-iodine/
32. IODINE/
33. Silver Nitrate/
34. Silver Sulfadiazine/
35. or/24-34
36. 16 and 23 and 35
37. limit 36 to yr=2000-2004

British Nursing Index strategy (OVID interface)

1. exp research methods/
2. clin$ trial$.tw.
3. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
4. placebo$.tw.
5. random$.tw.
6. (control$ or prospectiv$ or volunteer$).tw.

7. ((study or studies) adj1 design$).tw.
8. or/1-7
9. limit 8 to yr=2000-2004
10. pressure ulcers/
11. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
12. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
13. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
14. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
15. or/10-14
16. (antiseptic$ or anti-septic$ or antibiotic$ or anti-biotic$ or antimicrobial$ or anti-microbial$ or antibacterial$ or anti-bacterial$).tw.
17. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex).tw.
18. (eusol or dakins solution$ or edinburgh university solution of lime or hypochlorite$ or hydrogen peroxide$ or mafenide or dermablend or oxyquinoline or A&D ointment$).tw.
19. (skin substitute$ or apligraft$).tw.
20. (acticoat or aquacell or contreet or nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).tw.
21. or/16-20
22. 9 and 15 and 21

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. ANTI-INFECTIVE AGENTS single term (MeSH)
#9. ANTI-INFECTIVE AGENTS LOCAL explode all trees (MeSH)
#10. ANTIFUNGAL AGENTS single term (MeSH)
#11. POVIDONE single term (MeSH)
#12. POVIDONE-IODINE single term (MeSH)
#13. IODINE single term (MeSH)
#14. SODIUM HYPOCHLORITE single term (MeSH)
#15. HYDROGEN PEROXIDE single term (MeSH)
#16. MAFENIDE single term (MeSH)
#17. OXYQUINOLINE single term (MeSH)
#18. (antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)
#19. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or (cadexomer next iodine) or betadine or iodoflex)
#20. (eusol or (dakins next solution*) or (edinburgh next university next solution next lime) or hypochlorite* or (hydrogen next peroxide*) or mafenide)
#21. dermablend
#22. ((skin next substitute*) or apligraft* or oxyquinoline)
#23. (acticoat or aquacell or contreet or (nanocrystalline next silver) or (ionic next silver))
#24. ((silver next nitrate) or (silver next sulphadiazine) or actisorb or aquacel or avance or (silver next sulfadiazine) or flamazine or (silver next based))
#25. (#8 or #9 or #10 or #11 or #12 or #13 or #14 or #15)
#26. (#16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25)
#27. (#7 and #26) (2000 to current date)

AMED strategy (OVID interface)

1. exp clinical trials/
2. exp research design/ or double blind method/ or random allocation/
3. clinical trial.pt.
4. clin$ trial$.tw.

5. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
6. placebo$.tw.
7. placebos/
8. random$.tw.
9. (control$ or prospectiv$ or volunteer$).tw.
10. ((study or studies) adj1 design$).tw.
11. or/1-10
12. limit 11 to english language
13. skin ulcer/ or decubitus ulcer/
14. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
15. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
16. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
17. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
18. or/13-17
19. 18 not (commentary or editorial or notes or letter).pt.
20. (antiseptic$ or anti-septic$ or antibiotic$ or anti-biotic$ or antimicrobial$ or anti-microbial$ or antibacterial$ or anti-bacterial$).tw.
21. (iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex).tw.
22. (eusol or dakins solution$ or edinburgh university solution of lime or hypochlorite$ or hydrogen peroxide$ or mafenide or dermablend or oxyquinoline or A&D ointment$).tw.
23. (skin substitute$ or apligraft$).tw.
24. (acticoat or aquacell or contreet or nanocrystalline silver or ionic silver or silver nitrate or silver sulphadiazine or actisorb or aquacel or avance or silver sulfadiazine or flamazine or silver based).tw.
25. antiinfective agents/ or antibiotics/ or antifungal agents/
26. iodine/
27. hydrogen peroxide/
28. or/20-27
29. 12 and 19 and 28
30. limit 29 to yr=2000-2004

Health Management Information Consortium (OVID interface)

#7 (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))) or (((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based)))) and ((PY:HMIC = 2000-2004) or (PY:HQ = 1999-2010))
#6 (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))) or (((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based))))

#5 ((antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))) or (((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based)))
#4 ((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based))
#3 (antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))
#2 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)
#1 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)

SIGLE strategy (SilverPlatter interface)

#6 (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))) or (((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based))))
#5 ((antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))) or (((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based)))
#4 ((skin substitute*) or apligraft*)or(acticoat or aquacell or contreet or (nanocrystalline silver) or (ionic silver) or (silver nitrate) or (silver sulphadiazine) or actisorb or aquacel or avance or (silver sulfadiazine) or flamazine or (silver based))
#3 (antiseptic* or anti-septic* or antibiotic* or anti-biotic* or antimicrobial* or anti-microbial* or antibacterial* or anti-bacterial*)or(iodine or inadine or iodosorb or povidone-iodine or chlorehexidine or cadexomer iodine or betadine or iodoflex)or(eusol or (dakins solution*) or (edinburgh university solution of lime) or hypochlorite* or (hydrogen peroxide*) or mafenide or dermablend or oxyquinoline or (A&D ointment*))
#2 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)
#1 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)

Clinical effectiveness search strategies for Question J

Medline & Medline In-Process Citations strategy (OVID interface)

1 Skin Ulcer/
2. decubitus ulcer/
3. (decubitus or decubital or skin breakdown$).tw.
4. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
5. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=ti, ab, rw, sh]
7. or/1-6
8. limit 7 to english language
9. animal/
10. human/
11. 9 not (9 and 10)
12. 8 not 11 not (letter or editorial or comment).pt.
13. BEDS/is, nu [Instrumentation, Nursing]
14. "Bedding and Linens"/
15. Protective Support surfaces/ or posture/ or head-down tilt/ or prone position/ or supine position/
16. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=ti, ab, rw, sh]
17. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=ti, ab, rw, sh]
18. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=ti, ab, rw, sh]
19. (support$ pillow$ or film$).mp. [mp=ti, ab, rw, sh]
20. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=ti, ab, rw, sh]
21. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=ti, ab, rw, sh]
22. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=ti, ab, rw, sh]
23. (turning adj1 (bed$ or frame$)).mp. [mp=ti, ab, rw, sh]
24. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=ti, ab, rw, sh]
25. or/13-24
26. 12 and 25
27. limit 26 to yr=2002-2004

Embase strategy (OVID interface)

1. Skin Ulcer/
2. Decubitus/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
7. or/1-6
8. limit 7 to english language
9. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
10. exp ANIMAL/
11. Animal Experiment/
12. Nonhuman/
13. Human/
14. Human Experiment/
15. or/9-12
16. 13 or 14

17. 15 not (15 and 16)
18. 8 not 17
19. 18 not (editorial or letter or note).pt.
20. limit 19 to yr=2002-2004
21. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
22. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
23. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
24. (support$ pillow$ or film$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
25. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
26. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
27. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
28. (turning adj1 (bed$ or frame$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
29. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
30. bed/ or fluidized bed/ or hospital bed/
31. protective equipment/ or body position/ or body posture/ or recumbency/ or sitting/ or standing/ or supine position/ or head position/
32. or/21-31
33. 20 and 32

Cinahl strategy (OVID interface)

1 . skin ulcer/ or pressure ulcer/
2. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
3. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
4. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
6. or/1-5
7. limit 6 to english
8. 7 not (editorial or letter or anecdote or commentary).pt.
9. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
10. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
11. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
12. (support$ pillow$ or film$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
13. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
14. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
15. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=title, cinahl subject headings,

abstract, instrumentation]
16. (turning adj1 (bed$ or frame$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
17. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
18. "bedding and linens"/ or "beds and mattresses"/ or cribs/ or flotation beds/ or "pillows and cushions"/
19. Protective Support surfaces/ or patient positioning/ or prone position/ or supine position/
20. or/9-19
21. 8 and 20
22. limit 21 to yr=2002-2003

British Nursing Index strategy (OVID interface)

1. pressure ulcers/
2. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
4. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
6. or/1-5
7. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=heading words, title]
8. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=heading words, title]
9. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=heading words, title]
10. patients positioning/ or (support$ pillow$ or film$).mp. [mp=heading words, title]
11. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=heading words, title]
12. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=heading words, title]
13. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=heading words, title]
14. (turning adj1 (bed$ or frame$)).mp. [mp=heading words, title]
15. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=heading words, title]
16. or/7-15
17. 6 and 16
18. limit 17 to yr=2002-2003

Cochrane Library strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. BEDS single term (MeSH)
#9. BEDDING AND LINENS single term (MeSH)
#10. PROTECTIVE SUPPORT SURFACES single term (MeSH)
#11. posture
#12. POSTURE single term (MeSH)
#13. HEAD-DOWN TILT single term (MeSH)
#14. PRONE POSITION single term (MeSH)
#15. SUPINE POSITION single term (MeSH)
#16. ((pressure next relie*) or pressure-relie* or (pressure next reduc*) or pressure-reduc*)
#17. (bed or beds or bedding or mattress* or couch* or cot or cots or crib or cribs or cradle or cradles or bolster* or cushion*)
#18. ((pressure near overlay*) or (pressure near over-lay*) or (decubit* near overlay*) or (decubit* near over-lay*) or (bedulcer* near overlay*) or (bedulcer* near over-lay*))

