NHS
National Institute for Health and Clinical Excellence

Issue date: July 2007

Acutely ill patients in hospital

Recognition of and response to acute illness in adults in hospital

NICE clinical guideline 50
Developed by the Centre for Clinical Practice at NICE

NICE clinical guideline 50
Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital

Ordering information
You can download the following documents from www.nice.org.uk/CG050

- The full guideline (this document) – all the recommendations, details of how they were developed, and reviews of the evidence they were based on.
- A quick reference guide – a summary of the recommendations for healthcare professionals.
- 'Understanding NICE guidance' – information for patients and carers.

For printed copies of the quick reference guide or 'Understanding NICE guidance', phone the NHS Response Line on 0870 1555 455 and quote:

- N1284 (quick reference guide)
- N1285 ('Understanding NICE guidance').

NICE clinical guidelines are recommendations about the treatment and care of people with specific diseases and conditions in the NHS in England and Wales

This guidance represents the view of the Institute, which was arrived at after careful consideration of the evidence available. Healthcare professionals are expected to take it fully into account when exercising their clinical judgement. The guidance does not, however, override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer and informed by the summary of product characteristics of any drugs they are considering.

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Foreword

Patients who are admitted to hospital believe that they are entering a place of safety, where they, and their families and carers, have a right to believe that they will receive the best possible care. They feel confident that, should their condition deteriorate, they are in the best place for prompt and effective treatment.

Yet there is evidence to the contrary. Patients who are, or become, acutely unwell in hospital may receive suboptimal care. This may be because their deterioration is not recognised, or because – despite indications of clinical deterioration – it is not appreciated, or not acted upon sufficiently rapidly. Communication and documentation are often poor, experience might be lacking and provision of critical care expertise, including admission to critical care areas, delayed.

We have endeavoured to produce practical guidance with recommendations for the measurement and recording of a set of physiological observations, linked to a 'track and trigger' system (see section 2.1.1). We have emphasised the importance of a full clinical assessment, and of tailoring the written monitoring and management plans to the individual patient's clinical circumstances. Throughout the document we have emphasised the importance of training; by ensuring that routine measurements are accurately taken and recorded by staff that understand their clinical relevance, and by linking these observations to a graded track and trigger system, care can be escalated appropriately. The foundations for patient safety are laid through doing and recording simple measurements well and having agreed response strategies in place.

The Guideline Development Group struggled with the lack of evidence to identify any one best model of response. It needed to balance making clear recommendations about the level and nature of the response with the absence of evidence regarding optimal configuration. Given this, the Guideline Development Group considered that the optimal configuration of response should be agreed and delivered locally. Whatever model of care is agreed, the

clinical team must have the necessary competencies. Where admission to a critical care area is considered necessary, we have emphasised the importance of involving both critical care consultants and the team caring for the patient on the ward.

The Guideline Development Group recognised the pressure on both critical care beds and inpatient hospital beds, and the difficulties of ensuring smooth, planned transfer from critical care areas back to the wards. Nevertheless, we have set out recommendations to avoid transfer out of critical care areas between the hours of 22.00 and 07.00. If this occurs, it should be documented as an adverse incident. We have been prescriptive about the need for a formal, structured handover of care between the transferring and receiving teams, recognising the understandable anxiety of patients and their carers and the need to provide reassurance and information to them at this time.

This is the first National Institute for Health and Clinical Excellence (NICE) short clinical guideline to be developed. The methodology is of the same rigour as for the standard NICE clinical guidelines, but the scope is narrower, and the development and consultation phases have been compressed. The Guideline Development Group recognises the importance of producing guidance rapidly in an area in which patients and clinicians need advice urgently to ensure patient safety. This philosophy sits well with our emphasis on a timely and rapid response to the acutely ill hospital patient. We hope that the guideline will be welcomed by all who plan, deliver, or experience hospital inpatient clinical care.

Dr Mary Armitage
Guideline Development Group Chair

1 Summary

1.1 Patient-centred care

This guideline offers best practice advice on the care of adult patients within the acute hospital setting.

Treatment and care should take into account patients' needs and preferences. People with an acute illness should, if appropriate, have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If patients do not have the capacity to make decisions, healthcare professionals should follow the Department of Health (2001) guidelines – 'Reference guide to consent for examination or treatment' (available from www.dh.gov.uk). From April 2007 healthcare professionals will need to follow a code of practice accompanying the Mental Capacity Act (summary available from www.dca.gov.uk/menincap/bill-summary.htm).

Good communication between healthcare professionals and patients is essential. It should be supported by evidence-based written information tailored to the patient's needs. Treatment and care, and the information patients are given about it, should be culturally appropriate. It should also be accessible to people with additional needs such as physical, sensory or learning disabilities, and to people who do not speak or read English.

If the patient agrees, carers and relatives should have the opportunity to be involved in decisions about treatment and care.

Carers and relatives should also be given the information and support they need.

1.2 List of recommendations and care pathway

1.2.1 Key priorities for implementation

- Adult patients in acute hospital settings, including patients in the emergency department for whom a clinical decision to admit has been made, should have:
  - physiological observations recorded at the time of their admission or initial assessment
  - a clear written monitoring plan that specifies which physiological observations should be recorded and how often. The plan should take account of the:
    - ◊ patient's diagnosis
    - ◊ presence of comorbidities
    - ◊ agreed treatment plan.

  Physiological observations should be recorded and acted upon by staff who have been trained to undertake these procedures and understand their clinical relevance.

- Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings.
  - Physiological observations should be monitored at least every 12 hours, unless a decision has been made at a senior level to increase or decrease this frequency for an individual patient.
  - The frequency of monitoring should increase if abnormal physiology is detected, as outlined in the recommendation on graded response strategy.

- Staff caring for patients in acute hospital settings should have competencies in monitoring, measurement, interpretation and prompt response to the acutely ill patient appropriate to the level of care they are providing. Education and training should be provided to ensure staff have these competencies, and they should be assessed to ensure they can demonstrate them.

- A graded response strategy for patients identified as being at risk of clinical deterioration should be agreed and delivered locally. It should consist of the following three levels.
  - Low-score group:
    - Increased frequency of observations and the nurse in charge alerted.
  - Medium-score group:
    - Urgent call to team with primary medical responsibility for the patient.
    - Simultaneous call to personnel with core competencies for acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.
  - High-score group:
    - Emergency call to team with critical care competencies and diagnostic skills. The team should include a medical practitioner skilled in the assessment of the critically ill patient, who possesses advanced airway management and resuscitation skills. There should be an immediate response.

- If the team caring for the patient considers that admission to a critical care area is clinically indicated, then the decision to admit should involve both the consultant caring for the patient on the ward and the consultant in critical care.

- After the decision to transfer a patient from a critical care area to the general ward has been made, he or she should be transferred as early as possible during the day. Transfer from critical care areas to the general ward between 22.00 and 07.00 should be avoided whenever possible, and should be documented as an adverse incident if it occurs.

- The critical care area transferring team and the receiving ward team should take shared responsibility for the care of the patient being transferred. They should jointly ensure:
  - there is continuity of care through a formal structured handover of care from critical care area staff to ward staff (including both medical and nursing staff), supported by a written plan
  - that the receiving ward, with support from critical care if required, can deliver the agreed plan.

  The formal structured handover of care should include:

  - a summary of critical care stay, including diagnosis and treatment
  - a monitoring and investigation plan
  - a plan for ongoing treatment, including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
  - physical and rehabilitation needs
  - psychological and emotional needs
  - specific communication or language needs.

1.2.2 All recommendations

Physiological observations in acute hospital settings (section 2.1.3)

1.2.2.1 Adult patients in acute hospital settings, including patients in the emergency department for whom a clinical decision to admit has been made, should have:

- physiological observations recorded at the time of their admission or initial assessment
- a clear written monitoring plan that specifies which physiological observations should be recorded and how often. The plan should take account of the:
  - patient's diagnosis
  - presence of comorbidities
  - agreed treatment plan.

Physiological observations should be recorded and acted upon by staff who have been trained to undertake these procedures and understand their clinical relevance.

1.2.2.2 As a minimum, the following physiological observations should be recorded at the initial assessment and as part of routine monitoring:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

Identifying patients whose clinical condition is deteriorating or is at risk of deterioration (section 2.1.4)

1.2.2.3 Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings.

- Physiological observations should be monitored at least every 12 hours, unless a decision has been made at a senior level to increase or decrease this frequency for an individual patient.
- The frequency of monitoring should increase if abnormal physiology is detected, as outlined in the recommendation on graded response strategy (recommendation 1.2.2.10).

Choice of physiological track and trigger system (section 2.1.5)

1.2.2.4 Track and trigger systems should use multiple-parameter or aggregate weighted scoring systems, which allow a graded response. These scoring systems should:

- define the parameters to be measured and the frequency of observations
- include a clear and explicit statement of the parameters, cut-off points or scores that should trigger a response.

Physiological parameters to be used by track and trigger systems (section 2.1.6)

1.2.2.5 Multiple-parameter or aggregate weighted scoring systems used for track and trigger systems should measure:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

1.2.2.6 In specific clinical circumstances, additional monitoring should be considered; for example:

- hourly urine output
- biochemical analysis, such as lactate, blood glucose, base deficit, arterial pH
- pain assessment.

Critical care outreach services for patients whose clinical condition is deteriorating (section 2.2.3)

1.2.2.7 Staff caring for patients in acute hospital settings should have competencies in monitoring, measurement, interpretation and prompt response to the acutely ill patient appropriate to the level of care they are providing. Education and training should be provided to ensure staff have these competencies, and they should be assessed to ensure they can demonstrate them.

1.2.2.8 The response strategy for patients identified as being at risk of clinical deterioration should be triggered by either physiological track and trigger score or clinical concern.

1.2.2.9 Trigger thresholds for track and trigger systems should be set locally. The threshold should be reviewed regularly to optimise sensitivity and specificity.

Graded response strategy (section 2.2.3)

No specific service configuration can be recommended as a preferred response strategy for individuals identified as having a deteriorating clinical condition.

1.2.2.10 A graded response strategy for patients identified as being at risk of clinical deterioration should be agreed and delivered locally. It should consist of the following three levels.

- Low-score group:
  - Increased frequency of observations and the nurse in charge alerted.
- Medium-score group:
  - Urgent call to team with primary medical responsibility for the patient.
  - Simultaneous call to personnel with core competencies for acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.
- High-score group:
  - Emergency call to team with critical care competencies and diagnostic skills. The team should include a medical practitioner skilled in the assessment of the critically ill patient, who possesses advanced airway management and resuscitation skills. There should be an immediate response.

1.2.2.11 Patients identified as ‘clinical emergency’ should bypass the graded response system. With the exception of those with a cardiac arrest, they should be treated in the same way as the high-score group.

1.2.2.12 For patients in the high- and medium-score groups, healthcare professionals should:

- initiate appropriate interventions
- assess response
- formulate a management plan, including location and level of care.

1.2.2.13 If the team caring for the patient considers that admission to a critical care area is clinically indicated, then the decision to admit should involve both the consultant caring for the patient on the ward and the consultant in critical care.

Transfer of patients from critical care areas to general wards (section 2.3.3)

1.2.2.14 After the decision to transfer a patient from a critical care area to the general ward has been made, he or she should be transferred as early as possible during the day. Transfer from critical care areas to the general ward between 22.00 and 07.00 should be avoided whenever possible, and should be documented as an adverse incident if it occurs.

Care on the general ward following transfer (section 2.3.4)

1.2.2.15 The critical care area transferring team and the receiving ward team should take shared responsibility for the care of the patient being transferred. They should jointly ensure:

- there is continuity of care through a formal structured handover of care from critical care area staff to ward staff (including both medical and nursing staff), supported by a written plan
- that the receiving ward, with support from critical care if required, can deliver the agreed plan.

The formal structured handover of care should include:

- a summary of critical care stay, including diagnosis and treatment

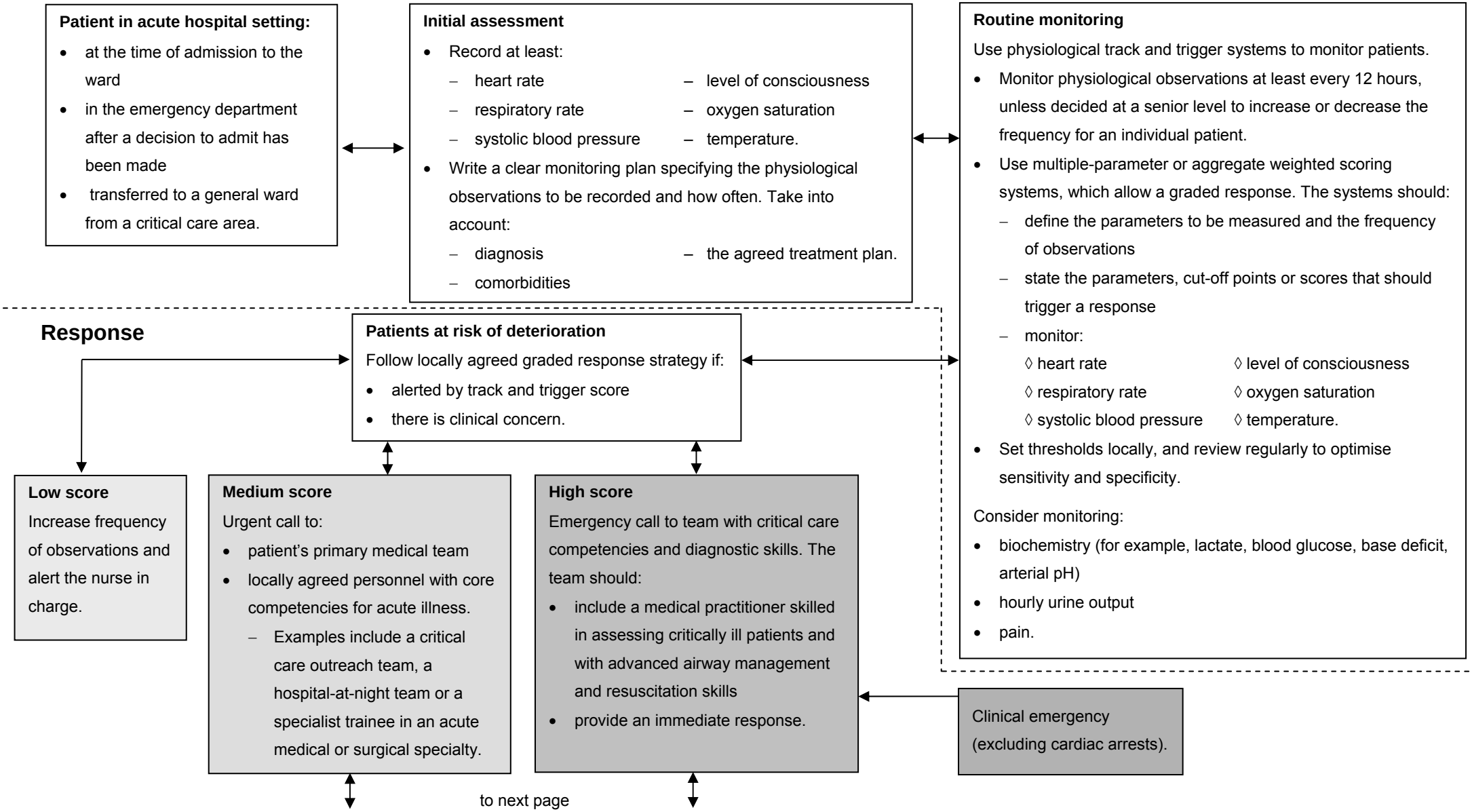
- a monitoring and investigation plan
- a plan for ongoing treatment, including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
- physical and rehabilitation needs
- psychological and emotional needs
- specific communication or language needs.

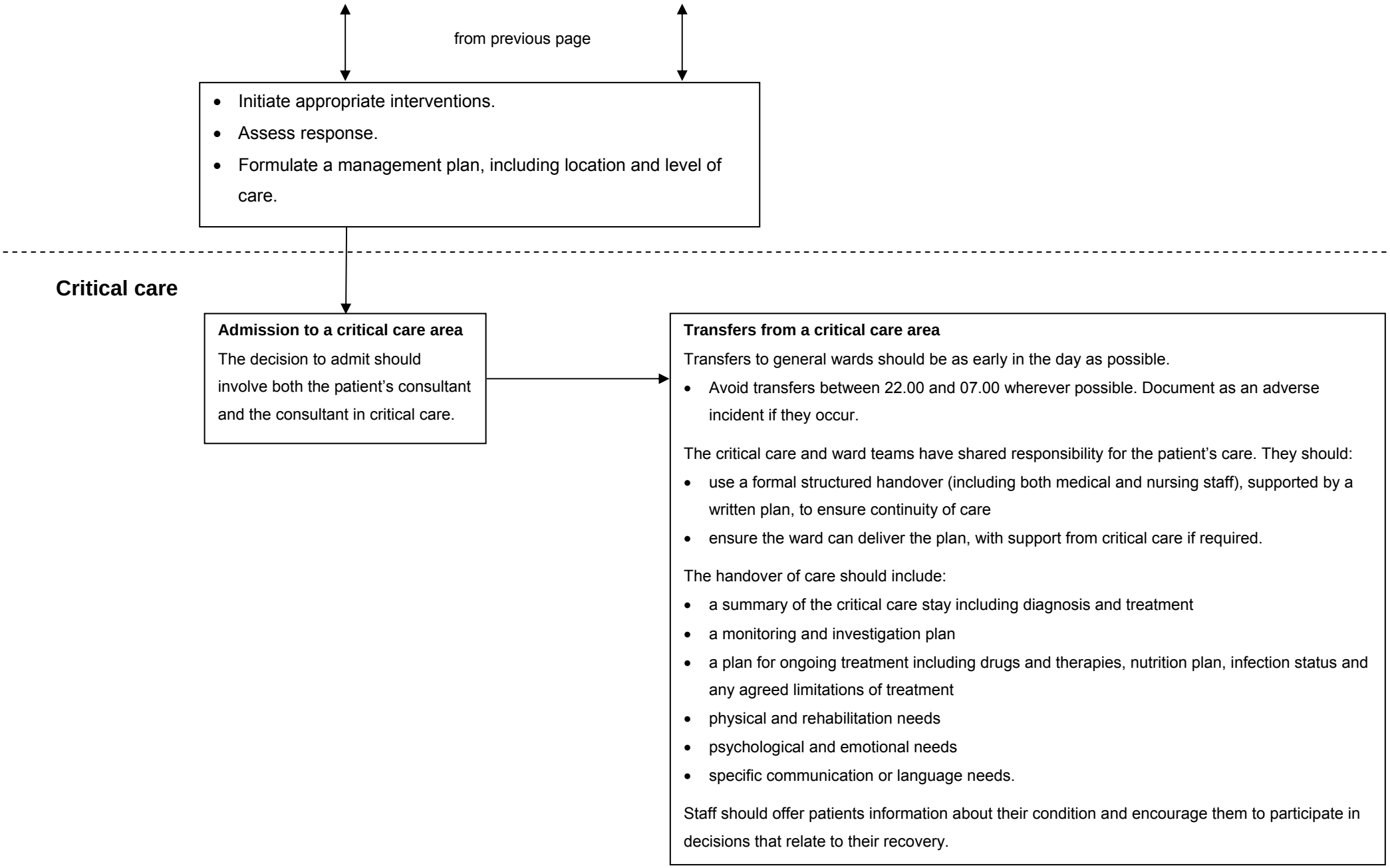
1.2.2.16 When patients are transferred to the general ward from a critical care area, they should be offered information about their condition and encouraged to actively participate in decisions that relate to their recovery. The information should be tailored to individual circumstances. If they agree, their family and carers should be involved.

1.2.2.17 Staff working with acutely ill patients on general wards should be provided with education and training to recognise and understand the physical, psychological and emotional needs of patients who have been transferred from critical care areas.

1.2.3 Care pathway

Assessment and monitoring

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Initiate appropriate interventions.
Assess response.
Formulate a management plan, including location and level of care.
Critical care
Admission to a critical care area
The decision to admit should involve both the patient's consultant and the consultant in critical care.
Transfers from a critical care area
Transfers to general wards should be as early in the day as possible.
Avoid transfers between 22.00 and 07.00 wherever possible. Document as an adverse incident if they occur.
The critical care and ward teams have shared responsibility for the patient's care. They should:
use a formal structured handover (including both medical and nursing staff), supported by a written plan, to ensure continuity of care
ensure the ward can deliver the plan, with support from critical care if required.
The handover of care should include:
a summary of the critical care stay including diagnosis and treatment
a monitoring and investigation plan
a plan for ongoing treatment including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
physical and rehabilitation needs
psychological and emotional needs
specific communication or language needs.
Staff should offer patients information about their condition and encourage them to participate in decisions that relate to their recovery.