#19. ((support* next pillow*) or film*)
#20. (pillow* or (foam next wedge*) or (foam next block*) or gelpad* or (gel next pad*) or gel-pad* or (gell next pad*) or gellpad* or gell-pad*)
#21. ((air next support*) or air-support* or air-fluidised or air-fluidised or (air next fluidized) or air-fluidized or (support next surface*) or support-surface*)
#22. (sheepskin* or sheep-skin* or (alternat* next pressure*))
#23. ((turning next bed*) or (turning next frame*))
#24. ((limb* next protect*) or (limb* next guard*) or (limb* next defend*) or (limb* next defenc*) or (limb* next shield*) or (limb* next rest*))
#25. (#8 or #9 or #10 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24)
#26. (#7 and #25)
#27. (#7 and #25) (2002 to current date)

DARE strategy (internal CRD Cairs interface)

19. S decubitus or decubital or skin breakdown$
20. S (bedulcer$ or bed(w1)ulcer$)
21. S (pressure or bed)(w3)ulcer$
22. S (pressure)(w3)(ulcer$ or wound$ or damag$ or injur$)
23. S s1 or s2 or s3 or s4
24. s pressure(w)relie$ or pressure(w)reduc$
25. s (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$)
26. s (pressure or decubit$ or bedulcer$ or bed(w1)ulcer$)(w10)(overlay$ or over(w1)lay$) s support$(w)pillow$ or film$ or pillow$ or foam(w)wedge$ or foam(w)block$ or gelpad$ or gel(w)pad$ or gell(w)pad$ or gellpad$
27. s air(w)support$ or air(w)fluidised or air(w)fluidized or support(w)surface$
28. s sheepskin$ or sheep(w)skin$ or alternat$(w)pressure$
29. s turning(w1)(bed$ or frame$)
30. s limb$(w1)(protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)
31. s s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13
32. s s5 and s14
33. s (French or spanish or italian or dutch or german or russian)/lan
34. s s15 andnot s16
35. s 2002:2003/dat
36. s s17 and s18

AMED strategy (OVID interface)

1 . skin ulcer/ or decubitus ulcer/
2. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
3. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
4. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
5. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
6. or/1-5
7. limit 6 to english language
8. 7 not (commentary or editorial or notes or letter).pt.
9. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=abstract, heading words, title]
10. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=abstract, heading words, title]
11. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=abstract, heading words, title]
12. (support$ pillow$ or film$).mp. [mp=abstract, heading words, title]
13. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=abstract, heading words, title]
14. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=abstract, heading words, title]
15. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=abstract, heading words, title]
16. (turning adj1 (bed$ or frame$)).mp. [mp=abstract, heading words, title]

17. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=abstract, heading words, title]
18. protective support surfaces/ or pronation/ or range of motion/ or rotation/ or posture/ or head down tilt/ or prone position/ or supine position/ or sitting/
19. or/9-18
20. limit 19 to yr=2002-2003
21. 8 and 20

Health Management Information Consortium (OVID interface)

1. pressure ulcers/
2. skin ulcers/
3. (decubitus or decubital or skin breakdown$).mp. [mp=title, other title, abstract, heading words]
4. (bedulcer$ or bed-ulcer$).mp. [mp=title, other title, abstract, heading words]
5. ((pressure or bed) adj ulcer$).mp. [mp=title, other title, abstract, heading words]
6. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, other title, abstract, heading words]
7. or/1-6
8. (pressure relie$ or pressure-relie$ or pressure reduc$ or pressure-reduc$).mp. [mp=title, other title, abstract, heading words]
9. (bed or beds or bedding or mattress$ or couch$ or cot or cots or crib or cribs or cradle or cradles or bolster$ or cushion$).mp. [mp=title, other title, abstract, heading words]
10. ((pressure or decubit$ or bedulcer$ or bed?ulcer$) adj10 (overlay$ or over-lay$ or over lay$)).mp. [mp=title, other title, abstract, heading words]
11. (support$ pillow$ or film$).mp. [mp=title, other title, abstract, heading words]
12. (pillow$ or foam wedge$ or foam block$ or gelpad$ or gel pad$ or gel-pad$ or gell pad$ or gellpad$ or gell-pad$).mp. [mp=title, other title, abstract, heading words]
13. (air?support$ or air support$ or air?fluidi?ed or air fluidi?ed or support?surface$ or support surface$).mp. [mp=title, other title, abstract, heading words]
14. (sheepskin$ or sheep-skin$ or alternat$ pressure$).mp. [mp=title, other title, abstract, heading words]
15. (turning adj1 (bed$ or frame$)).mp. [mp=title, other title, abstract, heading words]
16. (limb$ adj1 (protect$ or guard$ or defend$ or defenc$ or shield$ or rest$)).mp. [mp=title, other title, abstract, heading words]
17. beds/ or adjustable beds/ or bed cradles/ or cots/ or fluidised beds/ or hospital beds/ or light duty beds/ or non adjustable beds/ or roto rest beds/ or water beds/ or back rests/ or bed aids/ or bed blocks/ or bed centres/ or bed frames/ or bed lifts/ or bed rails/ or bed spaces/ or bedding/ or bedside fittings/ or couches/ or hospital equipment/
18. turning frames/ or patient handling/ or pressure ulcer underpads/ or fleeces/ or bedding/ or pressure area care.mp. [mp=title, other title, abstract, heading words]
19. patient positioning equipment/ or mattresses/ or bedding/ or foam mattresses/ or ripple mattresses/ or sheepskin mattresses/ or water mattresses/
20. or/8-19
21. 7 and 20
22. limit 21 to yr=2002-2005

National Research Register (Issue 3:2003) (cd-rom)

21. (SKIN-ULCER:ME or DECUBITUS-ULCER:ME)
22. ((DECUBITUS or DECUBITAL) OR (SKIN next BREAKDOWN*))
23. (BEDULCER* or BED-ULCER*)
24. ((PRESSURE near ULCER*) or (BED near ULCER*))
25. ((((PRESSURE next ULCER*) or (PRESSURE next WOUND*)) OR (PRESSURE NEXT DAMAG*)) OR (PRESSURE NEXT INJUR*))
26. ((((#1 or #2) or #3) or #4) or #5)
27. ((BEDS:ME or BEDS-AND-LINENS:ME) or PROTECTIVE-SUPPORT SURFACES:ME)
28. ((POSTURE or POSTURE:ME) or HEAD-DOWN-TILT:ME)
29. (PRONE-POSITION:ME or SUPINE-POSITION:ME)
30. ((((PRESSURE next RELIE*) or PRESSURE-RELIE*) OR (PRESSURE NEXT REDUC*)) OR PRESSURE-REDUC*)

31. ((((((((((BED or BEDS) or BEDDING) or MATTRESS*) or COUCH*) or COT) or COTS) or CRIB) or CRIBS) or CRADLE) or CRADLES) or BOLSTER*) or CUSHION*)
32. ((((((PRESSURE next OVERLAY*) OR (PRESSURE near OVER-LAY*)) OR (DECUBIT* NEAR OVERLAY*)) OR (DECUBIT* NEAR OVER-LAY*)) OR (BEDULCER* NEAR OVERLAY*)) OR (BEDULCER NEAR OVER-LAY*))
33. ((SUPPORT* next PILLOW*) or FILM*)
34. ((((((((PILLOW* or (FOAM next WEDGE*)) OR (FOAM NEXT BLOCK*)) OR GELPAD*) OR (GEL NEXT PAD*)) OR GEL-PAD*) OR (GELL NEXT PAD*)) OR GELLPAD*) OR GELL-PAD*)
35. (((((((AIR next SUPPORT*) or AIR-SUPPORT*) OR AIR-FLUIDISED) OR (AIR NEXT FLUIDIZED)) OR AIR-FLUIDIZED) OR (SUPPORT NEXT SURFACE*)) OR SUPPORT-SURFACE*)
36. ((SHEEPSKIN* or SHEEP-SKIN*) OR (ALTERNAT* next PRESSURE*)) ((TURNING next BED*) or (TURNING next FRAME*))
37. ((((((LIMB* next PROTECT*) or (LIMB* next GUARD*)) OR (LIMB* NEXT DEFEND*)) OR (LIMB NEXT DEFENC*)) OR (LIMB* NEXT SHIELD*)) OR (LIMB NEXT REST*))
38. (((((((((#8 or #9) or #10) or #11) or #12) or #13) or #14) or #15) or #16) or #17)
39. ((#18 or #19) or #21)
40. (#7 and #22)
41.

Clinical effectiveness search strategies for Question I

Medline & Medline In-Process Citations strategy (OVID interface)

1. randomized controlled trial.pt.
2. exp randomized controlled trials/
3. random allocation/
4. double blind method/
5. single blind method/
6. clinical trial.pt.
7. exp clinical trials/
8. controlled clinical trials/
9. clin$ trial$.ti,ab.
10. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
11. placebo$.ti,ab.
12. placebos/
13. random$.ti,ab.
14. exp evaluation studies/
15. follow up studies/
16. exp research design/
17. prospective studies/
18. (control$ or prospectiv$ or volunteer$).ti,ab.
19. or/1-18
20. animal/
21. human/
22. 20 not (20 and 21)
23. 19 not 22
24. limit 23 to english language
25. 24 not (comment or letter or editorial).pt.
26. Skin Ulcer/
27. decubitus ulcer/
28. (decubitus or decubital or skin breakdown$).tw.
29. (bedulcer$ or bed-ulcer$).mp. [mp=ti, ab, rw, sh]
30. ((pressure or bed) adj ulcer$).mp. [mp=ti, ab, rw, sh]
31. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=ti, ab, rw, sh]
32. or/26-31
33. debridement/mt and (surg$ or sharp or scalpel or blade$ or scissor$).mp.
34. Surgery/
35. surgical$ debrid$.mp. [mp=ti, ab, rw, sh]

36. (surgical$ adj1 (interven$ or method$ or excis$ or remov$ or treatment$ or therap$ or manag$ or drainage)).mp.
37. surgical$ technique$.mp. [mp=ti, ab, rw, sh]
38. (debrid$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
39. (excis$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
40. ofd.ti,ab.
41. (openflap debrid$ or open flap debrid$).mp.
42. skin graft.ti.
43. Decubitus Ulcer/su [Surgery]
44. Bone Transplantation/
45. SKIN TRANSPLANTATION/
46. surgical flaps/
47. ((skin or bone) adj1 (graft$ or transplant$)).tw.
48. ((skin or tissue$ or muscle$ or bone$) adj1 (excis$ or debrid$ or remov$)).tw.
49. or/33-48
50. 25 and 32 and 49

Embase strategy (OVID interface)

1. randomized controlled trial/
2. randomization/
3. double blind procedure/ or single blind procedure/
4. exp clinical trial/
5. controlled study/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. Placebo/
10. random$.ti,ab.
11. evaluation/
12. follow up/
13. exp methodology/
14. prospective study/
15. (control$ or prospectiv$ or volunteer$).ti,ab.
16. or/1-15
17. limit 16 to english language
18. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab,de.
19. exp ANIMAL/
20. Animal Experiment/
21. Nonhuman/
22. Human/
23. Human Experiment/
24. or/18-21
25. 22 or 23
26. 24 not (24 and 25)
27. 17 not 26
28. 27 not (editorial or letter or note).pt.
29. Skin Ulcer/
30. Decubitus/
31. (decubitus or decubital or skin breakdown$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
32. (bedulcer$ or bed-ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
33. ((pressure or bed) adj ulcer$).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
34. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, abstract, subject headings, drug trade name, original title, support surface manufacturer, drug manufacturer name]
35. or/29-34
36. debridement/ and (surg$ or sharp or scalpel or blade$ or scissor$).mp.
37. surgery/

38. surgical$ debrid$.mp.
39. (surgical$ adj1 (interven$ or method$ or excis$ or remov$ or treatment$ or therap$ or manag$ or drainage)).mp.
40. surgical$ technique$.mp.
41. (debrid$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
42. (excis$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
43. ofd.ti,ab.
44. Decubitus/su [Surgery]
45. exp bone transplantation/
46. exp skin graft/
47. exp skin flap/
48. ((skin or bone) adj1 (graft$ or transplant$)).tw.
49. ((skin or tissue$ or muscle$ or bone$) adj1 (excis$ or debrid$ or remov$)).tw.
50. or/36-49
51. 28 and 35 and 50

Cinahl strategy (OVID interface)

1. clinical trial.pt.
2. Random Assignment/
3. double-blind studies/
4. single-blind studies/
5. exp clinical trials/
6. clin$ trial$.ti,ab.
7. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).ti,ab.
8. placebo$.ti,ab.
9. placebos/ or placebo effect/
10. random$.ti,ab.
11. Evaluation Research/
12. Prospective Studies/
13. exp Study Design/
14. (control$ or prospectiv$ or volunteer$).ti,ab.
15. or/1-14
16. limit 15 to english
17. 16 not (editorial or letter or anecdote or commentary).pt.
18. skin ulcer/ or pressure ulcer/
19. (decubitus or decubital or skin breakdown$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
20. (bedulcer$ or bed-ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
21. ((pressure or bed) adj ulcer$).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
22. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
23. or/18-22
24. Debridement/mt and (surg$ or sharp or scalpel or blade$ or scissor$).mp.
25. Surgery, Operative/
26. surgical$ debrid$.mp.
27. (surgical$ adj1 (interven$ or method$ or excis$ or remov$ or treatment$ or therap$ or manag$ or drainage)).mp.
28. surgical$ technique$.mp.
29. (debrid$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
30. (excis$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
31. ofd.ti,ab.
32. Pressure Ulcer/su [Surgery]
33. Bone Transplantation/
34. Skin Transplantation/
35. Surgical Flaps/
36. ((skin or bone) adj1 (graft$ or transplant$)).tw.
37. ((skin or tissue$ or muscle$ or bone$) adj1 (excis$ or debrid$ or remov$)).tw.
38. or/24-37
39. 17 and 23 and 38

British Nursing Index strategy (OVID interface)

1. exp research methods/
2. clin$ trial$.tw.
3. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
4. placebo$.tw.
5. random$.tw.
6. (control$ or prospectiv$ or volunteer$).tw.
7. ((study or studies) adj1 design$).tw.
8. or/1-7
9. pressure ulcers/
10. (decubitus or decubital or skin breakdown$).mp. [mp=heading words, title]
11. (bedulcer$ or bed-ulcer$).mp. [mp=heading words, title]
12. ((pressure or bed) adj ulcer$).mp. [mp=heading words, title]
13. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=heading words, title]
14. or/9-13
15. (debrid$ and (surg$ or sharp or scalpel or blade$ or scissor$)).mp.
16. surgical$ debrid$.mp.
17. (surgical$ adj1 (interven$ or method$ or excis$ or remov$ or treatment$ or therap$ or manag$ or drainage)).mp.
18. surgical$ technique$.mp.
19. (debrid$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
20. (excis$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
21. ofd.ti.
22. ((skin or bone) adj1 (graft$ or transplant$)).tw.
23. ((skin or tissue$ or muscle$ or bone$) adj1 (excis$ or debrid$ or remov$)).tw.
24. ((surgical or skin) adj1 (flap or flaps)).mp.
25. surgery operative/
26. plastic surgery/
27. or/15-26
28. 8 and 14 and 27

Cochrane Controlled Trials Register strategy (internet interface)

#1. SKIN ULCER single term (MeSH)
#2. DECUBITUS ULCER single term (MeSH)
#3. (decubitus or decubital or (skin next breakdown*))
#4. (bedulcer* or bed-ulcer*)
#5. ((pressure near ulcer*) or (bed near ulcer*))
#6. ((pressure next ulcer*) or (pressure next wound*) or (pressure next damag*) or (pressure next injur*))
#7. (#1 or #2 or #3 or #4 or #5 or #6)
#8. (surg* or sharp or scalpel or blade* or scissor*)
#9. DEBRIDEMENT [mt] single term (MeSH)
#10. (#8 and #9)
#11. SURGERY single term (MeSH)
#12. (surgical* next debrid*)
#13. ((surgical* next interven*) or (surgical* next method*) or (surgical* next excis*))
#14. ((surgical* next remov*) or (surgical* next therapy) or (surgical* next therapies) or (surgical* next manag*) or (surgical* next drainage))
#15. ((surgical* next treatments) or (surgical* next treatment))
#16. ((surgical* next technique*) or (openflap next debrid*) or (open next flap next debrid*))
#17. (ofd:ti or ofd:ab or (skin next graft*) or (skin next transplant*) or (bone next graft*) or (bone next transplant*))
#18. ((skin next excis*) or (skin next debrid*) or (skin next remov*) or (tissue* next excis*))
#19. ((tissue* next debrid*) or (tissue* next remov*) or (muscle* next excis*) or (muscle* next debrid*))
#20. ((muscle* next remov*) or (bone* next excis*) or (bone* next debrid*) or (bone* next remov*))
#21. ((debrid* near instrument*) or (debrid* near sharp) or (debrid* near sharps))
#22. ((debrid* near scalpel) or (debrid* near scissors) or (debrid* near blade*))
#23. ((excis* near instrument*) or (excis* near sharp) or (excis* near sharps))

#24. ((excis* near scalpel) or (excis* near scissors) or (excis* near blade*))
#25. DECUBITUS ULCER [su] single term (MeSH)
#26. BONE TRANSPLANTATION single term (MeSH)
#27. SKIN TRANSPLANTATION single term (MeSH)
#28. SURGICAL FLAPS single term (MeSH)
#29. (#10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20)
#30. (#21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29)
#31. (#7 and #30)

AMED strategy (OVID interface)

1. exp clinical trials/
2. exp research design/ or double blind method/ or random allocation/
3. clinical trial.pt.
4. clin$ trial$.tw.
5. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
6. placebo$.tw.
7. placebos/
8. random$.tw.
9. (control$ or prospectiv$ or volunteer$).tw.
10. ((study or studies) adj1 design$).tw.
11. or/1-10
12. limit 11 to english language
13. (comment or commentary or editorial or letter).pt.
14. 12 not 13
15. skin ulcer/ or decubitus ulcer/
16. (decubitis or decubital or skin breakdown$).mp. [mp=abstract, heading words, title]
17. (bedulcer$ or bed-ulcer$).mp. [mp=abstract, heading words, title]
18. ((bed or pressure) adj ulcer$).mp. [mp=abstract, heading words, title]
19. (pressure adj (ulcer$ or wound$ or damag$ or injur$)).mp. [mp=abstract, heading words, title]
20. or/15-19
21. surgery/
22. (debrid$ and (surg$ or scalpel$ or sharp or blade$ or scissor$)).mp.
23. surgical$ debrid$.mp.
24. (surgical$ adj1 (interven$ or method$ or excis$ or remov$ or treatment$ or therap$ or manag$ or drainage)).mp.
25. surgical$ technique$.mp.
26. (debrid$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
27. (excis$ adj2 (instrument$ or sharp or sharps or scalpel or scissors or blade$)).mp.
28. ofd.ti,ab.
29. ((skin or bone) adj1 (graft$ or transplant$)).tw.
30. ((skin or tissue$ or muscle$ or bone$) adj1 (excis$ or debrid$ or remov$)).tw.
31. ((surgical or skin) adj1 (flap or flaps)).mp.
32. or/21-31
33. 12 and 20 and 32

Health Management Information Consortium (OVID interface)

#8 (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((surgical or skin) near1 (flap or flaps)) or (((debrid* or excis*) near2 (instrument* or sharp or sharps or scalpel or scissors or blade*))or((skin or bone) near1 (graft* or transplant*))or((skin or tissue* or muscle* or bone*) near1 (excis* or debrid* or remov*))) or (surgical* near1 (interven* or method* or excis* or remov* or treatment* or therap* or manag* or drainage)) or ((debrid* and (surg* or scalpel* or sharp or blade* or scissor*))or((surgical* debrid*) or (surgical* technique*) or ofd)))
#7 ((surgical or skin) near1 (flap or flaps)) or (((debrid* or excis*) near2 (instrument* or sharp or sharps or scalpel or scissors or blade*))or((skin or bone) near1 (graft* or transplant*))or(