1.3 Overview

1.3.1 Recognition of and response to acute illness in adults in hospital

The care of the acutely ill patient in hospital may require input from critical care. Critical care in the NHS is provided within the continuum of secondary and tertiary care, with the majority of services delivered in the secondary care setting. The Department of Health in 2000 recommended that this care should be classified based on the level of care that individual patients need, regardless of location. It identified four levels of care. Level 0: patients whose needs can be met through normal ward care in an acute hospital; level 1: patients at risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team; level 2: patients requiring more detailed observation or intervention, including support for a single failing organ system or postoperative care and those 'stepping down' from higher levels of care; and level 3: either patients requiring advanced respiratory monitoring and support, or patients needing monitoring and support for two or more organ systems, one of which may be basic or advanced respiratory support.

The aging population, increasing complexity of medical and surgical interventions, and shorter length of hospital inpatient stays have meant that patients in hospital are at increasing risk of becoming acutely ill and may require admission to critical care areas. This has led to increasing demand for level 1 and level 2 care. Clinical deterioration can occur at any stage of a patient's illness, although there will be certain periods during which a patient is more vulnerable, such as at the onset of illness, during surgical or medical interventions and during recovery from critical illness. Patients on general adult wards and emergency departments who are at risk of deteriorating may be identified before a serious adverse event by changes in physiological observations recorded by healthcare staff. The interpretation of these changes, and timely institution of appropriate clinical management once

physiological deterioration is identified, is of crucial importance to minimise the likelihood of serious adverse events, including cardiac arrest and death. Should a patient be admitted to critical care areas for further care, then care on general adult wards following transfer from critical care areas may also have a significant impact on patient outcomes.

There is, however, a consistent body of evidence that shows that patients who become, or who are at risk of becoming, acutely unwell on general hospital wards receive suboptimal care (McQuillan et al. 1998; NCEPOD 2005; Seward et al. 2003). The National Confidential Enquiry into Patient Outcome and Death (NCEPOD 2005) identified the prime causes of the substandard care of the acutely unwell in hospital as being delayed recognition, and institution of inappropriate therapy that subsequently culminated in a late referral. The report found that on a number of occasions these factors were aggravated by poor communication between the acute and critical care medical teams. It also identified examples in which there was a lack of awareness by medical consultants of their patients' deteriorating health and their subsequent admission to critical care. Admission to an intensive care unit (ICU) was thought to have been avoidable in 21% of cases, and the authors felt that suboptimal care contributed to about a third of the deaths that occurred.

Any intervention delivered to patients in hospital who deteriorate clinically, or who show signs that they may deteriorate unexpectedly, should aim to reduce patient mortality, morbidity and length of stay both in the hospital overall and in a critical care area should they be admitted to critical care. Such interventions could have substantial health economic implications through, for example, reductions in ICU admission and re-admission. A level-3 ICU bed, for example, costs approximately £1716 per day (Department of Health 2006). In addition, a ward bed has been estimated to cost £220 per day (Harrison et al. unpublished).

This guideline aims to improve the care of the acutely ill in hospital by making evidence-based recommendations on the best way to identify and manage this group of patients. It is intended that its implementation will improve the

quality of care received by these patients and address the shortcomings in care identified by the NCEPOD report.

1.3.2 The NICE short clinical guidelines programme

'Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital' (NICE clinical guideline 50) is the first NICE short clinical guideline.

The Institute has established a 'short' clinical guidelines programme that will allow the rapid (9–11 month) development of clinical guidelines that address only part of a care pathway for which the NHS requires guidance rapidly.

Short clinical guidelines are developed by an internal NICE technical team (the Short Clinical Guidelines Technical Team) to the same rigorous methods as existing clinical guidelines developed by NICE's national collaborating centres. This will be achieved by narrowing down the scope of the guideline so that it addresses a small number of key clinical questions. This will allow the Short Clinical Guidelines Technical Team to prepare evidence reviews of the same high quality as those produced in standard clinical guidelines, but in a shorter time. These reviews will be presented to the Guideline Development Group and used to make recommendations for clinical practice.

The short clinical guidelines programme consists of four phases that follow those of the standard guidelines programme.

1. Referral of topic to NICE by the Department of Health.
2. Scoping the guideline topic.
3. The development phase, which begins with the first meeting of the Guideline Development Group and ends when a draft document is submitted by the Guideline Development Group for stakeholder consultation.
4. The validation phase, which consists of consultation with stakeholders and the public on the draft guidance, receiving advice from the Guideline Review Panel and expert reviewers, preparation of the final draft, sign off by Guidance Executive and publication.

To meet the time requirements and minimise the complexity of development, key stages of the scoping and development phase of the standard guidelines process have been adapted. An interim process guide to the short clinical guidelines programme, setting out in detail the short guideline development methods, has been the subject of public consultation. It is intended that the revised version of the interim process guide, which will take account of the public consultation comments, will be incorporated into the 2008 update of the 'The guidelines manual' (see www.nice.org.uk).

1.3.3 Using this guideline

This document is intended to be relevant to healthcare professionals within acute hospitals who have direct contact with patients. The target population is adult patients in hospitals. This includes patients in the accident and emergency department, once a decision to admit the patient has been made.

The full version of the guideline is available to download free of charge from the NICE website (www.nice.org.uk). NICE will also make available summary versions of this guideline on the website, including 'Understanding NICE guidance' (a version for patients) and a quick reference guide.

1.3.4 Using recommendations and supporting evidence

The Guideline Development Group took into consideration the overall benefits, harms and costs of the evidence it reviewed. It also considered equity and the practicality of implementation when drafting the recommendations set out within this guideline. However, healthcare professionals need to use their general medical knowledge and clinical judgement when applying recommendations that may not be appropriate in all circumstances. Decisions to adopt any particular recommendation should be made in the light of the individual patient's views and circumstances as well as available resources. To enable patients to participate in the process of decision-making to the extent that they are able and willing, clinicians need to be able to communicate information provided in this guideline. To this end, recommendations are often supported by evidence statements that provide summary information to help clinicians and patients discuss options.

1.3.5 Using flowcharts

Deriving an evidence-based rationale for care for acutely ill patients in hospital brings together an understanding of healthcare delivery and a vast literature providing evidence about tests and treatments. Flowcharts are inevitably a simplification and cannot capture all the complexities and permutations affecting the clinical care of individuals managed within the hospital setting. Flowcharts presented in this guideline are designed to help communicate the key elements of treatment, but are not intended for rigid use or as protocol.

2 Evidence review and recommendations

2.1 Identification and evaluation of risk scoring tools

2.1.1 Introduction

Physiological track and trigger warning systems are widely used within acute hospitals in the NHS. They are used to identify patients on general wards (outside critical care areas) at risk of clinical deterioration. Their main function is to ensure recognition of all patients with potential or established critical illness, so that timely attendance from appropriately skilled staff can be ensured (Gao et al. 2007). Their use has also been shown to increase the frequency of recording of physiological parameters on general wards (McBride et al. 2005).

Physiological track and trigger systems rely on periodic observation of selected basic physiological signs ('tracking') with predetermined calling or response criteria ('trigger') for requesting the attendance of staff who have specific competencies in the management of acute illness and/or critical care. These systems allow a large number of patients to be monitored without a large increase in workload. A number of physiological track and trigger systems are used internationally to detect patients at risk of deteriorating, some of which are shown in the table below.

Table 1 Types of track and trigger system

System	Characteristics
Single parameter system	Periodic observation of selected vital signs that are compared with a simple set of criteria with predefined thresholds, with a response algorithm being activated when any criterion is met.
Multiple parameter system	Response algorithm requires more than one criterion to be met, or differs according to the number of criteria met.
Aggregate scoring system	Weighted scores are assigned to physiological values and compared with predefined trigger thresholds.
Combination system	Single or multiple parameter systems used in combination with aggregate weighted scoring systems.

2.1.2 Overview

The Gao and coworkers (2007) review, a substudy of the work commissioned by the National Institute for Health Research Service Delivery and Organisation (SDO) from the Intensive Care National Audit and Research Centre (ICNARC) (see section 3.3.10), was used as the basis of this evidence review. This review included 36 papers, and reported the results of one primary study of data from acute hospitals in England and Wales. The search strategies developed by Gao and coworkers (2007) were obtained from the authors and re-run to identify studies from 2004 onwards. The updated literature search identified a further 11 studies that met our inclusion criteria (see appendices), making a total of 47 papers. The systematic review classified these papers either as concerned with the development and testing of a track and trigger system, or as describing the use of such a system. From the latter category, we identified studies that looked at the effect of introducing a track and trigger system on patient outcomes, and considered these as a third category (intervention studies). Hence there were three categories of study included in this review.

- Development/validation. These studies were analysed as diagnostic studies. Studies were included in this category only if they included patients both with and without the reference outcome (such as cardiac arrest, ICU admission or mortality). Studies in which the population included patients

with the reference outcome only were classified as descriptive. A key distinction between development and validation is that in development studies identification of parameters, cut-offs, and/or design of scoring systems are determined based on the outcomes of the study sample (for example, through the use of receiver operating characteristics [ROC] curves); for validation studies, these criteria have already been determined and their predictive ability is evaluated in a new sample of patients. Several of the studies included fall into both categories.

- Intervention. These studies considered the effect on patient outcomes of introducing a scoring tool (either alone or in combination with a critical care response team). Studies were included in this category only if they permitted a comparison of outcomes both with and without the scoring tool, for example randomised controlled trials, non-randomised controlled trials, before-and-after studies, cohort studies with historical control. Studies that reported the implementation of a scoring tool but did not permit this comparison were classified as descriptive.
- Descriptive. These were studies included in the systematic review (Gao et al. 2007) that described the use of a scoring tool, but did not fit into the categories outlined above. An overview of these studies is presented in the evidence table for the review of track and trigger systems (see appendix 5.4).

In terms of health economics, no published or unpublished health economic evidence on physiological track and trigger systems was identified. The best available clinical evidence could not support robust de novo economic modelling. Consequently, the recommendations in this section of the guideline are based in large part on informal consensus. Section 2.1.5 presents a discussion of the issues relating to assessing the cost effectiveness of track and trigger systems.

2.1.3 Physiological observations in acute hospital settings

Recommendation 1.2.2.1

Adult patients in acute hospital settings, including patients in the emergency department for whom a clinical decision to admit has been made, should have:

- physiological observations recorded at the time of their admission or initial assessment
- a clear written monitoring plan that specifies which physiological observations should be recorded and how often. The plan should take account of the:
  - patient's diagnosis
  - presence of comorbidities
  - agreed treatment plan.

Physiological observations should be recorded and acted upon by staff who have been trained to undertake these procedures and understand their clinical relevance.

Recommendation 1.2.2.2

As a minimum, the following physiological observations should be recorded at the initial assessment and as part of routine monitoring:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

Evidence review

The evidence relating to whether or not physiological abnormalities are a marker for clinical deterioration was not subjected to formal review in this guideline. It is well recognised that abnormal physiology is associated with adverse clinical outcomes. A multicentre, prospective, observational study (Kause et al. 2004) found that the majority (60%) of primary events (deaths, cardiac arrests and unplanned ICU admissions) were preceded by documented abnormal physiology, the most common being hypotension and a fall in Glasgow coma scale. In the NCEPOD report (2005), the majority (66%) of inpatients who had been in hospital for more than 24 hours before ICU admission exhibited physiological instability for more than 12 hours. Another study (Goldhill and McNarry 2004) found that mortality increased with the number of physiological abnormalities ($p < 0.001$), being 0.7% with no abnormalities, 4.4% with one, 9.2% with two and 21.3% with three or more.

Evidence statement

(IV) Physiological abnormalities are a marker for clinical deterioration.

(For a full definition of how the evidence is graded, please see section 3.3.7)

Evidence to recommendations

Through informal consensus of opinion, the Guideline Development Group agreed that measurement of physiological observations was important and all adult patients should receive a minimum set of physiological observations and a clear written monitoring plan at time of admission or initial assessment. Such measurements provide the necessary input data for the physiological track and trigger systems reviewed in the next section.

The Guideline Development Group considered that it was important to specify what physiological monitoring should be provided to adult patients in acute hospital settings so as to ensure prompt identification of those at risk of clinical deterioration.

It is important to note that most physiological track and trigger systems draw data from the routine observations of physiology (vital signs) carried out by

ward and emergency department staff. These observations are carried out on admission and/or initial assessment and repeated as indicated.

The Guideline Development Group considered it important to specify what physiological observations should be recorded and what the frequency of recording should be, in advance of considering specific physiological track and trigger systems.

2.1.4 Identifying patients whose clinical condition is deteriorating or is at risk of deterioration

Recommendation 1.2.2.3

Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings.

- Physiological observations should be monitored at least every 12 hours, unless a decision has been made at a senior level to increase or decrease this frequency for an individual patient.
- The frequency of monitoring should increase if abnormal physiology is detected, as outlined in the recommendation on graded response strategy (recommendation 1.2.2.10).

Evidence review

Twelve (Bell et al. 2006; Cuthbertson et al. 2007; Duckitt et al. 2007; Gao et al. 2007; Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill & McNarry. 2004; Garcea et al. 2006; Hodgetts et al. 2002; Lam et al. 2006; Subbe et al. 2001; Subbe et al. 2006) studies were identified that were concerned with the development and/or testing of track and trigger systems. All studies were cohort designs, with two exceptions: one (Gao et al. 2007) was a cohort study embedded in a systematic review and the other (Hodgetts et al. 2002) was a case–control design. Another eleven studies were identified that evaluated the effect on patient outcomes of introducing a physiological track and trigger system (Bellomo et al. 2004; Bristow et al. 2000; Buist et al. 2002; DeVita et al. 2004; Foraida et al. 2003; Hillman et al. 2005; Odell et al. 2002; Paterson

et al. 2006; Pittard 2003; Priestley et al. 2004; Subbe et al. 2003). There were two cluster-randomised controlled trials (Hillman et al. 2005; Priestley et al. 2004), and the rest of the studies were observational studies (the majority used a before-and-after study design).

Evidence statements

(III) Physiological track and trigger systems (single parameter, multiple parameter, aggregate weighted scoring and combination) have been developed and evaluated in selected patient populations.

The majority of identified studies were set on hospital wards. Three studies had a hospital-wide setting (including critical care areas) (Gao et al. 2007; Goldhill et al. 2005; Hodgetts et al. 2002), three studies were based on a medical admissions unit (Duckitt et al. 2007; Subbe et al. 2001; Subbe et al. 2003) and two on an accident and emergency department observation ward (Lam et al. 2006; Subbe et al. 2006). Fifteen studies were based in the UK (Cuthbertson et al. 2007; Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Odell et al. 2002; Paterson et al. 2006; Pittard 2003; Priestley et al. 2004; Subbe et al. 2001; Subbe et al. 2003; Subbe et al. 2006), five in Australia (Bellomo et al. 2004; Bristow et al. 2000; Buist et al. 2004; Buist et al. 2002; Hillman et al. 2005), two in the United States (DeVita et al. 2004; Foraida et al. 2003), one in Hong Kong (Lam et al. 2006) and one in Sweden (Bell et al. 2006).

(II) Physiological track and trigger systems, as currently used, have variable performance in measures of diagnostic test accuracy for detecting the following key outcomes:

- *hospital mortality*
- *cardiac arrest*
- *admission to critical care.*

There were seven UK-based diagnostic studies (Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Goldhill and McNarry 2004; Hodgetts et al. 2002; Subbe et al. 2001). One study, a systematic review (Gao

et al. 2007), investigated the diagnostic accuracy of various track and trigger systems in detecting 'composite outcomes' of mortality, critical care admission, do-not-resuscitate orders or the need for cardiopulmonary resuscitation. Two studies (Goldhill et al. 1999b; Subbe et al. 2001) used critical care admission as an outcome measure, three (Garcea et al. 2006; Goldhill and McNarry 2004; Subbe et al. 2001) used mortality, one (Hodgetts et al. 2002) used the need for cardiopulmonary resuscitation and one (Duckitt et al. 2007) used mortality and cardiac arrest. There was also one study from Hong Kong (Lam et al. 2006) that used mortality and critical care admission as outcome measures, and two studies (Buist et al. 2004 from Australia and Bell et al. 2006 from Sweden) that used mortality as a key outcome. In summary, considerable variation exists in the published literature among the type of systems evaluated, physiological parameters included, choice of trigger and the chosen patient outcomes (reference criteria).

(III) Physiological track and trigger systems, as currently used in the NHS in England and Wales, have low sensitivity and positive predictive values but high specificity and negative predictive values. The low sensitivity can be improved by reducing the trigger threshold.

Five specific diagnostic studies carried out in the UK were identified (Garcea et al. 2006; Goldhill et al. 1999b; Goldhill and McNarry 2004; Hodgetts et al. 2002; Subbe et al. 2001). One case–control study (Hodgetts et al. 2002) assessed the ability of a track and trigger system (based on 10 parameters) to predict in-hospital cardiac arrest. The study was carried out to inform the development of medical emergency team (MET) calling criteria. A panel of experts grouped and weighted the activation criteria and a cumulative scoring system was developed. A ROC analysis determined that a score of four has 89% sensitivity and 77% specificity for cardiac arrest; a score of eight has 52% sensitivity and 99% specificity. All patients scoring greater than 10 suffered a cardiac arrest.

A second study (Goldhill et al. 1999b) evaluated the ability of a patient-at-risk team (PART) to predict admission to ICU in hospital ward patients. Patients triggered the system if they had three out of six abnormal physiological

parameters (or reduced consciousness with increased heart or respiratory rate). Sensitivity and specificity for patients with three abnormal observations were 27% and 57% respectively. For patients with one abnormal observation only, sensitivity was 97% (specificity 18%) and for two abnormal observations, sensitivity was 80% (specificity 41%). In a third study (Goldhill and McNarry 2004), also based on the PART calling criteria, stepwise multiple regression identified five significant predictors of 30-day mortality (consciousness, heart rate, age, blood pressure and respiratory rate), sensitivity and positive predictive value of the model were 7.7% and 66.7% respectively. Specificity was 99.8%.

There were also two studies that evaluated aggregate scoring systems. One study (Subbe et al. 2001) evaluated the modified early warning system (MEWS) and found that a trigger score (of five or more) was associated with increased risk of death (odds ratio [OR] 5.4, 95% confidence interval [CI] 2.8 to 10.7), ICU admission (OR = 10.9, 95% CI 2.2 to 55.6) and high dependency unit (HDU) admission (OR = 3.3, 95% CI 1.2 to 9.2). However, diagnostic test accuracy data were not reported. The other study (Garcea et al. 2006) looked at the ability of the early warning score (EWS) to predict mortality in a sample of 110 patients admitted with acute pancreatitis. Sensitivities for the tool on days 1, 2 and 3 following admission were 85.7%, 71.4% and 100%. Specificities were 28.3%, 67.4% and 77.4% respectively.

(II) There is inter-rater and intra-rater variation in the measurement of the physiological variables, although better agreement exists in the thresholds to trigger.

One study (Subbe et al. 2007) evaluated the reproducibility of MET (single parameter), MEWS (aggregate scoring system) and ASSIST (assessment score for sick patient identification and step-up in treatment – aggregate scoring system) for identifying at-risk patients on the ward. It found that there was significant variation in the reproducibility of the three systems examined, and that all three showed better agreement on triggers than aggregate scores. In summary, the study found that MET achieved higher percentage agreement than ASSIST, and ASSIST higher than MEWS; and the intra-rater reliability

was better than inter-rater reliability. The results on triggers in the sub-inter-rater analysis were MET: Kappa = −0.03, 95% CI −0.05 to 0.00; MEWS: Kappa = 0.18, 95% CI 0.09 to 0.27; ASSIST: Kappa = 0.20, 95% CI 0.04-0.38. The results in the sub-intra-rater analysis were MET: Kappa = −0.01, 95% CI −0.02 to −0.01; MEWS: Kappa = 0.64, 95% CI 0.46 to 0.84; ASSIST: Kappa = 0.66, 95% CI 0.04 to 0.38. The study also showed that simpler systems were more reliable.

Evidence to recommendations

The Guideline Development Group discussed whether the evidence for physiological track and trigger systems could be generalised to all acutely ill patients in acute hospital settings. Although the primary studies were from selected population groups, the effects seen were consistent across groups. In addition, the cohort studies used routine data collected from a wide range of settings, including general wards or medical admissions units.