(skin or tissue* or muscle* or bone*) near1 (excis* or debrid* or remov*))) or (surgical* near1 (interven* or method* or excis* or remov* or treatment* or therap* or manag* or drainage)) or ((debrid* and (surg* or scalpel* or sharp or blade* or scissor*))or((surgical* debrid*) or (surgical* technique*) or ofd))
#6 (surgical or skin) near1 (flap or flaps)
#5 ((debrid* or excis*) near2 (instrument* or sharp or sharps or scalpel or scissors or blade*))or((skin or bone) near1 (graft* or transplant*))or((skin or tissue* or muscle* or bone*) near1 (excis* or debrid* or remov*))
#4 surgical* near1 (interven* or method* or excis* or remov* or treatment* or therap* or manag* or drainage)
#3 (debrid* and (surg* or scalpel* or sharp or blade* or scissor*))or((surgical* debrid*) or (surgical* technique*) or ofd)
#2 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)
#1 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)

SINGLE strategy (SilverPlatter interface)

#8 (((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)) and (((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)) and (((surgical or skin) near1 (flap or flaps)) or (((debrid* or excis*) near2 (instrument* or sharp or sharps or scalpel or scissors or blade*))or((skin or bone) near1 (graft* or transplant*))or((skin or tissue* or muscle* or bone*) near1 (excis* or debrid* or remov*))) or (surgical* near1 (interven* or method* or excis* or remov* or treatment* or therap* or manag* or drainage)) or ((debrid* and (surg* or scalpel* or sharp or blade* or scissor*))or((surgical* debrid*) or (surgical* technique*) or ofd)))
#7 ((surgical or skin) near1 (flap or flaps)) or (((debrid* or excis*) near2 (instrument* or sharp or sharps or scalpel or scissors or blade*))or((skin or bone) near1 (graft* or transplant*))or((skin or tissue* or muscle* or bone*) near1 (excis* or debrid* or remov*))) or (surgical* near1 (interven* or method* or excis* or remov* or treatment* or therap* or manag* or drainage)) or ((debrid* and (surg* or scalpel* or sharp or blade* or scissor*))or((surgical* debrid*) or (surgical* technique*) or ofd))
#6 (surgical or skin) near1 (flap or flaps)
#5 ((debrid* or excis*) near2 (instrument* or sharp or sharps or scalpel or scissors or blade*))or((skin or bone) near1 (graft* or transplant*))or((skin or tissue* or muscle* or bone*) near1 (excis* or debrid* or remov*))
#4 surgical* near1 (interven* or method* or excis* or remov* or treatment* or therap* or manag* or drainage)
#3 (debrid* and (surg* or scalpel* or sharp or blade* or scissor*))or((surgical* debrid*) or (surgical* technique*) or ofd)
#2 ((singl* or doubl* or trebl* or tripl*) near3 (blind* or mask*))or((clinic* trial*) or placebo* or random* or (control* or prospectiv* or volunteer*))or((study or studies) near design*)
#1 ((pressure near2 (ulcer* or wound* or damag* or injur*)) in ti, ab, de) or (((decubitus or decubital or skin breakdown*) in ti, ab, de)or((bedulcer* or bed-ulcer*) in ti, ab, de)or(((pressure or bed) near2 ulcer*) in ti, ab, de)) or (PRESSURE-ULCERS in DE)

Appendix C Quality assessment A – I

TABLE A: *Quality assessment of systematic reviews for pressure sores*

	Was an adequate search strategy used?	**Were the inclusion criteria appropriate and applied in an unbiased way?**	**Was a quality assessment of included studies undertaken?**	**Were the characteristics and results of the individual studies appropriately summarised?**	**Were data pooling methods appropriate?**	**Were sources of heterogeneity explored?**	Total score/6
Bradley 1999	✓	✓	✓	✓	✓	✓	6
Bradley 1999	✓	✓	✓	✓	✓	✓	6
Cullum 2001	✓	✓	✓	✓	✓	✓	6
Evans 2001	✓	✓	✓	✓	✓	✓	6
Flemming 2000	✓	✓	✓	✓	✓	✓	6
Flemming 2000a	✓	✓	✓	✓	✓	✓	6
Flemming 2001	✓	✓	✓	✓	✓	✓	6
Langer 2003	✓	✓	✓	✓	✓	✓	6
O'meara 2001	✓	✓	✓	✓	✓	✓	6

Yes = ✓ , No = × = not clear

TABLE B: *Quality assessment of cohorts' pressure sores*

	1. Study Design	2. Sample selection	3. Participation	4. Inception	5. Exposure status	6.Comparability	7. Outcome status	8. Blind assessment	9. Follow up period	10.Final analysis
Allman 1995	a	a	b	a	b,c,d	×	c	c	a	b
Reed 2003	a	b	c	c	c	×	b	b	a	b
Williams 2000	a	b	c	a	b,c,d	?	b	b	a	a

× = Not reported or unclear
† For full description of quality criterion see Appendix E

TABLE C: *Quality assessment of studies for ulcer assessment*

	1. Is an appropriate test being evaluated?	**2. Is the incremental value of the test being compared to other routine tests?**	**3. Were patients selected consecutively?**	**4. Is the decision to perform the reference standard independent of the test result?**	**5. Was there a valid reference standard?**	**6. Are the tests and reference standard measured independently?**	**7. Are tests measured independent of other clinical and test information?**	**8. If test has been compared has this been done independently?**	9. Was the test valid in a second, independent group of patients?	Is the test available, affordable, accurate and precise in setting?
Cutler 1993	✓	✓	*	×	*	*	*	*	*	✓
Griffin 1993	✓	✓	*	×	*	*	*	*	*	✓
Houghton 2000	✓	✓	*	×	*	*	*	*	*	✓
Shubert	✓	✓	*	×	✓		*	*	*	✓
Plassmann	✓	✓	*	×	*	*	*	*	*	✓

✓ = Yes, × = No, * Not reported or unclear

† For full description of quality criterion see Appendix E

TABLE D: *Quality assessment of RCTs of support surfaces for treatment of pressure sores*

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated, adequate allocation concealment	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Allman 1987	✓	72 [2]	✓	✓	✓c	✓	✓b	×
Caley 1994	×	55 [2]	×	×	✓	×	✓b	×
Clark 1999	×	33 [2]	×	×	✓c	×	✓a	×
Day 1993	✓	83 [2]	✓	✓	✓c	×	✓a	×
Devine 1995	✓	41 [2]	×	✓	✓c	×	✓a	×
Evans 2000	✓	32 [2]	✓ (not achieved)	✓	✓c	✓	✓a	✓
Ewing 1964	✓	36 [2]	×	×	×	×	×	×
Ferrell 1993	✓	84 [2]	✓	✓	✓c	×	✓a	✓
Keogh 2001	✓	100 [2]	✓	✓	✓	×	✓b	✓
Groen 1999	✓	120 [2]	✓	✓	✓c	×	✓a	×
Mulder 1994	✓	49 [2]	×	×	×	×	✓b	×
Munro 1989	✓	40 [2]	×	×	✓c	×	×	×
Russell 2000	✓	112 [2]	✓	×	✓	×	✓b	✓
Russell 2003	✓	158 [2]	✓	✓	✓	✓	✓	×
Strauss 1991	✓	112 [2]	×	×	✓	✓	✓a	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals)
* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† Withdrawals: ✓a = reported by group and with reason; ✓b = withdrawals but not reported by group or reason not given; × = withdrawals not reported

TABLE E: *Quality assessment of RCTs of dressings and topical applications for treatment of pressure sores*

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Brod 1990 [	✓	43 [2]	×	×	✓c	×	✓a	×
Collwell 1993	✓	70 [2]	×	×	✓c	×	✓a	×
Barrios 1993 Huchon 1992	✓	76 [2]	×	×	✓c	×	✓a	×
Bale 1998a	×	100 [2]	×	×	✓	×	✓a	×
Banks 1996	✓	98 [2]	×	×	✓c	×	N//A	N/A
Brown-Etris 1996	✓	121 [2]	×	×	✓	✓	✓b	×
Alm 1989	×	50 [2]	×	×	✓c	✓	✓b	×
Honde 1994	✓	168 [2]	×	✓	✓c	×	✓a	×
Banks 1994b	✓	40 [2]	×	✓	✓c	×	✓a	×
Banks 1994a	✓	29 [2]	×	×	✓c	×	✓a	×
Banks 1994c	✓	50 [2]	×	✓	✓c	×	✓b	×
Kraft 1993	✓	38 [2]	×	×	✓	×	✓a	✓
Xakellis 1992	✓	39 [2]	×	×	✓c	×	✓a	✓

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Sebern 1986 [37, 38]	✓	200 [2]	×	✓	✓c	×	✓b	×
van Ort 1976	✓	14 [2]	×	✓	✓	×	N/A	N/A
Mustoe 1994	✓	41 [3]	×	×	✓c	✓	✓a	×
Robson 1992b	✓	20 [4]	×	×	✓c	✓	N/A	N/A
Robson 1992a	✓	50 [3]	×	×	✓c	✓	✓a	×
Robson 1994	✓	26 [4]	×	×	×	×	✓b	×
Le Vassueur 1991	×	21 [2]	×	×	✓c	×	N/A	N/A
Palmieri 1992	✓	48 [2]	×	×	✓	×	N/A	N/A
Darkovitch 1990	✓	90 patients 129 wounds [2]	×	×	✓c	×	✓a	×