The use of a physiological track and trigger system increases the number of observations made by healthcare professionals (McBride et al. 2005), which the Guideline Development Group considered increased the likelihood of healthcare professionals identifying and acting on abnormal observations.

The Guideline Development Group considered that this recommendation would not be difficult to implement, because the majority of acute hospitals in England and Wales already use physiological track and trigger systems.

2.1.5 Choice of physiological track and trigger system

Recommendation 1.2.2.4

Track and trigger systems should use multiple-parameter or aggregate weighted scoring systems, which allow a graded response. These scoring systems should:

- define the parameters to be measured and the frequency of observations
- include a clear and explicit statement of the parameters, cut-off points or scores that should trigger a response.

Evidence review

Single parameter systems

Two studies (Bell et al. 2006; Buist et al. 2004) evaluated the MET track and trigger tools with a single parameter trigger. One of these (Buist et al. 2004) evaluated a system, based on the MET calling criteria, to predict in-hospital mortality in general ward patients. The MET responded to all abnormal observations. The study reported positive predictive values for mortality with a trigger of one abnormal observation only (positive predictive value = 16.2%), one or more abnormal observations (positive predictive value = 35%) and four or more abnormal observations (positive predictive value = 88.2%). The second study (Bell et al. 2006) considered the accuracy of a system based on four physiological parameters to predict mortality at 30 days and 6 months in general ward patients. If a patient obtained a trigger score on any of the parameters observed, the nurse in charge was informed. For 30-day mortality the system had a sensitivity of 33.3% and specificity of 96.5%; positive predictive value = 33.3% and negative predictive value = 33.3%. For 6-month mortality the system correctly identified 37.5% of patients (sensitivity = 37.5%, positive predictive value = 12.1%; specificity = 87.3%, negative predictive value = 96.8%). In summary, a single parameter system tends to have low sensitivity (range between 16.2% and 37.5% depending on trigger thresholds) and high specificity (range between 87.3% and 96.5%).

A further intervention study (Hillman et al. 2005) (cluster randomised controlled trial) showed that because of the low sensitivity of the MET system, its introduction in 12 Australian hospitals substantially increased call-out rates for the MET when compared with traditional cardiac arrest team (cardiac arrest team = 3.1, 1.3 standard deviation [SD]; MET = 8.7, 3.5 SD; $p = 0.0001$), and the mean number of calls not associated with an adverse event was also significantly higher in hospitals with the MET system (cardiac arrest team = 1.2, 0.8 SD; MET = 6.3, 2.4 SD; $p < 0.0001$).

Multiple parameter systems

Multiple parameter systems were evaluated in three studies (Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill and McNarry 2004), all three studies were based on the PART calling criteria. One of these studies (Goldhill et al. 1999b)

evaluated the ability of the system to predict admission to ICU in hospital ward patients. Patients triggered the system if they had three out of six abnormal physiological parameters (or reduced consciousness with increased heart or respiratory rate). Sensitivity and specificity for patients with three abnormal observations were 27% and 57% respectively. For patients with one abnormal observation only sensitivity was 97% (specificity 18%) and for two abnormal observations sensitivity was 80% (specificity 41%). The second study (Goldhill and McNarry 2004), also based on the PART calling criteria stepwise multiple regression, identified five significant predictors of 30-day mortality (consciousness, heart rate, age, blood pressure and respiratory rate), Sensitivity and positive predictive value of the model were 7.7% and 66.7% respectively (specificity 99.8%). In the third study (Goldhill et al. 2005), the patient-at-risk (PAR) scoring system was tested for its association with the patient's need for intervention and with hospital mortality. The findings showed significant association between PAR score (of > 0) and hospital mortality (chi-squared for trend, $p < 0.0001$), and its ability to discriminate between patients who needed intervention and those who did not (area under ROC curve = 0.822).

Aggregate weighted scoring systems

Five studies (Duckitt et al. 2007; Garcea et al. 2006; Hodgetts et al. 2002; Lam et al. 2006; Subbe et al. 2001) used track and trigger tools with aggregate scoring systems, one of which was based on EWS and two on MEWS. There was also one study that validated a newly developed scoring system – the Worthing Physiological Scoring System (Duckitt et al. 2007). The first study (Garcea et al. 2006) looked at the ability of EWS to predict mortality in a sample of 110 patients admitted with acute pancreatitis. Sensitivities for the tool on days 1, 2 and 3 following admission were 85.7%, 71.4% and 100%; specificities were 28.3%, 67.4% and 77.4% respectively. A ROC curve analysis found that EWS was the best predictor of adverse outcomes (defined as death, pancreatic necrosectomy or critical care admission) in the first 24 hours after admission compared with APACHE (acute physiology and chronic health evaluation) scores, ASA grade, Ranson score, Imrie score, and CT grades.

The second study (Lam et al. 2006) evaluated the ability of a five-parameter MEWS to predict serious outcome (ICU admission and/or death) in a sample of patients on an accident and emergency department observation ward. A score of four or more triggered the system, with a sensitivity of 60% and specificity of 97%. A ROC curve analysis suggested that the system performed best with a score of more than three: sensitivity 100%, specificity 97%.

The third study (Subbe et al. 2001) also evaluated the MEWS system on its ability to predict ICU/HDU admission, attendance of cardiac arrest team and 60-day mortality, in patients in an acute medical admissions unit. Diagnostic test accuracy data were not reported, but a trigger score (of five or more) was associated with increased risk of death (OR = 5.4, 95% CI 2.8 to 10.7), ICU admission (OR = 10.9, 95% CI 2.2 to 55.6), and HDU admission (OR = 3.3, 95% CI 1.2 to 9.2).

The fourth study had a case–control design (Hodgetts et al. 2002) (case–control designs have been shown to result in biased, usually inflated, estimates of test accuracy). A track and trigger system based on 10 parameters was assessed for its ability to predict in-hospital cardiac arrest (defined as cardiopulmonary resuscitation attempted) in hospital patients (including both wards and critical care areas). The study was carried out to inform the development of MET calling criteria. A panel of experts grouped and weighted the activation criteria and a cumulative scoring system was developed. A ROC analysis determined that a score of four had 89% sensitivity and 77% specificity for cardiac arrest; a score of eight had 52% sensitivity and 99% specificity. All patients scoring greater than 10 suffered cardiac arrest.

The fifth study had a prospective observational population based design (single-centre study) (Duckitt et al. 2007). A track and trigger system based on six parameters was validated to investigate the relative contributions of respiratory rate, pulse rate, arterial blood pressure, temperature, oxygen saturation and consciousness level to hospital mortality. The Worthing Physiological Scoring System was devised, with cut off points set at ≥ 2 (be

alert and increase frequency of observations) and ≥ 5 (urgent review). A ROC analysis showed that this scoring system was significantly better than the EWS (Worthing system: area under the ROC = 0.74, 95% CI: 0.71 to 0.77; EWS: area under the ROC = 0.68, 95% CI: 0.65 to 0.71; $p < 0.001$).

Furthermore, there was one cohort study embedded in a systematic review (Gao et al. 2007) that looked at the ability of 15 physiological track and trigger systems, used within acute NHS hospitals in England and Wales, to predict a composite outcome, which was the presence of critical illness (defined as death, admission to critical care, do-not-resuscitate orders, or cardiopulmonary resuscitation). Ten systems used an aggregate scoring system, one used a single parameter system, and four used combination systems. All included heart rate, respiratory rate, systolic blood pressure and level of consciousness, but systems varied in terms of the other physiological parameters assessed, assignment of scores to physiological values and the trigger thresholds used. There were also considerable differences in the response initiated if a patient had a trigger score. The diagnostic accuracy of the systems differed widely. Sensitivities and positive predictive values were low (median sensitivity = 43.3%, interquartile [IQ] range 25.4 to 69.2%; median positive predictive value = 36.7%, IQ range 29.3 to 43.8%). Specificities and negative predictive values were higher (median specificity = 89.5%, IQ range 64.2 to 95.7%; median negative predictive value = 94.3%, IQ range 89.5 to 97.0%). Within hospitals there were some differences in the discrimination of track and trigger systems in different age groups, wards and specialities, but these were not consistent across hospitals. A random-effects meta-regression was used to explore the heterogeneity amongst the datasets. Differences in diagnostic accuracy were not explained by the physiological parameters included in the system, the outcome variables recorded in the dataset, or the inclusion of critical care follow-up versus all ward/medical admissions unit patients.

Evidence statements on alternative track and trigger systems

(II) Single parameter systems, as used by MET systems, have low sensitivity, low positive predictive values but high specificity.

(II) Multiple parameter systems require the presence of one or more abnormal physiological variables. These systems have high sensitivity but low specificity when one abnormal observation is present. Sensitivity reduces and specificity increases as the number of abnormal variables increase.

(II) Multiple parameter systems require the presence of one or more abnormal physiological variables. These systems have comparatively high sensitivity but relatively low specificity when one abnormal observation is present (that is, at low scores). Sensitivity reduces and specificity increases as the number of abnormal variables increase.

(II) Aggregate weighted scoring systems demonstrate a range of sensitivities and specificities depending on the cut-off score used. It is possible to achieve high sensitivity and specificity at defined cut-off scores.

Physiological track and trigger systems have been examined in a variety of settings to determine their ability to identify patients at risk of deterioration. Considerable variation exists between the type of systems evaluated, physiological parameters included, choice of trigger and the patient outcomes (reference criteria) considered. No physiological track and trigger system was identified that had been validated in a variety of populations and settings. However, it could be summarised that:

(II) Single parameter systems trigger a single response strategy. Multiple parameter and aggregate warning systems allow for monitoring of a patient's condition and allow for a graded response strategy to be triggered, depending on the score.

See table 2 for a comparison of the advantages and disadvantages of different types of track and trigger system.

Table 2: Advantages and disadvantages of different types of track and trigger system

Track and trigger system	Advantages	Disadvantages
Single parameter (MET calling criteria)	• Simple to use • Simple system with better reproducibility	• Does not allow a patient's progress to be tracked • Does not allow a graded response strategy • Current evidence suggested that the system has low sensitivity, low positive predictive value but high specificity. This could potentially cause increased triggers that are not related to an adverse event • Not widely adopted in UK hospitals
Multiple parameter (PART)	• Allow monitoring of clinical progress • Allow for a graded response strategy • Widely used in UK hospitals	• May lack reproducibility and reliability because systems are prone to human calculation errors • These systems have high sensitivity but low specificity when one abnormal observation is present, but sensitivity reduces and specificity increases as the number of abnormal variables increase
Aggregate scoring system (EWS, MEWS, The Worthing Physiological Scoring System)	• Allow monitoring of clinical progress • Allow for a graded response strategy • Widely used in UK hospitals	• May lack reproducibility and reliability because systems are prone to human calculation errors • A range of sensitivities and specificities depending on the cut-off score used, but it is possible to achieve high sensitivity and specificity at defined cut-off point

(II) Simpler scoring systems may have better reproducibility than more complex ones.

One study (Subbe et al. 2007) showed that simpler track and trigger systems such as MET calling criteria have better reproducibility than more complex systems such as PART, EWS and MEWS. Another study (Prytherch et al. 2006) also showed that more complex systems such as EWS were prone to human calculation errors. However, the study also showed that this problem could be rectified by adopting electronic devices to calculate and chart EWS. In this study, a classroom comparison study of traditional 'pen and paper' method and 'hand-held computer' method on calculating and charting EWS was carried out. The findings suggested that the 'pen and paper' method resulted in more errors than the 'hand-held computer' method (pen and paper: error = 28.6% [24/84], computer: error = 9.5% [8/84]; pen and paper: incorrect clinical action = 14.3% [12/84], computer: incorrect clinical action = 4.8% [4/84]. The study also showed that the average time for participants to calculate and chart a set of EWS scores was significantly faster in the 'hand-held computer' group compared with the 'pen and paper' group (mean difference of average time for participants to calculate and chart = 24.5 ±12.2s, 95% CI 19.3 to 29.8, $p < 0.0001$).

Evidence to recommendations

The ROC curve plots all types of physiological track and trigger systems along a curve that suggests that all track and trigger systems have similar sensitivities, positive predictive value, specificities and negative predictive value once allowance is made for trigger threshold.

The decision to recommend one system over another depends, among other factors, on the systems' clinical utilities. Multiple parameter systems and aggregate scoring systems have the advantage of allowing tracking of a patient's condition and allow for a graded response strategy, depending on score.

The Guideline Development Group considered that recommendations 1.2.2.3 and 1.2.2.4 would not be difficult to implement, because the majority of acute

hospitals in England and Wales already use physiological track and trigger systems.

The Guideline Development Group noted that automated/electronic systems allow for better recording of data and may result in increased reproducibility. However, the Group identified a need for further research that evaluates the effectiveness and cost-effectiveness of automated/electronic systems before their widespread use could be recommended.

2.1.6 Physiological parameters to be used by track and trigger systems

Recommendation 1.2.2.5

Multiple-parameter or aggregate weighted scoring systems used for track and trigger systems should measure:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

Recommendation 1.2.2.6

In specific clinical circumstances, additional monitoring should be considered; for example:

- hourly urine output
- biochemical analysis, such as lactate, blood glucose, base deficit, arterial pH
- pain assessment.

Evidence review

Thirteen of the identified studies (Bell et al. 2006; Buist et al. 2004; Cuthbertson et al. 2007; Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Lam et al. 2006; Subbe et al. 2001; Subbe et al. 2006) were concerned with the development and/or testing of track and trigger systems. The number of physiological parameters included by the systems within these studies ranged from 4 to 10. All of the track and trigger systems evaluated included heart rate, respiratory rate and systolic blood pressure, and all but one (Hodgetts et al. 2002) also included level of consciousness. Temperature and/or oxygen saturation were often included in systems. Urine output was less frequently included (only 4 out of 13 studies used this as a parameter).

Evidence statements

(III) The following parameters were used in the majority of systems reviewed:

- *heart rate*
- *respiratory rate*
- *systolic blood pressure*
- *level of consciousness*
- *temperature*
- *oxygen saturation*
- *urine output.*

All 13 validation/development studies included heart rate, respiratory rate and systolic blood pressure as parameters. One study (Subbe et al. 2001) had level of evidence Ib, seven studies (Bell et al. 2006; Buist et al. 2004; Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Lam et al. 2006) had level of evidence II and five studies (Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999a; Subbe et al. 2006) had level of evidence III. One of the studies (Cuthbertson et al. 2007) also addressed the question as to the performance of individual physiological observations. It found that heart rate and respiratory rate could

differentiate between patients in a surgical HDU that would or would not require ICU admission, up to 7–8 hours before admission.

Twelve studies included level of consciousness as a parameter: one of these (Subbe et al. 2001) was graded Ib, six (Bell et al. 2006; Buist et al. 2004; Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Lam et al. 2006) were graded II and five (Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Subbe et al. 2006) were graded III.

There were nine studies that included temperature as a parameter. Of these there was one study graded Ib (Subbe et al. 2001), five studies graded II (Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Lam et al. 2006) and three studies graded III (Duckitt et al. 2007; Garcea et al. 2006; Subbe et al. 2006).

Eight studies included oxygen saturation in the systems evaluated. Five of them were graded II (Buist et al. 2004; Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002) and three were graded III (Duckitt et al. 2007; Goldhill et al. 1999b; Subbe et al. 2006). One of the studies (Cuthbertson et al. 2007) also addressed the question of the performance of individual physiological observations. It found that oxygen saturation could differentiate between patients in a surgical HDU who would or would not require ICU admission, up to 48 hours before admission.

Urine output was the least frequently included parameter in the review, used by only four studies. Two were graded II (Goldhill et al. 2005; Goldhill and McNarry 2004) and two were graded III (Goldhill et al. 1999b; Subbe et al. 2006).

Evidence to recommendations

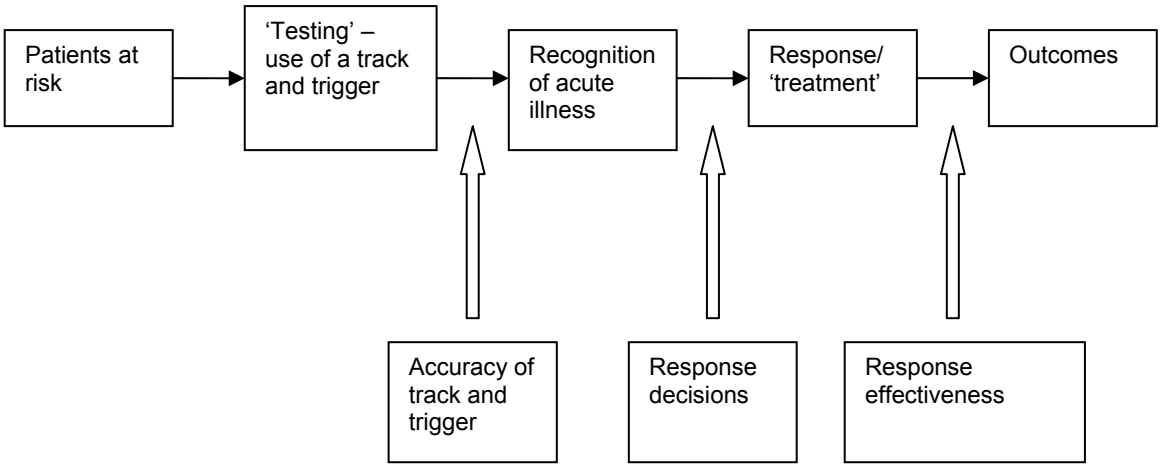
The Guideline Development Group considered that the chosen scoring system should measure a core set of physiological parameters. The evidence reviewed above was discussed and the consensus view of the Guideline Development Group was that heart rate, respiratory rate, systolic blood pressure, level of consciousness, oxygen saturation and temperature should be included. It was decided that although some multiple-parameter or

aggregate weighted scoring systems did not include oxygen saturation, this was an important early predictor of deterioration and should be included as a core parameter. Conversely, although it was noted that some multiple-parameter or aggregate weighted scoring systems included urine output, the consensus of the Guideline Development Group was that urine output should not be a core parameter because reliable assessment of urine output requires bladder catheterisation, and this is performed only in specific clinical circumstances.

2.1.7 Issues relating to assessing the cost effectiveness of physiological track and trigger systems

Track and trigger systems can be viewed as diagnostic technologies. The clinical effectiveness of a diagnostic technology is determined by the extent to which incorporating it into clinical practice improves health outcomes. So, in most instances, the effectiveness of the technology will depend on whether the overall accuracy of identification is improved by its inclusion, its impact on therapeutic decisions and the effectiveness of the treatments subsequently chosen (in this instance, the response strategies). A simplified clinical/evidence pathway for this guideline is shown in figure 1.

Figure 1 Simplified clinical/evidence pathway



Ideally, randomised controlled trials (such as cluster randomised controlled trials in this instance, randomised by hospital rather than ward) of a diagnostic

technology's ability to improve outcomes should be conducted. If such direct evidence is unavailable, it may be possible to link together separate pieces of evidence from the pathway. As noted above, in many cases, physiological track and trigger systems have been introduced in combination with a response strategy, such as outreach services. Section 2.2 discusses more fully the evidence available on response strategies, and an unpublished cost effectiveness analysis of critical care outreach services is described.

One approach to assessing the economic implications of track and trigger systems is to develop a model to estimate the incremental cost per correct 'diagnosis' for each type of system. At it simplest, there will be a limited range of costs included, for example, the cost of monitoring (that is, clinical contact time) and the cost of any tests or measurements necessary, such as costs related to the use of thermometers and other equipment. The costs of clinical contact time (such as healthcare professional time spent collecting and recording data) may be very important in terms of NHS resources. Multiple/aggregate parameter systems are likely to be more resource intensive in this respect than simpler systems.

The basic model described above needs data about the prevalence of the outcome of interest: relevant diagnostic outcomes could be mortality, admission to critical care or some composite measure such as 'established critical illness' (as in the 2007 Gao et al. review). The model also needs to include estimates of sensitivity and specificity. Cost effectiveness may also be influenced by the 'trigger' threshold. However, the evidence is insufficient to distinguish between the available track and trigger systems. The cost effectiveness estimates produced would be highly speculative and difficult to interpret from a decision maker's perspective.

To meaningfully address the issue of the cost effectiveness of track and trigger systems, data on the link between the track and trigger system and the associated response needs to be incorporated into an analysis, together with an estimate of the effectiveness of that response in improving patient outcomes.

2.2 Response strategies for patients identified as having a deteriorating clinical condition

2.2.1 Introduction

Response strategies for patients identified as having a deteriorating clinical condition on general medical and surgical wards and emergency departments in the NHS fall into two groups. Firstly, a ward level response, which ranges from an increased level of physiological monitoring by ward staff to call out of the medical or surgical staff responsible for the patient's care. Secondly, the use of a dedicated hospital team with specific skills in managing the critically ill patient.