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Mulder 1993	✓	67 [3]	×	✓	✓	×	✓b	×
Sayag 1996	✓	92 [2]	✓	✓	✓c	×	✓a	✓
Lee 1975	✓	28 [2]	×	×	✓	×	✓a	×
Rees 1999	✓	124 [4]	×	×	✓c	×	×	✓
Robson 2000	✓	61 [4]	×	×	✓c	×	✓a	✓
Landi 2003	✓	38 [2]	×	✓	✓c	✓	✓a	×
Burgos 2000a	✓	92 [2]	×	×	✓	×	✓a	×
Pullen 2002	✓	135 [2]	✓	×	✓c	✓	✓a	×
Alvarez 2002	✓	28 [2]	×	✓	✓c	×	✓a	×
Parish 1979(a, b)	×	12 patients 25 wounds [2]	×	×	✓c	×	N/A	N/A

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Colin 1996	✓	135 [2]	✓	×	✓c	×	✓a	✓
Thomas 1993	✓	40 [2]	×	✓	✓c	×	✓a	×
Ljungberg 1998	✓	23 patients 30 wounds [2]	×	×	✓	×	×	✓
Nasar 1982	✓	18 [2]	×	×	✓	✓	✓a	✓
Moberg 1983	✓	38 [2]	×	×	✓c	✓	✓a	×
Agren 1985	×	28 [2]	×	✓	✓c	×	✓a	✓
Burgos 2000b	✓	37 patients 43 wounds [2]	×	✓	✓	×	✓a	✓
Chang 1998	✓	34 [2]	×	×	✓	×	N/A	N/A
Matzen 1999	✓	32 [2]	×	×	✓	×	✓a	✓
Thomas 1998	✓	41 [2]	×	×	✓c	×	✓a	×
Kloth 2002	✓	53 patients 56 wounds [2]	×	✓	✓c	×	✓b	×
Whitney 2001	✓	29 [2]	×	×	✓c	×	✓a	✓
Belmin 2002	✓	110 [2]	✓	×	✓c	×	✓a	✓
Banks 1997	✓	20 [2]	×	✓	✓	×	✓a	×
Seeley 1999	✓	40 [2]	×	✓	✓c	×	✓a	×

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Thomas 1997	✓	99 [2]	×	✓	✓	×	N/A	N/A
Bale 1997	✓	61 [2]	×	✓	✓c	×	✓a	✓
Seaman 2000	✓	35 [2]	×	✓	✓c	×	✓b	✓
Graumlich 2003	✓	65 [2]	✓	✓	✓c	✓	✓a	✓
Meaume 2003	✓	38 [2]	×	✓	✓c	×	N/A	N/A
Bale 1998b	✓	50 [2]	×	✓	✓c	✓	✓a	×
Price 2000	✓	58 [2]	×	✓	✓c	×	✓a	×
Ritz 2002	✓	49 [2]	×	×	✓c	✓	×	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals)
* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† Withdrawals: ✓a = reported by group and with reason; ✓b = withdrawals but not reported by group or reason not given; × = withdrawals not reported

TABLE F: *Quality assessment of RCTs of antimicrobials for the treatment of pressure sores*

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated, adequate allocation concealment	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Della Marchina, 1997	✓	40[2]	×	×	✓	×	×	×
Gerding, 1992	✓	1102[2]	×	×	✓	×	×	×
Huchon, 1992	✓	76[2]	×	×	✓	×	×	×
Toba, 1997	✓	19[2]	×	✓	✓	×	×	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals)

* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† Withdrawals: ✓a = reported by group and with reason; ✓b = withdrawals but not reported by group or reason not given; × = withdrawals not reported

TABLE G: *Quality assessment of RCTs of adjunct therapies for the treatment of pressure sores*

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated, adequate allocation concealment	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Joseph 2000	✓	24 patients 36 wounds [2]	×	×	✓c	✓	×	×
McDiarmid 1985	✓	40 [2]	×	×	✓	✓	✓	×
Nussbaum 1994	✓	20 patients 22 wounds [3]	×	×	✓c	✓	✓a	×
ter Riet 1995	✓	88 [2]	×	✓	×	✓	✓b	✓
Gentzkow 1991	✓	49 [2]	✓	✓	✓c	✓	✓	×
Griffin 1991	✓	17 [2]	×	✓	✓c	×	✓	×
Wood 1993	✓	71 patients 74 wounds [2]	×	✓	✓c	✓	✓	×
Ritz 2002	✓	49 [2]	×	×	✓c	✓	×	×
Comorosan 1993	✓	30 [3]	×	×	✓	✓	✓	
Salzberg 1995	✓	31 [2]	×	✓	✓	✓	✓	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals)

* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† Withdrawals: ✓a = reported by group and with reason; ✓b = withdrawals but not reported by group or reason not given; × = withdrawals not reported

TABLE H: *Quality assessment of RCTs of nutrition for the treatment of pressure sores*

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated, adequate allocation concealment	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Chernoff,1990	✓	12[2]	×	×	✓c	✓	×	×
Norris, 1971	✓	14[2]	×	×	✓	✓	✓	×
Taylor, 1974	✓	20[2]	×	×	✓c	✓	✓	×
Ter Riet	✓	88[2]	×	✓	×	✓	×	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals)

* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† Withdrawals: ✓a = reported by group and with reason; ✓b = withdrawals but not reported by group or reason not given; × = withdrawals not reported

TABLE I: *Quality assessment of RCTs of mobility and positioning for the treatment of pressure sores*

Study	Inclusion and exclusion criteria stated	Overall sample size [arms]	*A priori* sample size calculation?	Randomisation procedure stated, adequate allocation concealment	Appropriate baseline characteristics reported*	Blinded outcome assessment reported	Withdrawals stated†	ITT analysis
Bates-Jensen 2003	✓	190[2]	✓	×	✓c	✓	✓	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals)

* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† Withdrawals: ✓a = reported by group and with reason; ✓b = withdrawals but not reported by group or reason not given; × = withdrawals not reported

TABLE J: *Quality assessment of case series of surgery for treatment of pressure ulcer*

Study	Aims of case series clearly stated	Case series collected in more than one centre (multi-centre trial)	Case definition clearly reported	Explicit statement that patients were recruited consecutively	Prospective data collection	Reporting of confidence intervals or other estimate of random variability	Reporting of mortality/recurrences/complications	> 10 cases	Baseline data for ulcers
Akguner 1998	✓	×	✓	×	✓c	×	✓	✓	✓
Akan 2001	✓	×	✓	×	✓c	×	✓	✓	✓
Bocchi 2002	✓	×	×	×	✓c	×	✓	✓	×
Eshaque 1994	✓	×	✓	×	✓	×	✓a	✓	×
Esposito 1992	✓	×	✓	×	✓	×	✓	✓	×
Forster 1997	?	×	✓	×	✓c	×	✓a	✓	✓
Geoffrey 1994	✓	×	✓	×	×	×	×	✓	×
Hayashi 1998	✓	×	✓	×	✓	×	✓	✓	✓
Hiroyuki 1995	✓	×	✓	×	×	×	✓b	✓	✓
Hovius 1979	✓	×	×	✓	×	×	✓	✓	×
Inoue 1990	✓	×	✓	×	?	×	×	✓	×
Josvay 1998	✓	×	×	×	?	×	✓	✓	×
Klein 1988	✓	×	✓	×	✓	×	✓	✓	×
Little 1982	✓	×	✓	×	✓	×	✓	✓	×

Study	Aims of case series clearly stated	Case series collected in more than one centre (multi-centre trial)	Case definition clearly reported	Explicit statement that patients were recruited consecutively	Prospective data collection	Reporting of confidence intervals or other estimate of random variability	Reporting of mortality/recurrences/complications	> 10 cases	Baseline data for ulcers
Maruyama 1980	✓	×	×	×	✓	×	✓	×	×
Norman 1980	✓	×	✓	×	✓	×	✓	×	✓
Rollin 1982	✓	×	✓	×	✓	×	✓	×	×
Shessel 2001	✓	×	✓	×	✓	×	✓	✓	×
Stevenson 1986	✓	×	✓	×	✓	×	×	✓	×
Tellioglu 1999	✓	×	✓	×	✓	×	×	✓	×
Tizian 1986	✓	×	✓	×	✓	×	✓	✓	×
William 1989	✓	×	✓	×	✓	×	✓	×	×

✓ = Yes; × = No; N/A = Not Appropriate (no withdrawals);? Don't know
* Baseline characteristics: ✓= one or more appropriate characteristics stated (but not initial wound size); ✓c = initial wound size stated
† mortality/recurrence/complications: ✓a = reported by group and with reason; ✓b = not reported by group or reason not given; × = not reported

Table K: Dressings and debridement economic evaluation checklist[1]

	Study number (refers to reference)																				
Study design	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9ab**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20ab**	**21**
The research question is stated	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
The economic importance of the research question is stated	√	√	√	√	X	√	X	√	√	√	X	√	√	X	X	X	√	X	X	√	√
The view point(s) of the analysis are clearly stated and justified	X	√	√	X	X	√	X	√	√	√	X	√	√	X	√	X	X	X	X	X	X
The rationale for choosing the alternative programmes or interventions compared is stated	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
The alternatives being compared are clearly described	√	√	√	√	P	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
The form of economic evaluation is stated	X	X	X	√	√	X	X	X	√	√	X	X	√	X	√	√	√	X	X	X	X
The choice of form of economic evaluation is justified in relation to the questions addressed	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Data collection																					
The source(s) of effectiveness estimates used are stated	√	√	U	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Details of the design and results of effectiveness study are given (if based on single study)	√	√	NA	√	√	√	√	√	NA	NA	√	√	NA	√	√	√	√	√	√	√	√
Details of methods of synthesis or meta-analysis of estimates are given (if based on an overview of a number of effectiveness studies)	NA	NA	U	NA	NA	NA	NA	NA	√	√	NA	NA	√	NA	NA	NA	NA	NA	NA	NA	NA
The primary outcome measure(s) for the economic evaluation are clearly stated	√	√	NA	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√
Methods to value health states and other benefits are stated	√	√	NA	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Details of the subjects from whom valuations were obtained are given	√	√	NA	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√
Productivity changes (if included) are reported separately	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
The relevance of productivity changes to the study question is discussed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Quantities of resources are reported separately from their unit costs	X	√	√	√	X	√	√	X	X	√	√	√	X	√	√	√	X	X	X	X	√
Methods for the estimation of quantities and unit cost are described	√	√	U	√	U	√	X	√	√	√	√	√	√	P	√	X	√	X	X	X	√
Currency and price date are recorded	X	√	√	√	X	X	X	X	X	√	X	X	√	X	√	X	√	X	X	X	√
Details of currency of price adjustments for inflation or currency conversion are given	NA	NA	√	√	NA	NA	NA	NA	NA	NA	NA	√	NA	NA	NA	NA	NA	NA	NA	NA	NA

Details of any model used are given	NA	NA	√	NA	NA	NA	NA	NA	√	√	NA	NA	√	NA	NA	NA	NA	NA	NA	NA	NA
The choice of model used and the key parameters on which it is based are justified	NA	NA	U	NA	NA	NA	NA	NA	√	√	NA	NA	√	NA	NA	NA	NA	NA	NA	NA	NA

Study number (refers to reference)

Analysis and interpretation of results	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9ab**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Time horizon of costs and benefits are stated	X	√	√	√	X	√	√	√	√	√	X	√	√	√	X	X	√	√	√	√	√
The discount rate(s) is stated	U	NA	NA	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	U	NA	NA	NA	NA	NA
The choice of rate(s) is justified	U	NA	NA	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	U	NA	NA	NA	NA	NA
An explanation is given if cost or benefits are not discounted	U	NA	NA	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	U	NA	NA	NA	NA	NA
Details of statistical tests and confidence intervals are given for stochastic data	X	√	√	√	√	P	P	P	X	X	P	√	X	P	√	X	P	√	P	√	√
The approach to sensitivity analysis is given	X	√	√	X	X	X	X	X	X	X	X	X	√	X	√	X	X	X	X	X	X
The choice of variables for sensitivity analysis is justified	NA	√	√	NA	NA	NA	NA	NA	NA	NA	NA	NA	√	NA	√	NA	NA	NA	NA	NA	NA
The ranges over which the variables are varied are stated	NA	√	√	NA	NA	NA	NA	NA	NA	NA	NA	NA	√	NA	√	NA	NA	NA	NA	NA	NA
Relevant alternatives are compared	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Incremental analysis is reported	NA	NA	√	X	NA	NA	NA	NA	X	X	NA	NA	√	NA	X	X	√	NA	NA	NA	NA
Major outcomes are presented in a disaggregated as well as aggregated form	√	√	NA	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
The answer to the study question is given	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Conclusions followed from the data reported	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Conclusions are accompanied by the appropriate caveats	P	√	P	P	X	√	P	√	X	X	P	P	√	√	√	X	√	P	P	P	√

[1]Drummond MF, Jefferson TO (1996) Guidelines for authors and peer reviewers of economic submissions to the BMJ**.** *British Medical Journal*, 313,pp.275-283.

Yes - √, NO - X, P – partial, Unclear – U, NA – Not Applicable

Dressings and debridement: study numbers

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3. Bergemann R et al. (1999) Economic evaluation of the treatment of chronic wounds: hydroactive wound dressings in combination with enzymatic ointment versus gauze dressings in patients with pressure ulcer and venous leg ulcer in Germany. *PharmacoEconomics*,16,pp.367-77.

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9b. Harding K, Cutting K and Price P (2001) Wound management protocols of care. *British Journal of Health Care Management*,7,pp.191-197.

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12. Kraft MR, Lawson L, Pohlmann B, Reid-Lokos C and Barder L. (1993) A comparison of Epi-Lock and saline dressings in the treatment of pressure ulcers. *Decubitus*,6,pp.42-4,46,48.

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15. Muller E, van Leen MWF and Bergemann R (2001) Economic evaluation collagenase-containing ointment and hydrocolloid dressing in the treatment of pressure ulcers. *PharmacoEconomics*,19,pp.1209-16.

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21. Xakellis GC and Chrischilles EA (1992) Hydrocolloid versus saline-gauze dressings in treating pressure ulcers: a cost-effectiveness analysis. *Archives of Physical Medicine & Rehabilitation*;73:463-9.

Table L: Adjunct therapies economic evaluation checklist*[1]

	Study number (refers to reference)	
Study design	**22**	**23**
The research question is stated	√	√
The economic importance of the research question is stated	X	√
The view point(s) of the analysis are clearly stated and justified	X	X
The rationale for choosing the alternative programmes or interventions compared is stated	√	√
The alternatives being compared are clearly described	√	X
The form of economic evaluation is stated	√	X
The choice of form of economic evaluation is justified in relation to the questions addressed	√	√
Data collection		
The source(s) of effectiveness estimates used are stated	√	√
Details of the design and results of effectiveness study are given (if based on single study)	NA	√
Details of methods of synthesis or meta-analysis of estimates are given (if based on an overview of a number of effectiveness studies)	√	NA
The primary outcome measure(s) for the economic evaluation are clearly stated	√	√
Methods to value health states and other benefits are stated	√	√
Details of the subjects from whom valuations were obtained are given	√	√
Productivity changes (if included) are reported separately	NA	NA
The relevance of productivity changes to the study question is discussed	NA	NA
Quantities of resources are reported separately from their unit costs	√	P
Methods for the estimation of quantities and unit cost are described	P	√
Currency and price date are recorded	√	X
Details of currency of price adjustments for inflation or currency conversion are given	NA	NA
Details of any model used are given	√	X
The choice of model used and the key parameters on which it is based are justified	√	X
Analysis and interpretation of results		
Time horizon of costs and benefits are stated	√	√
The discount rate(s) is stated	√	NA
The choice of rate(s) is justified	√	NA
An explanation is given if cost or benefits are not discounted	NA	NA
Details of statistical test and confidence intervals are given for stochastic data	√	X
The approach to sensitivity analysis is given	√	X
The choice of variables for sensitivity analysis is justified	√	X
The ranges over which the variables are varied are stated	√	X

Relevant alternatives are compared	√	√
Incremental analysis is reported	√	NA
Major outcomes are presented in a disaggregated as well as aggregated form	√	√
The answer to the study question is given	√	√
Conclusions followed from the data reported	√	√
Conclusions are accompanied by the appropriate caveats	√	X

[1.] Drummond MF, Jefferson TO (1996) Guidelines for authors and peer reviewers of economic submissions to the BMJ**.** *British Medical Journal*, 313,pp.275-283.

Adjunct therapies: study numbers

22. Macario A and Dexter F (2002) Is noncontact normothermic wound therapy cost-effective for the treatment of stages 3 and 4 pressure ulcers? *Wounds – A Compendium of Clinical Research & Practice*,14(3),pp.93-106.

23. Philbeck JTE, Whittington KT, Millsap MH, Briones RB, Wight DG and Schroeder WJ (1999) The clinical and cost-effectiveness of externally applied negative pressure wound therapy in the treatment of wounds in home healthcare Medicare patients. *Ostomy/Wound Management*,45(11),pp.41-50.

Table M: Pressure-relieving devices economic evaluation checklist[1]

	Study number (refers to reference)		
Study design	**1**	**2**	**3**
The research question is stated	√	√	√
The economic importance of the research question is stated	√	√	√
The view point(s) of the analysis are clearly stated and justified	√	√	√
The rationale for choosing the alternative programmes or interventions compared is stated	√	√	√
The alternatives being compared are clearly described	√	√	√
The form of economic evaluation is stated	X	√	X
The choice of form of economic evaluation is justified in relation to the questions addressed	√	√	√
Data collection			
The source(s) of effectiveness estimates used are stated	√	√	√
Details of the design and results of effectiveness study are given (if based on single study)	√	√	√
Details of methods of synthesis or meta-analysis of estimates are given (if based on an overview of a number of effectiveness studies)	NA	NA	NA
The primary outcome measure(s) for the economic evaluation are clearly stated	√	√	√
Methods to value health states and other benefits are stated	√	√	√
Details of the subjects from whom valuations were obtained are given	√	√	√
Productivity changes (if included) are reported separately	NA	NA	NA
The relevance of productivity changes to the study question is discussed	NA	NA	NA
Quantities of resources are reported separately from their unit costs	√	√	X
Methods for the estimation of quantities and unit cost are described	√	√	X
Currency and price date are recorded	X	√	X
Details of currency of price adjustments for inflation or currency conversion are given	NA	NA	√
Details of any model used are given	NA	√	NA
The choice of model used and the key parameters on which it is based are justified	NA	√	NA
	Study number (refers to reference)		
Analysis and interpretation of results	**1**	**2**	**3**
Time horizon of costs and benefits are stated	√	√	√
The discount rate(s) is stated	NA	NA	NA
The choice of rate(s) is justified	NA	NA	NA
An explanation is given if cost or benefits are not discounted	NA	NA	NA
Details of statistical test and confidence intervals are given for stochastic data	X	X	√
The approach to sensitivity analysis is given	X	√	X
The choice of variables for sensitivity analysis is justified	X	√	X

The ranges over which the variables are varied are stated	X	√	X
Relevant alternatives are compared	√	√	√
Incremental analysis is reported	NA	X	NA
Major outcomes are presented in a disaggregated as well as aggregated form	√	√	√
The answer to the study question is given	√	√	√
Conclusions followed from the data reported	√	√	√
Conclusions are accompanied by the appropriate caveats	P	√	√

[1] Drummond MF, Jefferson TO (1996) Guidelines for authors and peer reviewers of economic submissions to the BMJ**.** *British Medical Journal*, 313,pp.275-283.