In the NHS, dedicated hospital teams – called critical care outreach services (CCOS) – were identified as an important component of future critical care services in 'Comprehensive critical care' (Department of Health 2000). These services aim to prevent admission to critical care or ensure admission is appropriate, to enable discharges from critical care and to share skills with ward and community staff. Critical care networks and NHS trust critical care delivery groups were encouraged to develop their own locally customised service. Since 2000, a wide range of CCOS have been introduced at local level in the NHS (Department of Health and NHS Modernisation Agency 2003). In a recent survey of NHS acute hospitals in England that routinely provide care for level 1 patients, 73% had a formal CCOS (McDonnell et al. in press).

CCOS cover a wide range of activities undertaken for critically ill patients, including:

- education and training for general ward staff on the recognition of critical illness
- the introduction of and response to physiological track and trigger warning systems in general wards
- telephone 'hotline' advice for ward staff
- follow-up of patients on general wards after discharge from critical care

- direct bedside clinical support on general wards
- audit and evaluation of critical care outreach activity
- delivery of rehabilitation programmes (inpatient and outpatient) for patients after a period of critical illness.

2.2.2 Overview

The Esmonde and coworkers (2006) review, a substudy of the work commissioned by the SDO programme from ICNARC (see section 3.3.10), was used as the basis of the NICE evidence review. Critical care outreach services were defined broadly (as above) and the search strategy allowed papers that offered as their 'intervention' both CCOS (as defined above) and ward-level responses to be identified. The Esmonde and coworkers (2006) review included 23 published and unpublished papers: 15 were set in England and Wales, seven in Australia and one in the USA. After further study selection, six papers were excluded from the review because they were unpublished (one unpublished paper, two abstracts, three presentations). The search strategies developed by Esmonde and coworkers (2006) were obtained from the authors and re-run to identify studies from 2004 onwards. The updated literature search (see appendices) identified three extra studies that met our inclusion criteria (see appendices), making a total of 20 papers (10 England and Wales, nine Australia, one USA) to be included in the review.

The systematic review analysed the reported outcomes in the included papers, regardless of the type of outreach services or track and trigger system they used. For instance, the outcomes analyses in the review included impact on mortality, on length of stay, on cardiac arrest rate, on unplanned admissions to the critical care unit and on readmissions to the critical care unit. The study design, track and trigger system used, composition of outreach services and interventions provided by outreach services within the 19 studies and a service evaluation study that were identified by the update search differed widely. These are presented in table 3 and are also summarised in the following section.

- Randomised controlled trials (RCTs). There were two RCTs that used a cluster-randomised design. One study was set in England and Wales (critical care outreach team [CCOT] with a PAR score track and trigger system – multiple parameter system) and the other was set in Australia (MET with single parameter system). The outcomes measured in these two studies were: cardiac arrest rate, unplanned ICU admissions, hospital mortality and hospital length of stay. The quality of information on composition of the team and interventions provided by the team differed between the two studies.
- Observational studies. There were 17 observational studies (uncontrolled before-and-after). Nine were set in the UK (five studies were CCOT using MEWS; one was PART; one was MET; two other studies were CCOT but type of track and trigger system not mentioned), seven were set in Australia (six with MET using single parameter system and one looking at the effectiveness of CCOT on top of MET) and one was set in the USA (MET with single parameter system). The outcomes that were measured in these studies were: hospital mortality, ICU mortality, ICU mortality for unplanned admissions, surgical mortality, cardiac arrest mortality, hospital mortality associated with readmissions, hospital mortality after cardiac arrest, critical care mortality associated with readmissions, 30-day mortality associated with readmissions, 30-day surgical mortality, ICU mortality with tracheotomy tube in situ, cardiac arrest, hospital length of stay, ICU length of stay, hospital length of stay after cardiac arrest, ICU length of stay after cardiac arrest, hospital length of stay following readmissions, ICU length of stay following readmissions, length of stay after major surgery, unplanned ICU admissions and ICU readmissions.
- Service evaluation. There was one service evaluation study from Australia. The study looked at the effect of an education programme on the utilisation of MET.

Overall, the quality of the evidence was poor, and only two RCTs (using a cluster randomised design) were identified. These two studies were of acceptable quality (level of evidence 1+) and provided the evidence statements that formed the basis for the recommendations. The majority of

the other reported studies were retrospective uncontrolled before-and-after studies. These are susceptible to a large number of biases that make it very difficult to ascribe causality to the intervention. These have been graded as meriting an evidence level of 2−. Such studies are reported in the evidence tables but not used as the basis for making clinical guideline recommendations (National Institute for Health and Clinical Excellence 2006).

There were particular challenges in summarising and presenting the evidence of effectiveness of response strategies. CCOS is a complex intervention, with a variety of different components delivered at different times during the care pathway. It is therefore difficult to ascribe any observed effect to any particular part of the intervention and, conversely, to determine which aspects of the intervention may be ineffective. Considering the intervention in terms of population, intervention, comparison group and outcomes, the following issues were identified. The populations reviewed tended to be set in either England and Wales or Australia. In the Australian studies the intervention involved a multidisciplinary MET delivering CCOS responding to a single parameter track and trigger system. In the studies set in England and Wales the intervention was more variable, involving multidisciplinary teams that were often nurse led, and was initiated by the use of a multiple parameter (PART) or an aggregate scoring system (MEWS) track and trigger system. There was also variability in terms of the timing of the evaluation, particularly in the before-and-after studies reported. The literature on ward-level response – as opposed to CCOS – was very limited, with only one study identified as eligible for inclusion in the review.

In addition, the NICE technical team had access to the following unpublished SDO-commissioned ICNARC work (see also section 3.3.10).

- Substudy 4 (McDonnell et al. in press) – survey of outreach services.
- Substudy 5 (Baker et al. unpublished) – qualitative study of a number of case studies of different models of outreach services.
- Substudy 6 (Gao et al. unpublished) – interrupted time series analysis of the impact of outreach services on critical care admissions at the unit level.

- Substudy 7 (Harrison et al. unpublished) – a non-randomised, matched cohort analysis of outreach care at the patient level, within which an economic evaluation forms an important part.

The unpublished substudies 6 and 7 met the inclusion criteria for consideration as a quasiexperimental evaluation of CCOS, and are therefore summarised in this review. The provisional findings were also presented to the Guideline Development Group.

In terms of economic evaluations, a systematic search was carried out for any publications that considered the costs or cost-effectiveness of response strategies including outreach services. The criteria for inclusion were comparatively broad but no relevant published evaluation studies were identified, although some limited data were found on the costs of outreach services. An unpublished economic evaluation of outreach services was identified (part of ICNARC's substudy 7 mentioned above) and made available to the Guideline Development Group.

The limited available evidence on the effectiveness of CCOS has been highlighted by other researchers in the field (Winters et al. 2006). A particular area of concern has been that the implementation of CCOS or rapid response systems in various healthcare systems (including the UK) has occurred in the absence of clear evidence of effectiveness (Price et al. 2007; Teplick and Anderson 2006; Winters et al. 2006).

2.2.3 Critical care outreach services for patients whose clinical condition is deteriorating

Recommendation 1.2.2.7

Staff caring for patients in acute hospital settings should have competencies in monitoring, measurement, interpretation and prompt response to the acutely ill patient appropriate to the level of care they are providing. Education and training should be provided to ensure staff have these competencies, and they should be assessed to ensure they can demonstrate them.

Recommendation 1.2.2.8

The response strategy for patients identified as being at risk of clinical deterioration should be triggered by either physiological track and trigger score or clinical concern.

Recommendation 1.2.2.9

Trigger thresholds for track and trigger systems should be set locally. The threshold should be reviewed regularly to optimise sensitivity and specificity.

Graded response strategy

No specific service configuration can be recommended as a preferred response strategy for individuals identified as having a deteriorating clinical condition.

Recommendation 1.2.2.10

A graded response strategy for patients identified as being at risk of clinical deterioration should be agreed and delivered locally. It should consist of the following three levels.

- Low-score group:
  - Increased frequency of observations and the nurse in charge alerted.
- Medium-score group:
  - Urgent call to team with primary medical responsibility for the patient.
  - Simultaneous call to personnel with core competencies for acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.
- High-score group:
  - Emergency call to team with critical care competencies and diagnostic skills. The team should include a medical practitioner skilled in the assessment of the critically ill patient, who possesses advanced airway management and resuscitation skills. There should be an immediate response.

Recommendation 1.2.2.11

Patients identified as ‘clinical emergency’ should bypass the graded response system. With the exception of those with a cardiac arrest, they should be treated in the same way as the high-score group.

Recommendation 1.2.2.12

For patients in the high- and medium-score groups, healthcare professionals should:

- initiate appropriate interventions
- assess response
- formulate a management plan, including location and level of care.

Recommendation 1.2.2.13

If the team caring for the patient considers that admission to a critical care area is clinically indicated, then the decision to admit should involve both the consultant caring for the patient on the ward and the consultant in critical care.

Evidence review

Two good quality cluster-RCT studies (Hillman et al. 2005; Priestley et al. 2004) with the level of evidence (1+) were included as the basis for recommendations.

One cluster RCT (Hillman et al. 2005) (randomised at hospital level) was set in Australia using a MET, with a single parameter track and trigger system. This study included 23 hospitals in Australia (12 with MET – intervention group, 11 without MET – control group) with a study period of 6 months. There was education/training for all staff within the intervention group before the introduction of the MET system. The composition of the MET differed among the 12 participating hospitals but it was required to be at least the equivalent of the pre-existing cardiac arrest team and to consist of at least one doctor and one nurse from the emergency department or ICU. The type of interventions provided by the MET was not reported in this study.

The other cluster RCT (Priestley et al. 2004) used a stepped wedge trial design (Brown and Lilford 2006) and was set in an acute hospital in England using a nurse-led CCOT with a multiple parameter track and trigger system

(using PAR score). Education/training was introduced to staff sequentially, based on ward level, before the implementation of CCOT with PAR score to that particular ward. The composition of the CCOT in this study was a 24-hour service with one nurse consultant and a team of experienced nurses. In this study ward staff used PAR score to trigger referral to CCOT and involvement of the admitting team's consultant. CCOT would also to be called if there was concern about a patient, irrespective of PAR scores. The level of CCOT involvement was determined by the ward staff and the admitting team. As circumstances required, CCOT might support and advise ward staff, remain with the patient and provide individual nursing care on the ward during a crisis period or facilitate admission to ICU. The study design used (stepped wedge trial design) in this study is a pragmatic design, hence the findings of this study might be subject to bias and contamination.

Review findings

Composite outcomes

One cluster RCT (Hillman et al. 2005) had as its primary outcome the following composite outcomes: incidence of cardiac arrest, unplanned ICU admission (without do-not-resuscitate order) and unexpected death (without do-not-resuscitate order). However, the study found no difference in composite outcome (per 1000 admissions: control = 5.86, intervention = 5.31, difference = −0.264 [95% CI: −2.449 to 1.921], adjusted p = 0.640, adjusted OR = 0.98, 95% CI 0.83 to 1.16).

Mortality rates

One cluster RCT (Priestley et al. 2004) from the UK investigated the effectiveness of CCOT on hospital mortality using PAR scores (multiple parameter system) as calling criteria. There was an education/training phase before the implementation of the CCOT in the intervention group. The trial found a significant reduction in hospital mortality in patients in the intervention wards at cluster level (OR = 0.523, 95% CI 0.322 to 0.849). The cluster RCT from Australia (Hillman et al. 2005) found no difference in unexpected death (without do-not-resuscitate order) (secondary outcome) between control group and intervention group (per 1000 admissions: control = 1.18,

intervention = 1.06, difference = −0.093 [−0.423 to 0.237], 95% CI: −0.423 to 0.237; adjusted p = 0.752, adjusted OR = 1.03, 95% CI 0.84 to 1.28).

Cardiac arrest rates

Only the MERIT study (Hillman et al. 2005) included cardiac arrest rates as a secondary outcome measure. The other cluster RCT from the UK did not include cardiac arrest as a variable. In the MERIT study (Hillman et al. 2005), the analysis showed no significant difference in cardiac arrest rates between the control group and intervention group (control = 1.64, intervention = 1.31, difference = −0.208 [95% CI: −0.620 to 0.204], adjusted p = 0.736, adjusted OR = 0.94, 95% CI 0.79 to 1.13).

Length of stay

Only the UK cluster RCT (Priestley et al. 2004) included hospital length of stay as an outcome measure. The MERIT study did not investigate hospital length of stay. In the Priestley and coworkers (2004) study, the findings showed a possible increased hospital length of stay associated with outreach services but the results were not fully supported by confirmatory and sensitivity analyses. Consequently, hospital length of stay adjusted for clustering in this study was reported as yielding a non-significant effect.

Unplanned intensive care unit admissions

Only the MERIT study (Hillman et al. 2005) included unplanned ICU admissions as a secondary outcome measure. The Priestley and coworkers (2004) study did not include unplanned ICU admission as an outcome measure. The MERIT (Hillman et al. 2005) study showed no significant difference in the rates of unplanned ICU admission (without do-not-resuscitate order) between the control group and intervention group (control = 4.68, intervention = 4.19, difference = −0.135 [95% CI: −2.330 to 2.060], adjusted p = 0.599, adjusted OR = 1.04, 95% CI 0.89 to 1.21).

Number of call-outs to an outreach service

In the process data reported in the MERIT study (Hillman et al. 2005), there was a significant increase in the number of call outs to the MET after the implementation of the team (control = 3.1, 1.3 SD; intervention = 8.7, 3.5 SD;

p = 0.0001). The mean number of call outs not associated with an event – that is, admission to critical care – was also statistically significantly higher in the intervention group than in the control group (per 1000 admissions: control = 1.2, 0.8 SD; intervention = 6.3, 2.4 SD; p < 0.0001). The process measures were not reported in the Priestley and coworkers (2004) study.

Educational training

Both studies have a component of education/training preceding the implementation of CCOS. In the MERIT study (Hillman et al. 2005) the education programme was provided to all staff (over a 4-month period before introduction of the MET) using lectures, a MET video explaining the concept and process and books. The content of the education programme included the identification of patients at risk, the use of calling criteria, the need to call quickly if criteria were met and how to call the MET. A 4-week training programme facilitated by the CCOT was also given to all nurses and doctors in the Priestley and coworkers (2004) study. This training preceded the formal implementation of the CCOT. The training programme included formal and informal sessions on the use of an in-house 'patient-at-risk' score (PAR) as calling criteria.

Composition of, and the interventions provided by, the critical care outreach services

The composition of the MET and CCOT differed in the two studies. In the MERIT study (Hillman et al. 2005) the METs in the 12 intervention hospitals were different from each other but each was required to be at least the equivalent of the pre-existing cardiac arrest team and to consist of at least one doctor and one nurse from emergency department or ICU. In the Priestley and coworkers (2004) study, the composition of the CCOT consisted of a team led by a nurse consultant with five nurses (4.5 whole time equivalents) from various specialities and eight sessions per week of support from consultant anaesthetists with special interest in critical care. The five nurses were all senior and experienced and were seconded into the team from their posts in critical care, theatre recovery, general surgery, medicine and orthopaedics. Ward staff and the admitting team's consultant were also involved at ward-level during the calling process.

The type of interventions provided by the MET in the MERIT study (Hillman et al. 2005) was not reported. In the Priestley and coworkers (2004) study the level of CCOT involvement was determined by ward staff and the admitting team. As circumstances required, CCOT might support and advise ward staff, remain with the patient and provide individual nursing care on the ward during crisis period, or facilitate the admission to ICU. There was also emphasis on sharing skills, collaboration with the admitting team and provision of practical 'hands-on' help to ward staff.

Evidence statements

(1+) The two included studies differed from each other with regard to the population under study, baseline and study design, what was delivered as an intervention, the control group and outcomes under study. The intervention in each case was a complex intervention.

(1+) Both included studies delivered training on how to recognise and manage the acutely ill patient to ward staff before the implementation of CCOS. In addition, both studies delivered CCOS by healthcare professionals with appropriate training and competencies in the management of critically ill patients.

(1+) One study (MERIT) reported a composite outcome, which comprised the incidence of cardiac arrest, unplanned ICU admission (without NFR) and unexpected death (without NFR). It found no difference between the intervention group and the control group for this composite outcome.

(1+) There were conflicting findings in the two included studies on mortality rates: the Priestley and coworkers study found a significant reduction in mortality (but failed to report do-not-resuscitate orders), but MERIT found no difference between the two arms of the study for this outcome.

(1+) The MERIT study reported cardiac arrest data, finding no difference in arrest rates between the intervention group and the control group. In addition, MERIT showed no difference in 'unplanned intensive care unit admissions' between the intervention group and the control group. The Priestley and

coworkers study did not include unplanned ICU admission as an outcome measure.

(1+) The MERIT study reported a large increase in the number of call outs to the critical care outreach service (MET has single parameter calling criteria) that did not require admission to critical care areas.

(1+) Only the Priestley and coworkers study reported data on length of stay: it showed no difference in the length of stay between the intervention group and the control group.

No studies were identified as being of sufficient quality to be included as the basis for clinical recommendations on the use of ward-level interventions as a response strategy.

Unpublished National Institute for Health Research Service Delivery and Organisation work

Because the work from the National Institute for Health Research Service Delivery and Organisation (SDO) was unpublished and not yet accepted for peer-reviewed publication at the time of the going to press, the findings of substudy 6 (Gao et al. unpublished) and substudy 7 (Harrison et al. unpublished) were viewed as provisional.

Substudy 6 (Gao et al. unpublished) was a multicentre interrupted time-series analysis examining the impact of the introduction of CCOS in England. The method adopted aimed to control for long term trends and seasonality in the data. The introduction of outreach services at different times and at different locations provided a natural experiment that could be used to minimise (but not completely eliminate) the impact of historical biases. The analysis was based on population-level effects and it is important to emphasise that causality cannot be attributed to the observed associations.

This study found that the presence of formal outreach service was associated with a significant decrease in cardiopulmonary resuscitation rates during the 24 hours before admission, in out-of-hours admission and in mean ICNARC

physiology score for admissions from the ward. However, no sustained effect was seen on mortality or readmission rates for patients discharged alive from CCU.

Substudy 7 (Harrison et al. unpublished) was a matched cohort analysis of the impact of outreach services at the patient level, as characterised by the case mix, outcome and activity of patients admitted to/discharged from critical care units participating in the Case Mix Programme. An economic evaluation formed part of this substudy. Fifty two outreach services were included in the analyses, and the median period of prospective data collection was 9 months.

For each case (that is, included hospital outreach service) three sets of matched controls were selected.

- Match 1: historic control before the introduction of a CCOS.
- Match 2: a concurrent admission to different hospital with no outreach service.
- Match 3: an admission to the same hospital during the study period but not seen by the outreach team.

In addition, a propensity model was built for each cohort by using logistic regression to model the factors predictive of receiving critical care outreach visits before admission or after discharge. Sensitivity and subgroup analyses were undertaken.

In terms of outreach activity prior to admission, the primary analysis on the difference in mean ICNARC physiology score found a statistically significant difference for match 1, but not for matches 2 and 3 (see table 3). With respect to outreach activity following discharge from the critical care unit, the primary analysis on the difference in hospital mortality found that it was lower for cases than controls: the difference was statistically significant in match 2 (see table 4). The propensity model produced similar results to those from the individually-matched analyses.

Table 3 Individually-matched results for outreach before admission: primary outcome – difference in mean ICNARC physiology score

Match	Mean (standard deviation)		Difference in means	
	Case	Control	Δ (95%confidence interval)	p value
1	21.3 (9.8)	22.3 (10.4)	−1.00 (−1.81 to −0.19)	0.016
2	21.9 (10.1)	21.9 (10.9)	0.03 (−0.61 to 0.67)	0.93
3	22.2 (10.1)	21.8 (10.4)	0.35 (−0.36 to 1.06)	0.34

Table 4 Individually-matched results for outreach after discharge: primary outcome – hospital mortality

Match	Deaths (percentage)		Matched pairs risk ratio	
	Case	Control	Relative risk (95% confidence interval)	p value
1	174 (10.3)	220 (12.7)	0.85 (0.70 to 1.02)	0.085
2	426 (10.2)	497 (11.7)	0.87 (0.78 to 0.98)	0.022
3	156 (8.9)	158 (9.0)	1.01 (0.82 to 1.25)	0.90

Overall, the results from matches 1 and 2 were broadly consistent with each other both before and after transfer from the critical care unit. The main inconsistency was in match 3, and this was probably the result of severe selection biases.