Pressure-relieving devices: study numbers

24. Branom R and Rappl LM (2001) Constant force technology versus low-air-loss therapy in the treatment of pressure ulcers. *Ostomy Wound Management*,47(9),pp.38-46.

25. Ferrell BA, Keeler E, Siu AL, Ahn SH and Osterweil D (1995) Cost-effectiveness of low-air-loss beds for treatment of pressure ulcers. *Journal of Gerontology*,50A:M141-M146.

26. Strauss MJ (1991) The cost of home air-fluidized therapy for pressure sores. A randomized controlled trial. *J. Family Practice*,pp.52-59.

Appendix D: Table of excluded studies

Study	Reason excluded
Holistic assessment	
Bianchetti et al., 1993	The study's main focus is on those subjects without ulcers but who are at risk of developing pressure ulcers.
Clarke and Kadhom, 1988	Prevention study
Guralnik et al., 1988	Prevention study
Berlowits and Wilkin, 1989	Prevention study
Kemp et al., 1990	Prevention study
Ek et al., 1991	Prevention study
Marchette et al., 1991	Prevention study
Bergstrom et al., 1992	Prevention study
Rijswijk, 1993	Study design and methods not clear. Poor methodology. No multivariate analysis of risk factors.
Hoshowsky and Schramm, 1994	Prevention study
Brandeis et al., 1994	Prevention study
Bergstron et al.,1996	Prevention study
Schnelle et al., 1997	Prevention study
Nixon et al., 2000	Prevention study
Halfens et al., 2000	Prevention study
Theaker et al., 2000	Prevention study
Boyle and Green, 2001	Prevention study
Schoonhoven et al., 2002	Prevention study
Berquist, 2003	Prevention study
Baumgarten et al., 2003	Prevention study
Schoonhoven et al., 2003	Prevention study
Ulcer assessment	
Melhuish et al., 1994	Not pressure ulcers

Gardner et al., 2001	General chronic wound unclear what percentage were pressure ulcers.
Pressure-relieving surfaces	
Bennett et al., 1998	Prevention trial
Lazzara et al., 1991	Prevention trial
Marchand et al.	Prevention trial
Rosenthal et al., 1996	Prevention trial
Stoneberg et al., 1986	Prevention trial
Dressings and topical agents	
Cheneworth, 1994	Pressure sore prevention, not treatment.
Collier, 1992	No data on healing - mentions 'improved'.
Fowler, 1983	No outcome data.
Gorse, 1987	Not RCT. Patients allocated to wards to give a balance of surgical and medical patients, then one treatment used on each ward.
Isago, 2003	Not RCT. Case series.
Kloth, 2000	Not RCT. Control group was a convenience sample.
Lum, 1996	Not RCT. Quasi randomised trial: patients with odd admission number were allocated to the control group, those with an even number were assigned to the treatment group.
Maas-Irslinger, 2003	Not RCT. Controlled experiments on healthy volunteers.
Milward, 1995	Evaluation of a skin treatment rather than wound dressing.
Mosher, 1999	Not RCT. Decision analysis study.
Rhodes, 2001	Quasi experimental design: unit of randomisation was physicians not patients or ulcers.
Oleske, 1986	Quasi experimental design: unit of randomisation was nursing modules not patients or ulcers. Patients would receive the treatment assigned to the module.
Pierce, 1994	Outcome data was electron microscopy results.
Pittl, 1995	Conflicting results. Coloplast contacted for clarification - no reply.

Shutler, 1995	No data on healing.
Smith, 1996	Not RCT. A practice survey, excluded patients with pressure sores.
Shiraishi, 1997	Not RCT. Pharmacological study.
Tytgat, 1988	Not RCT. No objective outcomes measurement.
Vande Berg, 1995	Outcome based on histology.
Wongworawat, 2003	Not RCT. Case series.
Antimicrobials	
Baker, 1981	Before-after study.
Bendy, 1964	No objective wound healing outcomes.
Gorse, 1987	Unit of allocation was wards and this allocation was likely to produce heterogeneous treatment groups.
Hartman, 2002	Not truly randomised. Some patients acted as their own controls. Used essential oils as antimicrobial agent.
Kucan, 1981	Microbiological outcomes and subjective assessment of wounds the only outcomes available.
Nasar, 1982	Some patients were additionally given systemic antibiotics, but insufficient details given regarding this co-intervention. Some patients crossed over between treatment groups.
Norton 1962	The unit of allocation was wards and this allocation was likely to produce heterogeneous treatment groups.
Robson, 1991	Growth factor and disaccharide preparation evaluated within two double blind, placebo controlled RCTS. For both trials, silver sulphadiazine was allocated to any additional ulcers in a non-randomised, un-blinded fashion.
Subramanian, 1990	Separate data not available for chronic wounds. No objective wound healing outcomes.
Adjunct therapies	

Canedo-Dorantes, 2002	Not RCT, physiological study. Did not address treatment of pressure ulcers but chronic arterial and venous leg ulcers.
Elsberg, 2002	Not RCT. Case series (n=8) with stage 3-4 pressure ulcers that showed no improvement after conventional treatment for 2 weeks. Treatments given were topical hyperbaric oxygen and electrical stimulation.
Rippon, 1999	Not RCT. Experimentally induced wounds were monitored using pulse ultrasound over 21 days.
Selkowtiz, 2002	Not RCT. Description of single case (patient with stage 3 pressure ulcer) different treatment administered at different time periods.
Argenta, 1997	This study utilised TNP to treat 300 wounds, 175 of which were chronic. There was no control or comparison group therefore this is not a prospective RCT.
Banwell, 1998	This study utilised TNP to treat 200 acute and chronic wounds. There was no control or comparison group therefore this is not a prospective RCT.
Das Gupta, 1996	This study utilised TNP to treat 23 patients with chronic wounds. There was no control or comparison group therefore this is not a prospective RCT.
Deva, 2000	This study utilised TNP to treat 30 patients with pressure ulcers who were judged to be unsuitable for reconstructive surgery. The study is not a prospective RCT, but a prospective, consecutive case series.
Fabian, 2000	This study compared the healing of hypoxic full thickness ear wounds in rabbits (41) when treated with TNP or foam (not treated with TNP) and adhesive drape, with or without hyperbaric oxygen. This is a prospective RCT but not in humans.
Genecov, 1998	This study compared the healing rate of donor site wounds in pigs (4) when treated with TNP or Opsite. It also compared the epithelialisation rates of donor site wounds in humans (10) when treated with TNP or Opsite, but looking at acute wounds.
Greer, 1999	This study appeared to be a relevant RCT looking at the effect of TNP on pressure ulcer

	healing. The trial was terminated prematurely.(Personal communication KCI,USA)
Heath, 2002	This study compared the percentage of epithelialisation in surgical wounds in humans (30) when treated with a skin graft plus TNP or standard pressure dressing. This appears to be a prospective controlled trial in humans but in acute wounds.
Heissing, 1995	This study utilised either continous or variable TNP to treat 120 hip replacement patients. This is a prospective randomised controlled trial in humans but in acute wounds healing by primary intention.
Holmich, 1998	This study utilised TNP to treat 14 patients with acute (5) or chronic (9) wounds. There was no control or comparison group therefore this is not a prospective RCT.
Isago, 2003	Not an RCT. This study assessed the effect of negative pressure dressings on 10 patients with stage 4 pressure ulcers. There was no control group or random allocation of patients.
Ladin, 2000	This study utilised TNP to treat 8 patients with diabetic foot ulcers, venous stasis ulcers or post traumatic ulcers. There was no control or comparison group therefore this is not a prospective RCT.
de Lange, 2000	This study utilised TNP to treat 100 patients, 23 of which had 26 stage 4 pressure ulcers. There was no control or comparison group therefore this is not a prospective RCT.
McCallom, 2000	This RCT assessed the effect of TPN on patients with diabetic foot ulcers, and not on pressure ulcers.
Mooney, 2000	This study utilised TNP to treat 27 paediatric patients,16 of which had chronic extremity and axial wounds. There was no control or experimental group therefore this is not a prospective RCT.
Morykwas, 1993	This study compared the healing rates of full thickness dorsal wounds in pigs (5) when treated with TNP or saline wet to moist dressings. This appears to be a prospective controlled trial on acute wounds and not in humans.
Morykwas, 1995	This study retrospectively analysed the

	length of stay and total charges for 159 hospitalised patients with chronic wounds treated with either TNP (35) or other modalities (124) over a 21-month period. Patients were not randomly allocated to the two treatment groups.
Morykwas, 1997	This series of studies of the effect of TNP on blood flow in the wound and adjacent tissue (5), the rate of granulation tissue formation (10), the clearance of bacteria from infected wounds (5) and the measurement of nutrient flow (5). These studies appear to be prospective controlled trials but on acute wounds and not in humans.
Mullner, 1997	This study utilised TNP to treat 45 patients, 17 of whom had sacral pressure ulcers. There was no control or comparison group therefore this is not a prospective RCT.
Philbeck, 1995	Retrospective analysis of wound healing, and from this estimated the financial cost, in 1,032 home healthcare patients with 1,170 chronic wounds, when treated with TNP. This group was compared with an historical control group that had been treated with saline-soaked gauze therefore this is not a prospective RCT.
Wu, 2000	This study utilised TNP to treat 26 patients, 11 of whom had chronic wounds. There was no control or comparison group therefore this is not a prospective RCT.
Nutrition	
Benati, 2001	36 patients with severe cognitive impairment and pressure ulcers were randomised into three intervention groups but no outcome data were reported.
Bergstrom, 1987	129 institutionalised elderly, who were at risk but did not have pressure ulcers at admission, were studied to determine whether dietary and serum zinc and copper differ between those who developed pressure ulcers and those who did not.
Bourdel, 1997	Retrospective case-control study with 108 patients to discover early and late tolerance of long-term feeding with PEG for older and frail patients. Not an RCT or CCT.
Breslow, 1990	PHD thesis. Published report see Breslow, 1991.