Health economics

Response strategies can be quite complex and are often introduced alongside a track and trigger system, although responses can be initiated in the absence of a track and trigger score if there is adequate concern. Ideally an economic evaluation would therefore wish to link the effectiveness of the track and trigger system with the appropriate response and estimate incremental costs per quality-adjusted life year (QALY) gained. At a basic level, an economic model could consider three alternatives:

- track and trigger plus outreach
- track and trigger plus ward level response
- conventional management.

Because many track and trigger systems allow for graded responses, typically increasing the frequency of observations at a relatively low threshold and informing more senior staff or an outreach team at higher thresholds, it would be important to incorporate this aspect of response into any model. Important parameters in this model would include length of hospital stay, the risk of cardiac arrest and death, and quality of life.

However, the data to convincingly inform such a model are largely absent, at least in the published literature. Of the effectiveness studies reviewed, the overwhelming majority considered the impact of introducing some form of outreach service. Only one identified study (a 'before-and-after' investigation by Paterson and coworkers, 2006) considered a form of ward-level response. However, because of the substantial risks of bias in that study, it would be impossible to draw any robust conclusions from its findings. Ward-level responses are not 'simple' interventions because, as noted above, the precise details will depend on, among other things, the thresholds put in place during patient monitoring. No study was identified that assessed the impact of the use of a particular response strategy on health-related quality of life.

Outreach services are complex interventions with no apparently consistent typology. Generalisability is therefore a significant problem based on the available data. Any data on the effectiveness of such a service is likely to be specific to the particular characteristics of the intervention in an individual study. Because outreach services as assessed in the studies have multiple components (that is, a track and trigger system, educational elements and the outreach team itself), it is unclear how these individual components might separately influence outcomes.

In terms of the costs of CCOS, Whiting and Edbrook (2006) cited mean annual outreach nursing and physiotherapy costs of £4427.20 per ICU bed (2003–4 prices) based on audit data sourced from the Medical Economics and Research Centre, Sheffield. There was considerable variation around that estimate, however. In addition, the mean cost of medical staff input into an outreach service was estimated at £456 per ICU bed per year.

ICNARC undertook an economic evaluation of outreach services following discharge from the critical care unit. In this analysis (part of the unpublished substudy 7 (Harrison et al. unpublished) described in 'Unpublished National Institute for Health Research Service Delivery and Organisation work, section 2.2.3), the estimated direct costs of an outreach service were based on whole time equivalent staff with dedicated time allocated to the particular outreach service. The mean cost per visit for each outreach service was calculated as the annual staff costs divided by the annual number of visits, and was estimated to be £115 for the hospitals participating in the prospective cohort analysis.

The other costs considered in the analysis that applied to both cases (the intervention group) and controls, related to intensive care after the original discharge from critical care (at a cost of £1716 per day), and the number of days of ward care following the original discharge from critical care (at a cost of £220 per day). The mean number of days in intensive care after the original discharge from the critical care unit was found to be higher for cases than matched controls, but the mean number of days in hospital not in intensive care was lower for cases than for controls. In terms of overall costs, for matches 1 and 2 cases were on average less costly than controls (that is, the existence of a CCOT appears to be associated with overall cost savings). In contrast, the mean costs were higher for cases than for controls in match 3. However, none of the cost differences reached statistical significance.

Incremental costs were plotted against incremental benefits (absolute risk reduction for mortality before ultimate discharge from an acute hospital) for 10,000 bootstrap samples of the original data. ('Bootstrapping' is a statistical method based on repeated random sampling with replacement from an original sample, allowing a sampling variance to be empirically estimated). The paper also showed cost-effectiveness acceptability curves.

In terms of the individually matched results in the base case analysis, it was found that for matches 1and 2 there was an apparent high probability that outreach visits after transfer from CCU are cost effective, regardless of willingness to pay. Outreach services dominated (were less expensive and

more effective) in 82% of bootstrap samples in match 1; in match 2 CCOS dominated in 57% of samples. However, in match 3 the control arm dominated in 44% of bootstrap samples. The outcomes were similar when using the propensity model results and also after undertaking certain sensitivity analyses (for example, altering the unit cost of hospitalisation).

It is important to note that this economic analysis was based on observational patient level data. It considered only outreach activity after discharge from the critical care unit, over a comparatively short time horizon. The authors had sufficiently detailed data only on the patients that were admitted to critical care. The evidence presented in substudy 7 (Harrison et al. unpublished) appeared not to favour outreach services before admission to critical care, at least in terms of ICU mortality, length of stay and hospital mortality. However, these were secondary outcomes in the authors' analysis, and should be cautiously interpreted.

The economic results were partly sensitive to the estimate of mean effectiveness (and the degree of uncertainty around this estimate), although match 3 could be considered an extreme and unlikely scenario. The effectiveness outcome measure used in the analysis – hospital death averted – is not ideal. No estimate was made of the incremental (discounted) life years gained. The impact on health-related quality of life is unknown. It is unclear whether extrapolation beyond hospital survival would have significantly altered the conclusions of the analysis.

The weight of evidence is equivocal with respect to the effectiveness of outreach services on patient outcomes such as mortality, although aspects of its subcomponents (such as education and training, and use of a track and trigger system) may be very important. Interpreting the evidence is further complicated by the diversity of outreach service configurations. On this basis, the overall cost-effectiveness of outreach services compared with conventional care in its absence remains unknown.

Evidence to recommendations

The Guideline Development Group noted that response strategies in the included studies were triggered by both physiological track and trigger scores and by 'clinical concern' on the part of the relevant healthcare professional.

The Guideline Development Group noted that the two included studies that evaluated the effectiveness of a response strategy (critical care outreach) provided education and training on the recognition and response to critical illness to ward staff as well as delivering a specific response strategy. The Guideline Development Group considered the delivery of education and training of ward staff of key importance. The Guideline Development Group considered this to be a factor that underpins the correct measurement of physiological variables, the correct use of track and trigger systems and the correct response to a patient at risk of clinical deterioration.

The Guideline Development Group considered that there should be a graded response strategy. The details of the strategy might differ according to the type of multiple or aggregate track and trigger system used. The recommendations in this section were developed by group consensus because of the difficulties with current evidence on the effectiveness of response strategies, which are documented below.

The Guideline Development Group noted the conflicting findings of the two included studies on response strategies. It considered on the basis of the two included studies that there was no firm evidence of effectiveness and an absence of evidence of cost-effectiveness of CCOS. The Guideline Development Group was therefore unable to recommend any specific service configuration for the care of patients whose clinical condition is deteriorating.

The Guideline Development Group reviewed the unpublished SDO-funded ICNARC work (substudy 6 [Gao et al. unpublished] and substudy 7 [Harrison et al. unpublished]) with the aim of determining whether these data were likely to lead to a change in the recommendations based on the two included studies. The Guideline Development Group's view was that this work did not

offer firm evidence of effectiveness and cost-effectiveness of CCOS, and that the recommendations should stand.

The Guideline Development Group also considered that the components of the complex intervention in both included studies – education of ward staff and a response strategy – should form the basis of its consensus recommendations in this area. It considered that a range of service configurations could deliver these components, and that NHS trusts should decide which configuration was most appropriate to local NHS service needs.

2.3 Transfer of patients from critical care areas

2.3.1 Introduction

Critical care area transfer planning ought to seek safe and efficient transition from the critical care area to general medical and surgical wards. Poor planning may result in discontinuity of care, delayed recovery, adverse health outcomes and re-admission to critical care areas. The timing of transfer from critical care areas to general wards is an important issue in this planning and is specifically included in the scope for this guideline. Thus the first part of this evidence review specifically considers whether the timing of transfer from critical care areas to the general ward, specifically 'in hours' as opposed to 'out of hours' or 'night' transfer, has an impact on health outcomes for patients. This question is asked in the context of the decision to transfer on clinical grounds having already been made. The decision to transfer a patient from critical care areas is outside the scope of this guideline.

Patients being treated in a critical care area will be recovering from a serious illness and will have required a level of dependency on medical, nursing and allied healthcare professionals that is much greater than that found on general wards. Consequently the transition back to the general wards can be anxiety provoking for many patients. The situation can be exacerbated if healthcare professionals on the general wards are not fully aware of the patient's physical, emotional and psychological condition. A period of critical illness can have a significant impact on a patient's quality of life and functional status. The longer the period of illness and the greater the complexity of care

required in critical care, the greater the potential for residual physical, emotional and psychological morbidity. Any ongoing care issues related to the original reason for admission to the critical care area will also need to be addressed in planning the transfer back to the general ward.

Unfortunately the step down of nursing care from 'one-to-one' to 'one-to-many' is sometimes also accompanied by a lack of continuity of care from the critical care and parent teams and a reduction in the depth and breadth of care provided. These factors commonly lead to patient distress. It is therefore important to consider what elements of care on general wards are viewed as important by patients and healthcare professionals following transfer from critical care areas. The second part of this evidence review specifically addresses the evidence of patients' experiences of care received, and focuses on the period immediately after transfer from the critical care area.

As well as the timing of transfer and patients' experiences of care, it is also important to establish whether there are any interventions, such as routine ward-based follow-up from CCOTs or other response strategies, that can be delivered to this particular group of patients on general wards following transfer and that have been shown to improve health outcomes. Therefore, the third key clinical question this evidence review sought to address was what interventions can be delivered to patients who have been transferred from critical care areas in the immediate post-transfer phase on general wards.

A systematic review of the economic literature was undertaken where relevant.

2.3.2 Overview

Seven studies were identified that investigated the effect on patient outcomes of the time of transfer from a critical care area to the general ward. All seven were observational studies (cohort studies) and no randomised control trials were identified. After full review of the paper, one study (Hixson et al. 2005) was excluded because its study population was not covered by the guideline scope (age range of study population was 0–21, and specific data on age

range 16–21 was not available in the study). Consequently, there were six studies included in this review. Two were set in the UK (one is a single hospital study, the other is a study using national databases), two in Australia, one in Canada and one in Finland. The patient outcomes that were measured were hospital mortality, ICU length of stay and unplanned ICU readmission. However, hospital mortality was the only outcome that was analysed after case-mix adjustment and hence this narrative summary focuses on this particular patient outcome. All studies were of acceptable quality (level of evidence: 2+). These six studies provided the evidence statements that formed the basis for the recommendations.

For the second review, on patients' experiences of care, six studies were identified on the basis of title and abstract as addressing aspects of care considered important by patients following transfer from critical care areas. All studies used a qualitative design. After full review of these papers, four were excluded from the review because they addressed care given in critical care areas and concerns regarding transfer, rather than providing accounts of the care on general wards after transfer. Both included studies were set in the UK. A further relevant unpublished study was identified by the NICE Patient and Public Involvement Unit from the Database of Individual Patient Experiences team (DIPEx). Qualitative studies were assigned evidence level 3 in accordance with NICE technical guidance (National Institute for Health and Clinical Excellence 2006).

Economic evaluation was not viewed as directly relevant with respect to the timing of transfer from the critical care unit, and the elements of care on the general ward viewed as important by patients following transfer. Economic analyses were neither identified in the literature nor prepared de novo. The timing of transfer may have important patient-related and economic consequences, although no study was identified that specifically examined this issue. It appears from the evidence that issues related to 'premature transfer' and bed availability may be important factors influencing outcomes. An economic analysis would therefore be best focused on interventions (such as outreach services) that may have an impact on premature discharge and

the timing of discharge. Similarly, the current review did not directly address strategies or interventions (such as informational booklets) that might further improve patient experience following transfer and whose cost effectiveness could be estimated.

The final evidence review in this section investigated what interventions should be delivered to patients who have been transferred from critical care areas in the immediate post-transfer phase on general wards. The search strategy for section 2.2, 'Does a specific response strategy improve outcomes for patients identified as having a deteriorating clinical condition?', identified a subgroup of studies that looked specifically at patients transferred from critical care areas. Four studies (Ball et al. 2003; Bellomo et al. 2004; Garcea et al. 2004; Pittard 2003) were identified that investigated the impact or effect of critical care services on mortality rates and ICU readmission for this patient subgroup. Three studies were from the UK and one from Australia. All four were uncontrolled before-and-after studies with level of evidence of grade (2−). Such intervention studies were considered to have a high risk of bias and confounding factors, and therefore could not be used to make recommendations for clinical practice in this guideline. An unpublished SDO-commissioned ICNARC study (Substudy 7; Harrison et al. unpublished) also investigated the impact of CCOS on mortality, ICU readmission and length of stay in hospital for patients post-discharged from ICU. However, due to the inconsistent findings within different matches and different analysis models in this particular study, the unpublished evidence provided could not be used to make recommendations for clinical practice in this guideline. All of these studies are therefore presented in the relevant evidence table but not in this review.

As described in 'Unpublished National Institute for Health Research Service Delivery and Organisation work', section 2.2.3, a single unpublished study was identified that undertook an economic analysis of outreach services following ICU transfer. No other economic evidence is available.

2.3.3 Timing of transfer of patient from critical care areas to general wards

Recommendation 1.2.2.14

After the decision to transfer a patient from a critical care area to the general ward has been made, he or she should be transferred as early as possible during the day. Transfer from critical care areas to the general ward between 22.00 and 07.00 should be avoided whenever possible, and should be documented as an adverse incident if it occurs.

Evidence review

Six studies were identified for this particular key clinical question. Five out of six studies (Beck et al. 2002; Duke et al. 2004; Goldfrad and Rowan 2000; Priestap and Martin 2006; Tobin and Santamaria 2006) (with level of evidence: 2+) found that the timing of transfer from ICU to general ward was associated with increased hospital mortality. Two of the studies were from the UK (Beck et al. 2002; Goldfrad and Rowan 2000), one from Canada (Priestap and Martin 2006) and two from Australia (Duke et al. 2004; Tobin and Santamaria 2006). The study from Finland (Uusaro et al. 2003) found no associations between times of transfer and death.

Apart from hospital mortality, two studies (Duke et al. 2004; Priestap and Martin 2006) also found that the timing of transfer had an impact on ICU re-admission.

Evidence statement

(2+) The timing of transfer of patients from critical care areas (ICU) to general wards is associated with adverse patient outcomes. Transfer at night is associated with:

- *an increased hospital mortality rate*
- *a higher ICU re-admission rate.*

All six studies have hospital mortality as an outcome measure, but only two include ICU re-admission as an outcome measure. One cohort study

(Goldfrad and Rowan 2000) from the UK investigated hospital mortality with night-time transfers from intensive care. This study used data from a national database (Intensive Care National Audit and Research Centre's Case Mix Programme Database – CMPD) from 1995 to 1998 to examine hospital mortality rates with night transfers compared with day transfers. There were two definitions of 'night transfer' in the study: from 22:00 to 06:59 and from 00:00 to 04:59. Both 'night' definitions were analysed as separate variables.

The analysis showed that both night transfers (from 22:00 to 06:59 and from 00:00 to 04:59) had significantly higher unadjusted odd ratios of hospital mortality compared with day transfers. After case-mix adjustment using the APACHE II method, the study found that both definitions of night transfer had a higher hospital mortality rate compared with day transfer ('22:00 to 06:59': adjusted OR = 1.33, 95% CI 1.06 to 1.65; '00:00 to 04:59': adjusted OR = 1.53, 95% CI 1.11 to 2.13). When looking at the data on 'direct transfer to the wards', both definitions of night transfer had a higher case-mix adjusted hospital mortality rate compared with day transfer ('22:00 to 06:59': adjusted OR = 1.37, 95% CI 1.06 to 1.78; '00:00 to 04:59': OR = 1.73, 95% CI 1.19 to 2.53). However, when further adjustment was made for 'premature transfer', the findings were statistically not significant for either group (overall transfer: '22:00 to 06:59': adjusted OR = 1.17, 95% CI 0.92 to 1.49; '00:00 to 04:59': adjusted OR = 1.33, 95% CI 0.95-1.87; direct transfer to the wards: '22:00 to 06:59': adjusted OR = 1.18, 95% CI 0.90 to 1.56; '00:00 to 04:59': adjusted OR = 1.47, 95% CI 0.97 to 2.17). It should be noted that 'premature transfer' in this particular study was based on an analysis of the data collected under the heading of 'reason for transfer from ICU' and was based on a clinician's subjective assessment of a patient's readiness for transfer in the light of the needs of other patients for the ICU beds. There was no attempt made to impose standard explicit criteria for this variable. The decision to transfer is a clinical judgement based on physiological variables, concurrent treatment and clinical assessment. This model of care could potentially be strengthened by statistical modelling of physiological, organ dysfunction and other clinical data (Daly et al. 2001).

In another single-hospital UK cohort study (Beck et al. 2002), the findings showed that both crude (unadjusted) mortality risk and adjusted mortality risk were significantly higher for 'late' transfer compared with 'early' transfer. In this study, 'early' transfer was defined as from 08:00 to 19:59 and 'late' transfer was defined as from 20:00 to 07:59. The results of the study after adjusting for disease severity suggested that 'late' transfers from ICU would increase the mortality risk of patients ('late' transfers compared with 'early' transfers: adjusted relative risk [RR] = 1.70, 95% CI 1.28 to 2.25). Looking at the adjusted mortality risk for patients 'transferred directly to general wards', the study also found 'late' transfer increased the mortality risk of patients compared with 'early' transfer (adjusted RR = 1.87, 95% CI 1.36 to 2.56). On the other hand, the difference in mortality risk of patients 'transferred directly to HDU' did not reach statistical significance ('late' transfers compared with 'early' transfers: adjusted RR = 1.35, 95% CI 0.77 to 2.36).

The third cohort study (Priestap and Martin 2006) was a Canadian study. Data was extracted from a Canadian national database that involved 31 Canadian hospitals. Again, both crude (unadjusted) and adjusted in-hospital mortality rates were significantly higher for night-time transfer compared with day-time discharge. The definition of 'day-time' transfer was from 07:00 to 20:59. There were two different definitions for 'night-time' transfer (from 21:00 to 06:59 and from 00:00 to 06:59) and both 'night-time' definitions were analysed as separate variables. After adjusting for severity of illness, the analysis of the study indicated that patients transferred from ICU at night have an increased risk of dying in hospital compared with those transferred during the day (adjusted $OR_{21:00–06:59}$ = 1.22 (95% CI 1.10-1.36); adjusted $OR_{00:00–06:59}$ = 1.26, 95% CI 1.07 to 1.49).

There were two single-hospital cohort studies from Australia. In one (Duke et al. 2004) the times of transfer were defined as 'day' (from 07:30 to 15:00), 'evening' (from 15:00 to 22:00) and 'night' (from 22:00 to 07:30). The crude (unadjusted) analysis showed that the case-fatality rate for 'night' transfer was significantly higher than for 'day' transfer and 'evening' transfer. After adjusting for severity of illness, limitation of medical treatment (LMT) status

and premature or delayed ICU transfer, logistic regression analysis found that 'night' transfer, together with APACHE II predicted mortality and LMT order were significant predictors for hospital death ('night' discharge: adjusted RR = 1.7, 95% CI 1.03 to 2.9, p = 0.03; APACHE II predicted mortality : adjusted RR = 3.3, 95% CI 1.3 to 7.6, p < 0.001; LMT order: adjusted RR = 5.1, 95% CI 2.2 to 12, p < 0.001). The findings of this study suggested that the timing of ICU transfer, in addition to the (initial) severity of illness and LMT order, influenced ICU survival.

In the second Australian study (Tobin and Santamaria 2006), the times of transfer were defined as morning shift (07:00 to 14:59), afternoon shift (from 15:00 to 21:59) and night shift (from 22:00 to 06:59). Unadjusted odd ratios showed that both afternoon shift and night shift had significantly higher hospital mortality than morning shift. After adjusting for severity of illness, multivariate analysis also showed that hospital mortality was significantly higher for afternoon shift and night shift than for morning shift (afternoon: adjusted OR = 1.36, 95% CI 1.08 to 1.70; night: adjusted OR = 1.63, 95% CI 1.03 to 2.57).

The Finish study was a cohort study of 18 ICUs (Uusaro et al. 2003). There were two 'time of transfer' categories. Category one defined times of transfer as 'out of office hours' (from 16:00 to 08:00) and 'office hours' (from 08:00 to 16:00); category two defined them as 'weekday' (from 00:01 Monday to 15:59 Friday) and 'weekend' (from 16:00 Friday to 24:00 Sunday). In category one, analysis showed that crude (unadjusted) hospital mortality rate was significantly higher for 'out of office hours' transfer than for 'office hours' transfer. However, logistic regression analysis (after adjustment) showed no difference between 'office hours' transfer and 'out of office hours' transfer on hospital mortality rate (adjusted OR = 1.11, 95% CI 0.93 to 1.31, p = 0.24). Both crude (unadjusted) and logistic regression analysis (after adjustment) showed no differences on hospital mortality rate between 'weekday' and 'weekend' transfer (logistic regression: adjusted OR with 'weekend' transfer = 0.88, 95% CI 0.73 to 1.07, not significant, p-value not reported).