Breslow, 1991	Comparison of nutritional status and dietary intake of 14 tube fed nursing home patients with pressure ulcers to 12 tube fed patients without pressure ulcers. Not an RCT or CCT.
Breslow, 1993	28 malnourished patients with pressure sores received 24% protein or 14% protein supplements for a period of 8 weeks. First RCT, then CCT justified by unbalanced groups and high drop-out rate; effects of bed type on results are unclear.
Burr, 1972	Not an RCT. Study assessed the leucocyte ascorbic acid concentration of 91 paraplegic patients on admission (33 of which had pressure sores) and 41 controls. 10 of the patients with pressure sores were given a course of ascorbic acid or placebo, but allocation to the treatments were not made at random.
Cruse, 2000	Review of immune function, healing of pressure ulcers and nutritional status in patients with spinal cord injury. Not linked to pressure ulcers laboratory study of immune function and nutritional markers.
Gardner, 1999	Literature review and meta-analysis of studies assessing the effect of electrical stimulation on chronic wound healing.
Gray, 2003	Literature review article of vitamin C supplementation to promote pressure ulcer healing.
Gray, 2003	Literature review article of oral zinc supplementation to promote healing of chronic wounds.
Gray, 2003	Literature review article of supplementation of vitamin A or E to promote healing of chronic wounds.
Henderson, 1992	This study examined the nutritional status and clinical outcomes including pressure ulcers and death in 40 tube fed patients. Not linked to pressure ulcer healing.
Jackobs, 1999	13 patients in long-term care with grade 2 or 3 pressure ulcers were included in this study to evaluate the cost of nutrition therapy to heal pressure ulcers. Not a randomised or controlled clinical trial. Diet regimes were allocated according to pressure ulcer stage. Main outcomes reported were economic.

Langkamp Henken, 2000	32 nursing home residents with pressure ulcers received 0g, 8.5 g or 17 g arginine for 4 weeks. Not pressure ulcers but only immune functions were measured.
Lawson, 2003	Studied the effect of unselected post-operative nutritional supplementation on nutritional status and clinical outcome of orthopaedic patients. Not pressure ulcers.
Larsson, 1990	501 geriatric patients received standard hospital diet or additional nutritional supplements for 26 weeks. Pressure ulcers not measured.
Lewis, 1996	A literature review of protein levels and the aetiology of pressure sores.
Myers, 1990	80 patients with pressure ulcers were treated with wound care, with nutritional support, with both or with standard hospital treatment for 7 days. Nutritional supplementation was not clearly described.
North, 1999	Systematic review of studies that compared the impact of oral or enteral supplements of Vitamin C on the rate of healing of pressure sores. The review included other systematic reviews, randomised trials, quazi-exerimental studies and nonexperimental studies.
Prescott, 2003	Expert opinion paper with literature review. Abstract notes that five RCTs have been conducted to assess the effect of zinc supplementation on the healing of pressure ulcers, but the five trials referred to all assessed the effect of zinc supplementation in healing venous leg ulcers.
Rypkema, 2004	298 older patients in a prospective controlled study. Randomisation was wards. Not pressure ulcer healing.
Senapati, 1989	Not an RCT. A physiological study assessing plasma zinc levels in elderly patients with leg, sacral or gluteal decubitus ulcers, and three groups of different types of control patients.
Thomas, 2001	Literature review of nutritional interventions to improve outcomes for people with pressure ulcers.
Mobility and positioning	
Defloor, 1999	Not RCT

Defloor, 2000	Not RCT
Defloor, 2000	Prevention trial
Defloor, 2001	Interface pressure outcome
Surgery	
Arregui et al., 1965	Retrospective chart review
Aydan et al., 2003	Retrospective chart review
Brucks et al., 1991	Animal study
Chan et al., 2003	Retrospective chart review
Gusenoff, 2002	Retrospective chart review
Higins et al., 2002	Single case report
Hollis, 1979	Single case report
Inoue, 1990	2 subjects only
Patel and Kuzon, 2001	Single case report
Rubayi, 1999	Retrospective review
Thomson et al., 2001	4 subjects only

Appendix E: **Quality assessment for risk factor studies**

All studies will fulfil the following criteria for inclusion

- Eligible cohort of participants.
- High participation at baseline and follow up > 70%.
- Risk factors conceptually relevant.
- Baseline measurement of risk factors.
- Reporting of methods, explicit inclusion criteria and demographic information.
- Adequate length of follow up > 6 months.
- Measurement of falls as outcome.
- Statistical methods detailed. Adequate reporting for data extraction. Methods of adjustment for confounding reported: see below.

Studies then have to be assessed against these criteria:

High quality

- Large sample.
- High participation at baseline and follow up > 80%.
- Baseline measurement of risk factors: clear methods of measurement given. Balance between clinical tests and subjective measurement.
- Methods of outcome measurement clear. Falls diaries with frequent researcher follow up. Minimal reliance on recall of fall events.
- Methods of adjustment: all factors adjusted and reported.

Medium quality

- Large sample.
- Participation at baseline and follow up 70-80%.
- Baseline measurement of risk factors: Unclear methods of measurement given. Subjective methods of measurement.

or

- Methods of outcome measurement clear. Inadequate measurement of outcome – i.e. relying on memory at follow up alone.
- Methods of adjustment: some adjustment and reporting.

Low quality

- Small sample < 200.
- Low participation at baseline and follow up < 70%.
- Baseline measurement of risk factors: unclear methods of measurement given. Subjective methods of measurement.

or

- Methods of outcome measurement clear. Inadequate measurement of outcome – i.e. relying on memory at follow up alone.
- Methods of adjustment: adjusted variables not reported.

Case Series quality checklist

Case series collected in more than one centre (multi-centre study) Y/N

Aims of case series clearly stated Y/N

Case definition clearly reportedY/N

Explicit statement that patients were recruited consecutively Y/N

Prospective data collection Y/N

Reporting of confidence intervals or other estimate of random variability Y/N

Reporting of mortality/recurrences/complications Y/N

Baseline data for ulcers Y/N

Y =1
N= 0

Case control studies – quality assessment (generic issues)

Please circle as appropriate for each paper. The approach recommended by the Centre for Statistics in Medicine is to describe the quality of each paper rather than consign to the dustbin if it scores "b's" or "c's". However, you may decide that if multiple flaws, the paper should not be included as it may be too biased.

Selection

1. How were cases selected?
   a. All eligible subjects diagnosed as cases over a defined period of time, or in a defined catchment area, or a random or systematic sample of such cases
   b. Unrepresentative or biased sample of cases
   c. Unclear

2. Are the case and control definitions adequate and validated? (Cases=specific for review question, looking for validated or accepted diagnostic criteria/outcome measure. Control=defined and shown not to be a case.)
   a. Yes
   b. No, case definition inadequate
   c. No, control definition inadequate
   d. No, case and control definitions inadequate
   e. Unclear

3. How were controls selected?
   a. General population controls (ie, same population as cases)
   b. Hospital/clinic controls
   c. Other
   d. Unclear

4. Are the controls representative?
   a. Individually matched
   b. Frequency matched
   c. Not matched, but all non-cases over a defined period of time, or in a defined catchment area or a random or systematic sample of such subjects
   d. Unrepresentative
   e. Unclear

5. What percentage of selected individuals agreed to participate in the study?
   Cases_____
   Controls_____
   a. ≥ 80% agreed in both groups
   b. ≥ 80% cases agreed, < 80% controls

c. < 80% cases agreed, ≥ 80% controls
d. <80% in both groups agreed
e. Not reported or unclear

Exposure/intervention ascertainment

6. How was exposure status ascertained (*this will be specific to review question*)?
   a. Questionnaire
   b. Clinical examination
   c. Medical record review
   d. Unclear

7. Were assessors of exposure blind to outcome status? (ie, whether a case or control)
   a. Yes
   b. No
   c. Unclear

Comparability of groups

8. Are the groups (exposed/unexposed) comparable with respect to confounding factors? (*The list in the table will be specific to the review question*)

Confounding factors	**Matched design**	**Balanced by design**	**Imbalance adjusted for in analysis**	**Neither or unclear**
Age				
Gender				
Smoking status				
Etc				

Outcome assessment

9. How was the outcome status ascertained? (*specific to the review question*)
   a. Self-assessed questionnaire
   b. Medical record review
   c. Clinical examination
   d. Type of diagnostic test
   e. Unclear

10. Were outcome assessors blind to exposure status?
    a. Yes
    b. No
    c. Unclear

Analysis

11. What was the proportion of subjects included in the final analysis?
    Percentage_____
    a. All participants included in analysis
    b. 80% subjects included in final analysis
    c. < 80% subjects included in analysis with no description of those missing
    d. < 80% subjects included in analysis with no description of those missing
    e. Based on a description of the missing subjects, bias likely to be introduced.

Quality criteria for systematic reviews (NHMRC 2001)

Include:
Yes: No:

Name of paper_____

Was an adequate search strategy used?
Yes /No/Not stated

Were the inclusion criteria appropriate and applied in an unbiased way?
Yes/No/Not stated

Was a quality assessment of included studies undertaken?
Yes/No/Not stated

Were the characteristics and results of the individual studies appropriately summarized?
Yes/No/Not stated

Were the methods for pooling the data appropriate?
Yes/No/Not stated

Were sources of heterogeneity explored?
Yes/No/Not stated

Total Score:……..
Yes = 1, No = 0, Not stated = 0