Apart from hospital mortality rate, two studies (Duke et al. 2004; Priestap and Martin 2006) also included unplanned ICU re-admission as an outcome measure. In Priestap and Martin's (2006) study, the crude (unadjusted) unplanned ICU re-admission rate within 48-hours of ICU transfer to the ward was significantly higher for night-time transfer (from 21:00 to 06:59) than for day-time transfer (from 07:00 to 20:59) (day = 1.7%, night = 2.4%, $p < 0.001$). In another study (Duke et al. 2004), crude (unadjusted) unplanned ICU re-admission rate for day transfer to the ward was also significantly lower than for evening and night transfer (day 3.5%, evening 5.1%, night 7.5%, $p = 0.015$).

Evidence to recommendations

The Guideline Development Group noted that discharge at night was consistently associated with increased mortality in the reviewed studies and considered this justified a recommendation not to transfer patients out of critical care areas at night whenever possible. However, it also noted that 'night transfer' is generally viewed by UK clinicians as a consequence of pressure for ICU beds and is a proxy for premature transfer. This is supported by one UK study (Goldfrad and Rowan 2000) that specifically used transfer at night as a proxy measure to investigate pressure on ICU beds and found that night transfer was not significantly associated with increased mortality once adjustment was made for premature transfer.

The Guideline Development Group considered that it was possible to specify a 'core' night-time range on the basis of the evidence reviewed, during which one could be reasonably certain that there was a likelihood of adverse outcomes.

2.3.4 Elements of care on the general ward viewed as important by patients following transfer

Recommendation 1.2.2.15

The critical care area transferring team and the receiving ward team should take shared responsibility for the care of the patient being transferred. They should jointly ensure:

- there is continuity of care through a formal structured handover of care from critical care area staff to ward staff (including both medical and nursing staff), supported by a written plan
- that the receiving ward, with support from critical care if required, can deliver the agreed plan.

The formal structured handover of care should include:

- a summary of critical care stay, including diagnosis and treatment
- a monitoring and investigation plan
- a plan for ongoing treatment, including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
- physical and rehabilitation needs
- psychological and emotional needs
- specific communication or language needs.

Recommendation 1.2.2.16

When patients are transferred to the general ward from a critical care area, they should be offered information about their condition and encouraged to actively participate in decisions that relate to their recovery. The information should be tailored to individual circumstances. If they agree, their family and carers should be involved.

Recommendation 1.2.2.17

Staff working with acutely ill patients on general wards should be provided with education and training to recognise and understand the physical, psychological and emotional needs of patients who have been transferred from critical care areas.

Evidence review

Three studies were found that addressed the question 'What elements of care on the general ward are viewed as important by patients following discharge?' All three used a qualitative design (phenomenological approach with purposive sampling) and all were set in the UK (two in Northern Ireland and one in England). The findings of these three studies were reviewed and synthesised into four themes.

Evidence statements

(3) Patients identified four areas that they considered to require specific attention during the period immediately after transfer from the critical care area to general wards.

- *Continuity of care between critical care area staff and ward staff (patients felt that problems arose because of poor communication).*
- *Help with managing their physical and emotional experiences.*
- *Help with managing the transition from one-to-one care in critical care areas to the lower staffing levels on general wards.*
- *Information on their condition and process of recovery that was tailored to their individual circumstances.*

The four themes that were identified were continuity of care and coordination on the ward, physical and emotional experiences, provision of care on the ward and information for patients. Patients reported in two studies (DIPEx; Strahan and Brown 2005) that a lack of continuity of care was caused by inadequate communication between ICU staff and those in the general wards, and had led to unnecessary stress for the patients. For instance, some patients said that communication was poor between ICU staff and ward staff,

and occasionally – for example when nurses on the ward were unaware of their medications or dietary restrictions – they felt this had affected their treatment and progress. However, there were also positive experiences: a few patients recalled being visited by outreach nurses, and felt that this had made the transition easier.

All three studies (DIPEx; McKinney and Deeny 2002; Strahan and Brown 2005) presented details on patients' physical and emotional experiences. In terms of physical experiences following transfer from ICU to a general ward, patients generally reported physical weakness/frailty, lack of mobility, sleep disturbances, minor to moderate pain, bowel complications and feelings of sickness, nausea and lack of appetite. In terms of emotional experiences, there were mixed positive and negative feelings among patients following transfer from ICU. Some patients were very positive about being transferred to a general ward because it was associated with progression towards physical recovery and equipped patients with a feeling of control. However, following transfer some patients also felt anxious, lonely and isolated, depressed, insecure, exhausted, confused and worried because they were extremely weak physically.

Patients in all three studies also reported their experiences of the differences in level of care between ICU and general wards. Overall, patients commented that attitude, attention and organisation were important aspects of care management on the ward and they desired a high quality of individualised care. Many patients felt that ward nurses had unrealistic expectations about how much they could do for themselves (for example, ward nurses were reported as lacking understanding about the degree of physical weakness/frailty of patients following transfer from ICU). In general, patients acknowledged the differences in staffing levels between ICU and general wards but they still found it difficult to adjust to the transition from 'one-to-one care' in ICU to 'one patient among many' on a general ward, and less monitoring (either by ward staff or monitoring machines). Some patients felt 'abandoned' and some experienced being left unattended for varying lengths of time when they needed to go to the toilet or be washed or cleaned on the

general ward. Patients found these experiences hard to cope with and some reported that they felt themselves 'go downhill'.

Two of the studies (DIPEx; Strahan and Brown 2005) also reported the patients' desire for information. Patients stressed the importance of information about their own critical illness and the need for an explanation of the recovery process (information at different stages of illness and recovery and on different topics). For example, some patients were given information about recovery before they were discharged from hospital, particularly on diet, exercise and drug management; others said that the only information they really wanted was to know whether they were improving. Moreover, most patients who had been given diaries of their ICU stay, either when leaving the hospital or at a follow-up appointment, said they learnt a lot more about their stay after reading these, including information about the illness, treatments, changes and improvements, family reactions and visitors.

Evidence to recommendations

The Guideline Development Group considered that the transition of care between critical care areas and general ward settings needed a specific recommendation. It was considered important that patients receive continuity of care and that patients should not be transferred from critical care areas unless the receiving ward has the resources to be able to deliver the agreed care plan.

The Guideline Development Group considered that a formal structured handover of care would address the patient needs identified in the reviewed qualitative evidence.

The Guideline Development Group noted that the need for information tailored to individual circumstances was a consistent finding of the reviewed qualitative literature.

The Guideline Development Group considered that the reported experiences of patients on general wards following their discharge from critical care areas justified a specific recommendation on educational and training needs for relevant healthcare staff.

2.3.5 Interventions on general wards following transfer from critical care areas

No specific recommendation has been made regarding what interventions can be delivered to patients on general wards following transfer from critical care areas to improve health outcomes.

Evidence review

No evidence is presented because no studies were of sufficient quality to be used as the basis for making evidence-based clinical guideline recommendations.

Evidence to recommendations

The Guideline Development Group noted the lack of good quality evidence on the effectiveness of specific interventions in the immediate post-transfer phase on general wards to improve health outcomes for patients who have been transferred from critical care areas.

The Guideline Development Group considered that all the recommendations made in section 2.2 applied to this subgroup of patients.

2.4 Research recommendations

Identification and evaluation of risk scoring tools (see section 2.1)

- What is the clinical effectiveness and cost effectiveness of automated (electronic) monitoring systems compared with manual recording systems in identifying people at risk of clinical deterioration in general hospital ward settings?
- What are the sensitivities and specificities of track and trigger systems in different clinical settings?
- Can track and trigger systems that have higher sensitivities and specificities than existing scores be developed and validated?

Response strategies for patients identified as having a deteriorating clinical condition (see section 2.2)

- What is the clinical and cost effectiveness of a structured educational programme to improve recognition of and response to acute illness compared with no structured programme in improving outcomes for people who clinically deteriorate in general hospital ward settings?
- What is the clinical and cost effectiveness of CCOS compared with usual care or educational outreach in improving health outcomes for patients who clinically deteriorate in general hospital ward settings? Such research should:
  - use a cluster RCT design conducted on multiple sites, with analysis of the cluster at hospital level rather than ward level
  - investigate a range of health outcomes, including mortality, morbidity, quality of life measures and patient satisfaction
  - include a parallel qualitative process evaluation to help establish which components of outreach (a complex intervention) are likely to be most effective
  - consider 24-hour critical care outreach as well as daytime outreach.

Transfer of patients from critical care areas (see section 2.3)

- What is the clinical and cost effectiveness of providing structured educational advice (such as an information booklet) compared with usual care to patients who have been transferred from critical care areas back to general hospital ward settings?
- What is the clinical and cost effectiveness of a transfer facilitator for patients transferred from critical care to a general ward environment? Such research could include outcome measures on:
  - patient satisfaction
  - time to discharge from acute hospital
  - destination when transferred.

3 Methods

3.1 Scope and purpose

3.1.1 Scope

NICE guidelines are developed in accordance with a scope that defines what the guideline will and will not cover (see appendix 5.1). The aim of this guideline is to provide evidence-based recommendations to guide healthcare professionals in the appropriate care of acutely ill patients in hospital.

3.1.2 Areas covered by this guideline

This guideline provides guidance on:

- Identification of patients who are at risk of clinical deterioration or whose clinical condition is deteriorating. This includes assessment of:
  - scoring tools that record physiological parameters and neurological state
  - the level of monitoring needed and the recording and interpretation of the data obtained.
- Response strategies to manage patients who are at risk of clinical deterioration or whose clinical condition is deteriorating, including:
  - the timing of response and patient management
  - the communication of monitoring results to relevant healthcare professionals, including the interface between critical care and acute specialties.
- Transfer of patients from critical care areas. This includes:
  - monitoring requirements.
  - timing of transfer.

3.1.3 Areas outside the remit of this guideline

This guideline does not address care that should be provided to: children, dying patients receiving palliative care or patients in critical care areas who are directly under the care of critical care consultants. It does not address the decision to discharge a patient from a critical care area.

3.1.4 Disclaimer

The guideline development group assumes that the healthcare professionals will use general medical knowledge and clinical judgement in applying the general principles and specific recommendations of this document to the management of individual patients. Recommendations may not be appropriate in all circumstances. Decisions to adopt any particular recommendation must be made by the practitioner in light of the circumstances presented by individual patients and available resources. Clinicians will need to share appropriately the information within this guideline to enable patients to participate in the decision making to the extent that they are able and willing.

3.2 Contributors

3.2.1 The Guideline Development Group

The Guideline Development Group was composed of relevant healthcare professionals, patient representatives and NICE technical staff.

The members of the Guideline Development Group are listed below.

Mrs Sheila Adam
Nurse Consultant in Critical Care

Dr Mary Armitage (Guideline Development Group Chair)
Consultant Physician

Mr Peter Brewer
Patient/carer representative

Dr Brian Cuthbertson
Clinical Senior Lecturer and Consultant in Intensive Care

Dr Jane Eddleston (Guideline Development Group Clinical Adviser)
Consultant in Intensive Care Medicine

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Dr John Hindle

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Dr Simon Mackenzie

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Dr Patrick Nee

Consultant in Emergency Medicine and Intensive Care Medicine

Professor Brian J Rowlands

Consultant Surgeon

Mrs Kirsty Ward

Registered Nurse

The following individuals were not full members of the guideline development group but were co-opted onto the group as expert advisers

Dr David Harrison

Statistician and Health Services Researcher

Professor Gary Smith

Consultant in Critical Care

3.2.2 The Short Clinical Guidelines Technical Team

The Short Clinical Guidelines Technical Team was responsible for this guideline throughout its development. It was responsible for preparing information for the Guideline Development Group, for drafting the guideline and for responding to consultation comments. The following people, who are employees of NICE, formed the Short Clinical Guidelines Technical Team for this guideline.

Dr Tim Stokes
Guideline Lead and Associate Director – Centre for Clinical Practice (from December 2006)

Nicole Elliott
Commissioning Manager

Michael Heath
Project Manager (from December 2006)

Toni Tan
Technical Analyst, (from January 2007)

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3.2.3 Acknowledgements

In addition to the healthcare professionals, patient representatives and NICE staff mentioned above, we would like to thank the Patient and Public Involvement Programme (PPIP), Communications and Implementation Directorates of NICE for their help in the production of this guideline. We would also like to thank the Guideline Review Panel (GRP) for its work on this guideline. The GRP consisted of:

- Mike Drummond
- Dr Graham Archard
- Barry Stables
- Karen Cowley
- David Gillen.

We would like to thank all the stakeholders who took the time to register and comment on the scope and the final draft of the guideline. For full details of registered stakeholders please see the NICE website (www.nice.org.uk).

Finally, we would like to offer our condolences to Peter Brewer's family; sadly, Peter died during the development of this guideline. Peter was a great help during the development phase of this guideline and always had a friendly word to say to everyone. Peter will be sadly missed by his family and colleagues alike.

3.3 Development methods

This section sets out in detail the methods used to generate the recommendations for clinical practice that are presented in the previous chapters of this guideline. The methods used to develop the recommendations are in accordance with those set out by the National Institute for Health and Clinical Excellence ('NICE' or the 'the Institute') in 'The guidelines manual: an overview for stakeholders, the public and the NHS' (2006, available at www.nice.org.uk) . As noted in section 1.3.2, the interim process for the short clinical guidelines programme has been the subject of public consultation and the revised version will be incorporated into the 2008 update of 'The guidelines manual'.

3.3.1 Developing the guideline scope

The draft scope, which defined the areas the guideline would and would not cover, was prepared by the Short Clinical Guidelines Technical Team on the basis of the remit from the Department of Health, consultation with relevant experts and a preliminary search of the literature to identify existing clinical practice guidelines, key systematic reviews and other relevant publications. The literature search facilitated an overview of the issues likely to be covered by the guideline – the clinical need for the guideline and the clinical management of the acutely ill patient – and helped define key areas. It also informed the Short Clinical Guidelines Technical Team of the volume of literature likely to be available in the topic area, and therefore the amount of work required.

The draft scope was tightly focused and covered three clinical topic areas. It was presented to a representative group of stakeholders and potential Guideline Development Group members at a 1-day workshop. The workshop consisted of presentations in the morning and facilitated parallel-running working groups in the afternoon. The aim was to obtain detailed feedback on the draft scope and agree core areas of care to be covered in the guidance, to seek input about the composition of the Guideline Development Group and to request the attendees' help in encouraging applications for Guideline Development Group membership.

The draft scope was amended to address issues raised by the workshop and the revised scope was signed off by the Director of the Centre for Clinical Practice at NICE. Stakeholders were notified once the final version of the scope was available on the NICE website. On this occasion the scope was not the subject of public consultation, but this is planned for subsequent short guideline scopes (see interim process guide for the short clinical guidelines programme).

3.3.2 Forming and running the Short Clinical Guideline Development Group

The short clinical guideline for acutely ill patients in hospital was developed by a unique Guideline Development Group consisting of 14 members, two co-opted experts who attended two of the Guideline Development Group meetings, and the Short Clinical Guidelines Technical Team. The Guideline Development Group had a chair, and healthcare professional members and patient/carer members who were recruited through open advertisement. A clinical adviser, who had specific content expertise, was also appointed. Development took 4 months and the Guideline Development Group met on three occasions, every 6 weeks.

3.3.3 Developing key clinical questions

The third step in the development of the guidance was to refine the scope into a series of key clinical questions. These questions formed the starting point for the subsequent evidence reviews and facilitated the development of recommendations by the Guideline Development Group.

The key clinical questions were developed by the Guideline Development Group with assistance from the Short Clinical Guidelines Technical Team. As necessary, the questions were refined into specific research questions by the project teams to aid literature searching, appraisal and synthesis. The full list of key clinical questions is shown in appendix 5.2.

The Guideline Development Group and Short Clinical Guidelines Technical Team agreed appropriate review parameters (inclusion and exclusion criteria) for each question or topic area. A full table of the included and excluded studies is shown in appendix 5.5.

3.3.4 Developing recommendations

For each question, recommendations were derived from the evidence summaries and statements presented to the Guideline Development Group.

3.3.5 Literature search

The evidence reviews used to develop the guideline recommendations were underpinned by systematic literature searches following the methods described in 'The guidelines manual' (National Institute for Health and Clinical Excellence 2006). The purpose of systematically searching the literature is to attempt to comprehensively identify the published evidence to answer the key clinical questions developed by the Guideline Development Group and Short Clinical Guidelines Technical Team.

The Gao and coworkers (2007) and Esmonde and coworkers (2006) reviews – substudies of the work commissioned by the SDO from ICNARC (see section 3.3.10) – were used as the basis of two of the evidence reviews. The search strategies underpinning these systematic reviews were obtained from the authors and re-run across a number of databases to identify studies indexed from 2004 onwards.

The search strategies for the evidence reviews on discharge from critical care areas were developed by the Short Clinical Guidelines Technical Team, in consultation with the Guideline Development Group. Structured clinical questions were developed using the PICO (population, intervention, comparison, outcome) model and were translated in to search strategies using subject heading and free text terms. The strategies were run across a number of databases, with no date restrictions imposed on the searches.

To identify economic evaluations the NHS Economic Evaluation Database (NHS EED) and the Health Economic Evaluations Database (HEED) were searched, and search filters to identify economic evaluations were appended to the strategies developed by Gao and coworkers (2007) and Esmonde and coworkers (2006) to interrogate a range of bibliographic databases. There were no date restrictions imposed on the searches.

In addition to the systematic literature searches, the Guideline Development Group was asked to alert the Short Clinical Guidelines Technical Team to any additional evidence, published, unpublished or in press, that met the inclusion criteria.

The searches were undertaken between October 2006 and February 2007. Full details of the systematic search, including the sources searched and the MEDLINE strategies for each evidence review are presented in appendix 5.3.

3.3.6 Reviewing the evidence

The aim of the literature review was to systematically identify and synthesise relevant evidence in order to answer the questions developed from the guideline scope. The guideline recommendations were evidence based where possible; if evidence was not available, informal consensus of opinion within the Guideline Development Group was used. The need for future research was also specified. The review process consisted of four main tasks: selection of relevant studies; assessment of study quality; synthesis of the results; and grading of the evidence. The Technical Analyst had primary responsibility for reviewing the evidence but was supported by the Project Lead, Information Scientist and Health Economist.

After the scope was finalised, searches based on individual key clinical questions were undertaken. The searches were first sifted by the Short Clinical Guidelines Technical Team using title and abstract to exclude papers that did not address the specified key clinical question. After selection based on title and abstract, the full texts of the papers were obtained and reviewed by the Short Clinical Guidelines Technical Team in order to determine which studies should be included in the literature review. Studies suggested or submitted by the Guideline Development Group and expert advisers were also reviewed for relevance to the key clinical questions and included if they met the inclusion criteria.

The papers chosen for inclusion were then critically appraised by the Short Clinical Guidelines Technical Team for their methodological rigour against a number of criteria that determine the validity of the results. These criteria differed according to study type and were based on the checklists included in 'The guidelines manual' (2006) (available from www.nice.org.uk). The checklists that were used in this particular guidance included checklist C for randomised control trials, checklist B for cohort studies, checklist F for diagnostic studies, and checklist F for qualitative studies. 'The data collection

checklist' by the Effective Practice and Organisation of Care Group on controlled before-and-after studies was also used where relevant.

The data were extracted to standard evidence table templates. The findings were summarised by the Short Clinical Guidelines Technical Team into both a series of evidence statements and an accompanying narrative summary.

3.3.7 Grading the evidence

Intervention studies

Studies that meet the minimum quality criteria were ascribed a level of evidence to help the guideline developers and the eventual users of the guideline understand the type of evidence on which the recommendations have been based.

There are many different methods of assigning levels to the evidence and there has been considerable debate about what system is best. A number of initiatives are currently underway to find an international consensus on the subject. NICE has previously published guidelines using different systems and is now examining a number of systems in collaboration with its national collaborating centres and academic groups throughout the world to identify the most appropriate system for future use.

A decision has not yet been reached on the most appropriate system for NICE guidelines, so the Short Clinical Guidelines Technical Team used the system shown in table 5.

Table 5 Levels of evidence for intervention studies
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Level of evidence	Type of evidence
1^{++}	High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1^{+}	Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
1^{-}	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias[a]
2^{++}	High-quality systematic reviews of case–control or cohort studies High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal
2^{+}	Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the 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[a]
3	Non-analytic studies (for example, case reports, case series)
4	Expert opinion, formal consensus

[a] Studies with a level of evidence '–' should not be used as a basis for making a recommendation

It was the responsibility of the Guideline Development Group to endorse the final levels given to the evidence.

Diagnostic studies

The system described above covers studies of treatment effectiveness. However, it is less appropriate for studies reporting diagnostic tests of accuracy. In the absence of a validated ranking system for this type of test, NICE has developed a hierarchy for evidence of accuracy of diagnostic tests that takes into account the various factors likely to affect the validity of these studies (table 6). Because this hierarchy has not been systematically tested, NICE recommends that the national collaborating centres use the system when appropriate, on a pilot basis, and report their experience to us.

This evidence grading system was applied to the evidence review of track and trigger systems set out in section 2.1.

Table 6 Hierarchy for evidence of accuracy of diagnostic tests

Levels of evidence	Type of evidence
Ia	Systematic review (with homogeneity)[a] of level-1 studies[b]
Ib	Level-1 studies[b]
II	Level-2 studies[c] Systematic reviews of level-2 studies
III	Level-3 studies[d] Systematic reviews of level-3 studies
IV	Consensus, expert committee reports or opinions and/or clinical experience without explicit critical appraisal; or based on physiology, bench research or 'first principles'

[a] Homogeneity means there are no or minor variations in the directions and degrees of results between individual studies that are included in the systematic review.

[b] Level-1 studies are studies:
- that use a blind comparison of the test with a validated reference standard (gold standard)
- in a sample of patients that reflects the population to whom the test would apply.

[c] Level-2 studies are studies that have **only one** of the following:
- narrow population (the sample does not reflect the population to whom the test would apply)
- use a poor reference standard (defined as that where the 'test' is included in the 'reference', or where the 'testing' affects the 'reference')
- the comparison between the test and reference standard is not blind
- case–control studies.

[d] Level-3 studies are studies that have **at least two or three** of the features listed for level-2 studies.

3.3.8 Evidence to recommendations

The evidence tables and narrative summaries for the key clinical questions being discussed were sent to the Guideline Development Group 1 week before the Guideline Development Group meeting.

All Guideline Development Group members were expected to have read the evidence tables and narrative summaries before attending each meeting. The review of the evidence had three components. First, the Guideline Development Group discussed the evidence tables and narrative summaries and corrected any factual errors or incorrect interpretation of the evidence. Second, evidence statements drafted by the Short Clinical Guidelines Technical Team were presented to the Guideline Development Group, who agreed the correct wording of these. Third, from a discussion of the evidence statements and the experience of Guideline Development Group members, recommendations were drafted. The Short Clinical Guidelines Technical Team

explicitly stated that the Guideline Development Group should consider the following criteria (considered judgement) when developing the guideline recommendations from the evidence presented:

- internal validity
- consistency
- generalisability (external validity)
- clinical impact
- cost effectiveness
- ease of implementation
- patients' perspective
- overall synthesis of evidence.

The Guideline Development Group was able to agree recommendations through informal consensus. The process by which the evidence statements informed the recommendations is summarised in an 'evidence to recommendations' section in the relevant evidence review. Each recommendation was linked to an evidence statement if possible. If there was a lack of evidence of effectiveness, but the Guideline Development Group was of the view that a recommendation was important based on the Guideline Development Group members' own experience, this was noted in the 'evidence to recommendations' section.

3.3.9 Health economics

An economic evaluation aims to integrate data on the benefits (ideally in terms of quality adjusted life years, or QALYs), harms and costs of alternative options. An economic appraisal will consider not only whether a particular course of action is clinically effective, but also whether it is cost-effective (that is, value for money). If a particular treatment strategy were found to yield little health gain relative to the resources used, then it could be advantageous to redirect resources to other activities that yield greater health gain.

To assess the cost-effectiveness of strategies associated with the identification and response to acute illness, a systematic review of the economic literature relating to acutely ill patients was conducted. In addition,

the Guideline Development Group and expert advisers were questioned over any potentially relevant unpublished data. The search of the published literature yielded no relevant economic studies, save for one book chapter that simply cited some cost estimates of outreach services. However, relevant ongoing and unpublished data were identified (ICNARC substudy 7: See section 3.3.10 for further details) and made available to the Guideline Development Group and the Short Clinical Guidelines Technical Team at NICE.

Despite limitations of the unpublished research (for example, its focus on outreach activity after ICU discharge), further economic modelling by the NICE health economist was considered unnecessary. The key features of this research are presented within the relevant clinical chapter.

Health economics statements are made in the guideline in sections in which the use of NHS resources is considered.

3.3.10 Relation between this guideline and ongoing national research in the field of critical care outreach

In July 2004 the NHS National Institute for Health Research Service Delivery and Organisation Programme commissioned the ICNARC to undertake a rigorous, scientific evaluation of outreach services in critical care (SDO/74/2004). The findings of this research programme were submitted to the funding body on 31 March 2007 and are due to be published later in 2007.

A member of the ICNARC research team (Dr David Harrison) was co-opted onto the Guideline Development Group as a technical expert and the agreement of ICNARC and the funding body was sought and granted for the incorporation of published and unpublished work from this research programme into this guideline.

The following substudies from the SDO work have been incorporated into this guideline:

- Substudy 1 (a systematic review of the evidence base for outreach services). This published review (Esmonde et al. 2006) forms the basis for the review of CCOS presented in section 2.2.
- Substudies 2 and 3 (a systematic review of the evidence base for current 'early warning systems' and an analysis of available databases on 'early warning systems'). This review (Gao et al. 2007) forms the basis for the review of track and trigger systems presented in section 2.1. The primary research study (Subbe et al. 2007) is also used in the review.
- Substudy 4 (survey of outreach services). This survey (McDonnell et al. in press) is cited in the introduction section to section 2.3.
- Substudy 5 (qualitative study of a number of case studies of different models of outreach services), substudy 6 (interrupted time series analysis of the impact of outreach services on critical care admissions at the unit level) and substudy 7 (a non-randomised, case mix adjusted comparison of outreach care at the patient level, within which an economic evaluation forms an important part). When the first draft of this guideline was submitted for consultation these studies were unpublished and in the process of being written up. Permission was obtained for the use of selected parts of the health economic analysis in the draft guideline. It is intended that the final published version of this guideline will present the results of these three substudies in section 2.

3.3.11 Relation between this guideline and ongoing work on this area by the National Patient Safety Agency

The National Patient Safety Agency has analysed reported data on incidents, and other data sources, which further support the need for guidance and changes in practice. It has facilitated an ongoing multidisciplinary and multiagency working group, of which Dr Mary Armitage and Dr Jane Eddleston are members. This work seeks to bring together and offer mutual support across the several strands of work related to improvements in addressing deterioration of the acutely ill patient. Further exploration of

contributory and causal factors on the failure to detect or act upon deteriorating patients will support the implementation of this guideline.

3.3.12 Piloting and implementation

It is beyond the scope of the work to pilot the contents of this guideline or validate any approach to implementation. However, every effort has been made to maximise the relevance of recommendations to the intended audience through the use of a guideline development group with relevant professional and patient involvement, by use of relevant experienced expert reviewers and the stakeholder process facilitated by the NICE Short Clinical Guidelines Technical Team. Implementation support tools for this guideline will be available from the Implementation Team at NICE.

3.3.13 Audit methods

The guideline recommendations have been used to develop clinical audit criteria for use in practice. An audit criterion can be defined as 'a systematically developed statement that can be used to assess the appropriateness of specific healthcare decisions, services and outcomes' (Institute of Medicine, Field MJ and Lohr KN eds. 1992). Audit criteria are essential implementation tools for monitoring the uptake and impact of guidelines and thus need to be clear and straightforward for organisations and professionals to use.

NICE has commissioned the Clinical Accountability, Service Planning and Evaluation (CASPE) Research Unit and Health Quality Service to develop the audit criteria for all its guidance as part of its implementation strategy. CASPE will draft audit criteria for all guidelines for which stakeholder consultation starts on or after 1 April 2006.

3.3.14 Scheduled review of this guideline

The guidance has been developed in accordance with the NICE guideline development process for short clinical guidelines. This has included allowing registered stakeholders the opportunity to comment on the draft guidance. In addition, the first draft was reviewed by an independent Guideline Review Panel established by NICE.

The comments made by stakeholders, peer reviewers and the Guideline Review Panel were collated and presented anonymously for consideration by the Guideline Development Group. All comments were considered systematically by the Guideline Development Group and the Short Clinical Guidelines Technical Team recorded the agreed responses.

This guideline will be considered for an update after 2 years. However, if the evidence available has not changed we will not update it. Any agreed update would be carried out by the Short Clinical Guidelines Technical Team in conjunction with the Guideline Development Group. Alternatively the topic may be referred to the NICE Topic Selection Panel for it to consider developing a standard clinical guideline.

3.4 Declarations

3.4.1 Authorship and citation

Authorship of this full guideline document is attributed to the NICE Short Clinical Guidelines Technical Team and members of the Guideline Development Group under group authorship.

The guideline should be cited as:

NICE Short Clinical Guidelines Technical Team (2006) Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital. London: Natioanl Institute for Health and Clinical Excellence.

3.4.2 Declarations of Interest

A full list of all declarations of interest made by this Guideline Development Group is available on the NICE website (www.nice.org.uk).

4 References, glossary and abbreviations

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4.2 Glossary

Before-and-after study

A study design that involves selection of intervention and control groups other than by a random process, and inclusion of a baseline period of assessment of main outcomes. There are two minimum criteria for this study design: that pre- and post-intervention periods for study and control sites should be the same; and that if studies use a second site as a control, the sites should be

comparable with respect to dominant reimbursement system, level of care, setting of care and academic status.

Case–control study
Comparative observational study in which the investigator selects individuals who have experienced an event (for example, developed a disease), known as the 'case' and others who have not (controls), and then collects data to determine previous exposure to a possible cause.

Cohort study (also known as follow-up, incidence, longitudinal, or prospective study)
An observational study in which a defined group of people (the cohort) is followed over time. Outcomes are compared in subsets of the cohort who were exposed or not exposed (or exposed at different levels) to an intervention or other factor of interest.

Comorbidity
Two or more diseases or conditions occurring at the same time, such as depression and anxiety.

Confidence interval
The range within which the 'true' values (for example, size of effect of an intervention) are expected to lie with a given degree of certainty (for example, 95% or 99%).

Note: confidence intervals represent the probability of random errors, but not systematic errors or bias.

Cost-effectiveness analysis
An economic evaluation that compares alternative options for a specific patient group looking at a single effectiveness dimension measured in a non-monetary (natural) unit. It expresses the result in the form of an incremental (or average or marginal) cost-effectiveness ratio.

Economic evaluation
Technique developed to assess both costs and consequences of alternative health strategies and to provide a decision-making framework.

Generalisability

The degree to which the results of a study or systematic review can be extrapolated to other circumstances, particularly routine healthcare situations in the NHS in England and Wales.

Guideline Development Group

An independent group set up on behalf of NICE to develop a guideline. It includes academic experts, healthcare professionals and patient and carer representatives.

Heterogeneity

A term used to illustrate the variability or differences between studies in the estimates of effects.

Kappa

Kappa coefficient is a statistical measure of inter-rater reliability. It is generally thought to be a more robust measure than simple percent agreement calculation because kappa takes into account the agreement occurring by chance.

Negative predictive value

The proportion of patients with negative test results who do not have the disease.

Odds ratio

A measure of treatment effectiveness. The odds of an event happening in the intervention group, divided by the odds of it happening in the control group. The 'odds' is the ratio of non-events to events.

Phenomenological approach

A type of qualitative research that examines the lived experiences of humans. Phenomenological researchers hope to gain understanding of the essential 'truths' (that is, essences) of a phenomenon as experienced by people.

Positive predictive value

The proportion of people with a positive test result who actually have the disease.

Purposive sampling
A purposive sample is one which is selected by the researcher subjectively. The researcher attempts to obtain sample that appears to him/her to be representative of the population and will usually try to ensure that a range from one extreme to the other is included.

Quality-adjusted life year (QALY)
A measure of health outcome that assigns to each period of time a weight, ranging from 0 to 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 equivalent to death; these are then aggregated across time periods.

Randomised controlled trial (also called a randomised clinical trial)
An experiment in which investigators randomly allocate eligible people into groups to receive or not to receive one or more interventions that are being compared. The results are assessed by comparing outcomes in the different groups. The groups should be similar in all aspects apart from the treatment they receive during the study.

Relative risk (also known as risk ratio)
The ratio of risk in the intervention group to the risk in the control group. The risk (proportion, probability or rate) is the ratio of people with an event in a group to the total in the group. A relative risk (RR) of 1 indicates no difference between comparison groups. For undesirable outcomes, an RR that is less than 1 indicates that the intervention was effective in reducing the risk of that outcome.

ROC curve
In signal detection theory, a receiver operating characteristic (ROC), or ROC curve, is a graphical plot of the sensitivity against (1 − specificity) for a binary classifier system as its discrimination threshold is varied. The ROC can also be represented equivalently by plotting the fraction of true positives (TP) against the fraction of false positives (FP). ROC analysis provides tools to

select possibly optimal models and to discard suboptimal ones independently from (and before specifying) the cost context or the class distribution.

Sensitivity (of a test)
The proportion of people classified as positive by the gold standard test who are correctly identified by the study test.

Specificity (of a test)
The proportion of people classified as negative by the gold standard test who are correctly identified by the study test.

Systematic review
Research that summarises the evidence on a clearly formulated question according to a pre-defined protocol using systematic and explicit methods to identify, select and appraise relevant studies, and to extract, collate and report their findings. It may or may not use statistical meta-analysis.

Track and trigger systems
Physiological 'track and trigger' systems rely on periodic observation of selected basic physiological signs ('tracking') with predetermined calling or response criteria ('trigger') for requesting the attendance of staff who have specific competencies in the management of acute illness and/or critical care.

4.3 Abbreviations

APACHE	Acute physiology and chronic health evaluation
ASSIST	Assessment score for sick patient identification and step-up in treatment
CASPE	Clinical Accountability, Service Planning and Evaluation
CCOS	Critical care outreach services
CCOT	Critical care outreach team
CI	Confidence interval
DIPEx	Database of individual patient experiences
EWS	Early warning score
HDU	High dependency unit
HEED	Health Economic Evaluations Database
ICNARC	Intensive Care National Audit and Research Centre

ICU	Intensive care unit
LMT	Limitation of medical treatment
MET	Medical emergency team
MEWS	Modified early warning score
NCEPOD	National Confidential Enquiry into Patient Outcome and Death
NHS EED	NHS Economic Evaluation Database
OR	Odds ratio
PART	Patient-at-risk team
PAR	Patient-at-risk score
PICO	Population, intervention, comparison, outcome
QALY	Quality-adjusted life year
RCT	Randomised controlled trial
RR	Relative risk
ROC	Receiver operating characteristic
SD	Standard deviation
SDO	National Institute for Health Research Service Delivery and Organisation

5 Appendices

5.1 Appendix 1 – The Scope

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

SHORT CLINICAL GUIDELINE

SCOPE

1 Title

Recognition of and response to acute illness in adults in hospital

1.1 Short title

Acutely ill patients in hospital

2 Background

a) The Department of Health has asked the National Institute for Health and Clinical Excellence ('NICE' or 'the Institute') to 'prepare guidance on the care of acutely ill adults in hospital' for use in the NHS in England and Wales.

3 Clinical need for the guideline

a) There has been increasing recognition that the care provided to patients in hospital who deteriorate clinically, or show signs that they may deteriorate unexpectedly, has a marked impact on patient mortality, morbidity and length of stay both in the hospital overall and in a critical care area should they be admitted to critical care.

b) Clinical deterioration can occur at any stage of a patient's illness, although there will be certain periods during which a patient is more vulnerable, such as at the onset of illness, during surgical or

medical intervention and during recovery from critical illness. Patients on general adult wards who are at risk of deteriorating may be identified before a serious adverse event by changes in physiological observations recorded by clinical staff.

c) The interpretation of these changes, and timely institution of appropriate clinical management once physiological deterioration is identified, is of crucial importance if the likelihood of serious adverse events including cardiac arrest and death is to be minimised. Care strategies following a period of critical illness are also likely to have a significant impact on patient outcomes.

d) A recent report from the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) ('An Acute Problem', NCEPOD 2005)[1] identified delayed recognition and referral as prime causes of the substandard care of the acutely unwell in hospital. The report found that on a number of occasions this was aggravated by poor communication between the acute medical, surgical and critical care medical teams. It also identified examples in which there was a lack of awareness by medical consultants of their patients' deteriorating health and their subsequent admission to critical care. Admission to an intensive care unit (ICU) was thought to have been avoidable in 21% of cases, and the authors felt that sub-optimal care contributed to about a third of the deaths that occurred.

4 The guideline

4.1 Population

4.1.1 Groups that will be covered

All adult patients in hospital, including patients in the Emergency Department and those in transition.

[1] Cullinane M, Findlay G, Hargraves C et al. (2005) *An Acute Problem? A report of the National Confidential Enquiry into Patient Outcomes and Death*. London: National Confidential Enquiry into Patient Outcome and Death. Available from: www.ncepod.org.uk/2005.htm

4.1.2 Groups that will not be covered

a) Children

b) Dying patients who are receiving palliative care.

c) Patients in Critical Care areas who are directly under the care of critical care consultants.

4.2 Healthcare setting

All adult acute hospital settings.

4.3 Clinical management and service delivery strategies (including key interventions)

a) Identification of patients who are at risk of clinical deterioration or whose clinical condition is deteriorating. This will include assessment of:

- scoring tools that record physiological parameters and neurological state
- the level of monitoring needed and the recording and interpretation of the data obtained.

b) Response strategies to manage patients who are at risk of clinical deterioration or whose clinical condition is deteriorating , including:

- the timing of response and patient management
- the communication of monitoring results to relevant healthcare professionals, including the interface between critical care and acute specialties.

c) Discharge of patients from Critical Care areas. This will include:

- monitoring requirements.
- timing of transfer.

4.4 Key outcome measures

Key outcomes that will be considered when reviewing the evidence include:

- hospital mortality (survival to discharge), including number of unexpected deaths
- adverse events (for example, cardiac and respiratory arrest and organ failure)
- length of stay on acute wards and in Critical Care Areas
- number of avoidable Critical Care admissions
- number of readmissions into Critical Care Areas
- functional status, health-related quality of life and satisfaction with care.

4.5 Economic aspects

The developers will take into account both clinical and cost effectiveness.

4.6 Status

4.6.1 Scope

This is the final scope.

4.7 Other relevant NICE guidance

4.7.1 Guidelines

Nutrition support in adults: oral nutrition support, enteral tube feeding and parenteral nutrition. *NICE clinical guideline* no. 32 (2006). Available from: http://www.nice.org.uk/page.aspx?o=cg032

4.7.2 Guideline

The development of the guideline recommendations will begin in December 2006.

5 Further information

Information on the guideline development process is provided in:

- ‘The guideline development process: an overview for stakeholders, the public and the NHS’
- ‘The guidelines manual’.

These booklets are available as PDF files from the NICE website (www.nice.org.uk/guidelinesmanual). Information on the progress of the guideline will also be available from the website.

The development group will work in accordance with the methods set out in the documents above. The process for the short clinical guidelines programme is in development and will be consulted upon.

5.2 Appendix 2 - Key Clinical Questions

The key clinical questions were used by the GDG to help focus discussions on the key aspects of the subject area and also to help develop the recommendations for this guideline. The following key clinical questions formed the basis of the recommendations discussed in chapter 2 of this guideline:

- Which physiological observations should be undertaken in acute hospital settings?
- Can physiological track & trigger systems correctly identify those patients whose clinical condition is deteriorating or who are at risk of deterioration?
- What is the role of specific physiological track & trigger systems in identifying patients whose clinical condition is deteriorating or who are at risk of deterioration?
- Physiological parameters to be used by track & trigger systems
- Does a specific response strategy – provision of critical care outreach service - improve outcomes for patients identified as having a deteriorating clinical condition?
- Does the timing of transfer of a patient from Critical Care Areas to general wards affect health outcomes?
- What elements of care on the general ward are viewed as important by patients following discharge?
- What interventions can be delivered to patients on general wards following discharge from Critical Care Areas to improve health outcomes?

5.3 Appendix 3 – Search Strategies

5.3.1 Scoping searches

Scoping searches were undertaken using the following websites and databases in September 2006. Browsing or simple search strategies were employed.

Guidance/guidelines	Systematic reviews/economic evaluations
Websites ▪ Department of Health ▪ National Institute for Health and Clinical Excellence (NICE) ▪ National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) ▪ National Library for Health (NLH) Guidelines Finder ▪ National Library for Health (NLH) Protocols and Care Pathways database ▪ National Library for Health (NLH) Specialist Libraries ▪ TRIP Database ▪ Scottish Intercollegiate Guidelines Network (SIGN) ▪ National Guideline Clearinghouse (USA) ▪ Guidelines International Network (GIN) ▪ New Zealand Guidelines Group ▪ National Health and Medical Research Council (Australia) ▪ CMA Infobase (Canada) ▪ NHS Modernisation Agency ▪ NHS Institute for Innovation and Improvement ▪ Royal College of Physicians ▪ Royal College of Surgeons ▪ Royal College of Anaesthetists ▪ Royal College of Nursing ▪ Intensive Care Society ▪ Intensive Care Society – Ireland ▪ Association of Anaesthetists of Great Britain and Ireland ▪ Intensive Care National Audit & Research Centre ▪ British Association of Critical Care Nurses ▪ Scottish Intensive Care Society ▪ European Society of Intensive Care Medicine ▪ Society of Critical Care Medicine (USA) ▪ Resuscitation Council	*Websites* ▪ NHS Service Delivery and Organisation (SDO) Research and Development Programme ▪ National Coordinating Centre for Health Technology Assessment (NCCHTA) *Databases* ▪ Cochrane Database of Systematic Reviews (CDSR) ▪ Cochrane Central Register of Controlled Trials (CENTRAL) ▪ Database of Abstracts of Reviews of Effects (DARE) ▪ Health Technology Assessment (HTA) Database ▪ NHS Economic Evaluation Database (NHS EED)

5.3.2 Main searches

5.3.2.1 Sources

The following sources were searched for the topics presented in sections 5.3.2.2–5.3.2.4 below.

- Cochrane Database of Systematic Reviews – CDSR (Wiley)
- Database of Abstracts of Reviews of Effects – DARE (Wiley)
- Health Technology Assessment (HTA) Database – (Wiley)
- Cochrane Central Register of Controlled Trials – CENTRAL (Wiley)
- MEDLINE (Ovid)
- MEDLINE In-Process (Ovid)
- EMBASE (Ovid)
- CINAHL (Ovid)
- PsycINFO (Ovid)
- Science Citation Index (Dialog DataStar)
- Social Science Citation Index (Dialog DataStar)
- National Research Register

5.3.2.2 Identification & evaluation of risk scoring tools

The search strategies were closely based on the strategies developed by Gao et al. (2007), and were run as updates to the Gao et al. searches. The searches were run on 30 October 2006 and limited to records added to the databases from November 2004 onwards. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE search strategy

1 *Health Status Indicators/
2 exp *"Severity of Illness Index"/
3 *Sickness Impact Profile/
4 *Risk Assessment/
5 severity of illness ind$.tw.
6 health status ind$.tw.
7 risk assess$.tw.
8 sickness impact profile$.tw.
9 early warning.tw.
10 (warning adj2 (scor$ or system$)).tw.
11 ews.tw.
12 (mews or mew).tw.
13 (track and trigger).tw.
14 ((trigger or calling) adj5 criteria).tw.
15 *Point-of-Care Systems/
16 point of care system$.tw.
17 serious$ ill$.tw.
18 or/1-17
19 exp *Critical Care/
20 critical care.tw.
21 intensive care.tw.
22 exp *Intensive Care Units/
23 exp *Emergency Service, Hospital/
24 hospital emergency service$.tw.
25 medical emergency team$.tw.
26 met.tw.
27 hospital emergency team$.tw.
28 patient emergency team$.tw.
29 exp *Patient Care Team/
30 patient care team$.tw.
31 patient at risk$.tw.
32 par.tw.
33 (outreach adj (service$ or team$)).tw.
34 shock team$.tw.
35 or/19-34
36 18 and 35
37 200411$.ed
38 200412$.ed
39 2005$.ed
40 2006$.ed
41 or/37-40
42 36 and 41

5.3.2.3 Response strategies for patients identified as having deteriorating clinical condition

The search strategies were closely based on the strategies developed by Esmonde et al. (2006), and were run as updates to the Esmonde et al searches. The searches were run on 15 December 2006 and limited to records added to the databases from 2004 onwards. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE strategy

1 exp Critical Care/
2 critical care$.tw.
3 Critical Illness/
*4 exp *Intensive Care Units/*
5 intensive care$.tw.
6 ((critical$ or acute$ or sever$ or sudden$ or unexpected$) adj2 ill$).tw.
7 (patient$ adj2 deteriorat$).tw.
8 (risk$ adj2 deteriorat$).tw.
9 or/1-8
*10 exp *Emergency Service, Hospital/*
11 hospital emergency service$.tw.
12 exp Patient Care Team/
13 outreach.tw.
14 patient at risk$.tw.
15 patient care team$.tw.
16 hospital emergency team$.tw.
17 patient emergency team$.tw.
18 acute pain team$.tw.
19 night nurse practi$.tw.
20 night discharg$.tw.
21 or/10-20
22 9 and 21
23 rapid response team$.tw.
24 medical emergency team$.tw.
25 23 or 24
26 22 or 25
27 2004$.ed
28 2005$.ed
29 2006$.ed
30 or/27-29
31 26 and 30

5.3.2.4 Timing of discharge from critical care areas

Searches were undertaken on 17 February 2007. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE strategy

1 exp Critical Care/
2 exp Intensive Care Units/
3 Critical Illness/
4 or/1-3
5 exp Patient Care Planning/
6 Patient Discharge/
7 Patient Readmission/
8 Patient Transfer/
9 or/5-8
10 4 and 9
11 (critical$ adj2 care$ adj4 discharg$).tw.
12 (intensive$ adj2 care$ adj4 discharg$).tw.
13 ((ICU$ or SICU$ or MICU$ or ITU$) adj4 discharg$).tw.
14 ((critical$ or acute$ or sever$) adj2 ill$ adj4 discharg$).tw.
15 (critical$ adj2 care$ adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
16 (intensive$ adj2 care$ adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
17 ((ICU$ or SICU$ or MICU$ or ITU$) adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
18 ((critical$ or acute$ or sever$) adj2 ill$ adj4 (readmit$ or re-admit$ or readmission$ or re-admission$)).tw.
19 (critical$ adj2 care$ adj4 transfer$).tw.
20 (intensive$ adj2 care$ adj4 transfer$).tw.
21 ((ICU$ or SICU$ or MICU$ or ITU$) adj4 transfer$).tw.
22 ((critical$ or acute$ or sever$) adj2 ill$ adj4 transfer$).tw.
23 or/11-22
24 10 or 23
25 Time/
26 Time Factors/
27 Night Care/
28 After-hours Care/
29 (time$ or timing$).tw.
30 (night$ or day$ or morning$ or afternoon$ or evening$ or week$).tw.
31 ((after or out or early) adj2 hours).tw.
32 or/25-31
33 exp "Outcome and Process Assessment (Health Care)"/
34 Patient Readmission/
35 Length of Stay/
36 exp Mortality/
37 Death/
38 Death, Sudden/
39 Morbidity/
40 Survival/
41 Survival Rate/
42 Survival Analysis/
43 exp Heart Arrest/
44 Death, Sudden, Cardiac/
45 Respiratory Insufficiency/
46 Multiple Organ Failure/

47 (outcome$ or readmit$ or re-admit$ or readmission$ or re-admission$ or 'length of stay' or mortalit$ or death$ or fatal$ or morbidit$ or surviv$).tw.
48 ((cardiac or heart or respiratory or cardiorespiratory or cardio-respiratory or cardiopulmonary or cardio-pulmonary) adj2 arrest$).tw.
49 (organ$ adj2 (fail$ or dysfunction$)).tw.
50 or/33-49
51 24 and 32 and 50

5.3.2.5 Patients' experiences of care in the period immediately following discharge from critical care areas to general wards.

Searches were undertaken on 21 February 2007. The MEDLINE search strategy is presented below, which was translated for use in all other databases.

MEDLINE strategy

1 exp Critical Care/
2 exp Intensive Care Units/
3 Critical Illness/
4 (critical$ adj2 care$).tw.
5 (intensive$ adj2 care$).tw.
6 (intensive$ adj2 therap$).tw.
7 (ICU$ or SICU$ or MICU$ or ITU$).tw.
8 ((critical$ or acute$ or severe$) adj2 ill$).tw.
9 or/1-8
10 exp Patient Care Planning/
11 Patient Discharge/
12 Patient Readmission/
13 Patient Transfer/
14 discharg$.tw.
15 (readmit$ or re-admit$ or readmission$ or re-admission$).tw.
16 transfer$.tw.
17 or/10-16
18 Qualitative Research/
19 Nursing Methodology Research/
20 exp Interviews/
21 Questionnaires/
22 Narration/
23 (qualitative$ or interview$ or focus group$ or questionnaire$ or narrative$ or narration$).tw.
24 (ethno$ or emic or etic or phenomenolog$ or grounded theory or constant compar$ or (thematic$ adj3 analys$) or theoretical sampl$ or purposive sampl$).tw.
25 (hermeneutic$ or heidegger$ or husserl$ or colaizzi$ or van kaam$ or van manen$ or giorgi$ or glaser$ or strauss$ or ricoeur$ or spiegelberg$ or merleau$).tw.
26 (metasynthes$ or meta-synthes$ or metasummar$ or meta-summar$ or metastud$ or meta-stud$).tw.
27 or/18-26
28 Patients/px
29 Inpatients/px
30 Family/px
31 Caregivers/px
32 Stress, psychological/
33 Adaptation, psychological/
34 Emotions/
35 Anxiety/
36 Fear/
37 Loneliness/
38 Nursing Care/
39 Nurse's Role/
40 Aftercare/
41 Progressive Patient Care/
42 Continuity of Patient Care/
43 Subacute Care/

44 ((patient$ or famil$ or carer$ or caregiver$ or inpatient$ or in patient$) adj2 (experience$ or stress$ or adapt$ or emotion$ or anx$ or fear$ or lonel$ or concern$ or uncertain$ or unsure or thought$ or feeling$ or felt$ or memor$ or view$ or opinion$ or perception$ or satisfact$)).tw.
45 28-44
46 9 and 17 and 27
47 9 and 17 and 45
48 46 or 47
49 Hospital Units/
50 hospital unit$.tw.
51 (ward or wards).tw.
52 or/49-51
53 48 and 52

5.3.3 Health economics

5.3.3.1 Sources

The following sources were searched to identify economic evaluations:

- *NHS Economic Evaluation Database – NHS EED (via Cochrane Library, Wiley)*
- Health Economic Evaluations Database – HEED (OHE interface)
- MEDLINE (Ovid)
- *MEDLINE In-Process (Ovid)*
- *EMBASE (Ovid)*
- *CINAHL (Ovid)*
- *PsycINFO (Ovid)*
- *Science Citation Index (Dialog DataStar)*
- *Social Science Citation Index (Dialog DataStar)*

5.3.3.2 Strategies

The searches were undertaken on 30 November 2006. For NHS EED and HEED, the MEDLINE strategies presented in sections 5.3.2.2 and 5.3.2.3 were translated. For the bibliographic databases, filters to retrieve economic evaluations were appended to the search strategies used to identify the evidence for risk scoring tools and response strategies. The MEDLINE filter is presented below, which was translated for all other databases.

MEDLINE filter

1. Economics/
2. exp "Costs and Cost Analysis"/
3. Economics, Dental/

4. exp Economics, Hospital/
5. exp Economics, Medical/
6. Economics, Nursing/
7. Economics, Pharmaceutical/
8. Budgets/
9. "Quality of Life"/
10. "Value of Life"/
11. quality-adjusted life years/
12. exp models, economic/
13. markov chains/
14. monte carlo method/
15. Decision Trees/
16. economic$.tw.
17. quality of life.tw.
18. qol?.tw.
19. hrqol?.tw.
20. quality adjusted life year?.tw.
21. qaly?.tw.
22. cba.tw.
23. cea.tw.
24. cua.tw.
25. markov$.tw.
26. (monte adj carlo).tw.
27. (decision adj2 (tree? or analys$)).tw.
28. utilit$.tw.
29. pathway?.tw.
30. ((critical or clinical or patient) adj (path? or protocol?)).tw.
31. or/1-30

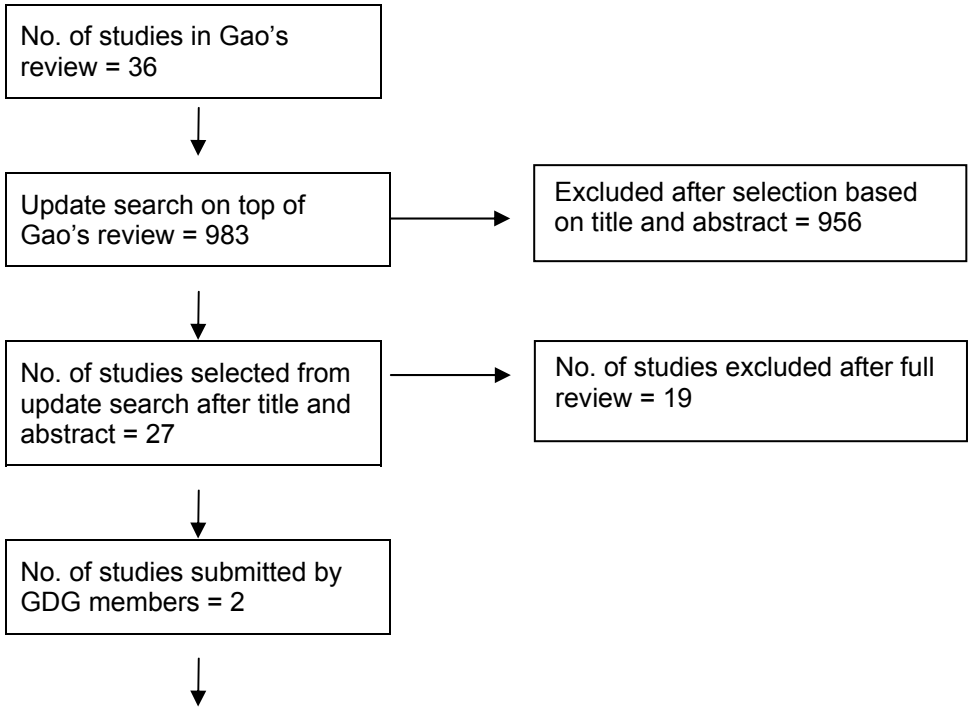
Esmonde L, McDonnell A, Ball C et al. (2006) Investigating the effectiveness of critical care outreach services: a systematic review. *Intensive Care Medicine* 32 (11) : 1713-1721.

Gao H, McDonnell A, Harrison DA et al. (2007) Systematic review and evaluation of physiological track and trigger warning systems for identifying at risk patients on the ward. *Intensive Care Medicine* 33 (4) : 667-679.

5.4 Appendix 4 – Evidence Tables

5.4.1 Topic 1: Identification and Evaluation of Risk Scoring Tool

Volume of Evidence



Total no. of included studies = 46

Acutely Ill Patient – Evidence Table

Topic 1: Identification and Evaluation of Risk Scoring Tool

KEY TO STUDY TYPE

Study type	Description
Development/validation	These studies have been analysed as diagnostic studies. Studies only included in this category if they include patients both with and **without** the reference outcome (e.g. cardiac arrest, ICU admission, mortality). Studies where the population includes patients **with the reference outcome only** have been classified as descriptive. Key distinction between development and validation is that, in development studies, identification of parameters, cut-offs, and/or design of scoring systems have been determined based on the outcomes of the study sample (e.g. through the use of ROC curves). For validation studies, these criteria have already been determined and their predictive ability is evaluated in a new sample of patients. Several included studies fall into both categories.
Intervention studies	Look at the effect on patient outcomes of introducing a scoring tool (either alone or in combination with a critical care response team). Studies have only been included in this category if they permit a comparison of outcomes both **with and without** the scoring tool e.g. randomised controlled trials, non-randomised controlled trials, before-and-after studies, cohort studies with historical control. Studies that report the implementation of a scoring tool but do not permit this comparison have been classified as descriptive.
Descriptive studies	Studies included in the Gao et al. (2007) systematic review that describe the use of a scoring tool, but do not fit into the categories outlined above.

TYPES OF SCORING TOOL (as used by Gao et al. (2007) review)

TYPE	DESCRIPTION
Single parameter system	Periodic observation of selected vital signs which are compared to a simple set of criteria with predefined thresholds, with a response algorithm being activated when any criterion is met
Multiple parameter system	Response algorithm requires more than one criterion being met or differs according to the number of criteria met
Aggregate scoring system	Where weighted scores are assigned to physiological values and compared to predefined trigger thresholds
Combination system	Involving single or multiple parameter systems in combination with aggregate weighted scoring systems.

DEVELOPMENT/VALIDATION (DIAGNOSTIC ACCURACY) STUDIES

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 22, Subbe et al. (2001), UK Cohort study Study period: 5 days Level of evidence: **(Ib)**	Acute medical admissions unit. All patients were medical emergency admissions (patients admitted directly to coronary care, HDU, or ICU were excluded). No of patients: 709 Length of follow-up: 60 days.	**TT system:** Modified Early Warning Score (MEWS). Aggregate scoring system. Parameters (5): Heart rate, respiratory rate, blood pressure, temperature, consciousness, MEWS score of 5 or more was considered 'critical'. **Response team:** Not reported. **Reference criteria:** ICU/HDU admission Attendance of cardiac arrest team	Score of 5 or more was associated with: Increased risk of death: OR 5.4 (95% CI 2.8 – 10.7) ICU admission: OR 10.9 (95% CI 2.2 – 55.6) HDU admission: OR 3.3 (95% CI 1.2-9.2).	HDU/ICU admission was at the discretion of attending physicians, who were unaware of patient's MEWS score. 2x2 table data (a,b,c,d) not reported. ROC curve presented, but sensitivity and specificity for a critical score of 5 or more not reported.

		60 day mortality		

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 1 Buist et al. (2004), Australia Prospective cohort study Study period: 33 weeks. Level of evidence: **(II)**	General wards (2medical, 2 surgical and 1 orthopaedic). DNR patients were not excluded. No of patients: 6303	**TT system:** MET calling criteria. Single parameter system Parameters (6): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, seizures. One or more abnormal observations triggers the system. **Response team:** Medical emergency team (MET) **Reference criteria:** In-hospital mortality	Patients with one or more abnormal observation PPV = 35% Patients with one abnormal observation only PPV = 16.2% Patients with 4 or more abnormal observations. PPV = 88.2% Univariate logistic regression found that the strongest predictors of mortality was: decrease in respiratory rate Multiple logistic regression identified 6 significant predictors of mortality: Decrease of consciousness, loss of consciousness, hypotension, decreased respiratory rate, O_2 saturation, and decreased heart rate.	564 study patients experienced 1598 pre-determined clinically abnormal events.146 of these patients subsequently died. Number of deaths for patients who did not trigger the system is not reported, therefore sensitivity, specificity, and negative predictive value could not be calculated. Medical emergency team responded to all abnormal observations and intervention may have averted death, therefore estimate of test accuracy may be lower?

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 5, Goldhill and McNarry (2004), UK Cohort study Study period: 1 day (with 30 day follow-up) Level of evidence: **(II)**	Non-obstetric beds (excluded ICU pts and known DNRs). 548 patients. Length of follow-up: 30 days	**Parameters assessed:** PART calling criteria (based on EWS). Parameters (7): heart rate, respiratory rate, blood pressure, temperature, urine, O_2 saturation, consciousness. **Response team:** Patient at risk team (PART). ICU outreach team. **Reference criteria:** 30-day mortality	Stepwise multiple logistic regression identified 5 significant variables (in decreasing significance): Level of consciousness, heart rate, age, blood pressure, and respiratory rate. Results, based on this model: Sensitivity: 7.7% Specificity: 99.8% Positive predictive value: 66.7%	Study does not report the use of a specific scoring system, but physiological parameters assessed (points awarded for increasing abnormality) and normal ranges used were the patient at risk team (PART) criteria, (with the addition of temperature). 2x2 table data (a,b,c,d) not reported. Mortality increased with the number of physiological abnormalities ($p<0.001$).

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 18, Hodgetts et al. (2002), UK Case-control study (cases were consecutive, controls randomly selected). Study period: 2 weeks Level of evidence: **(II)**	Hospital patients (included wards and critical care areas). Cases: 118 pts Controls: 132 pts	**Parameters assessed:** Risk factors for cardiac arrest, identified from case-notes review. Parameters (10): Heart rate, respiratory rate, blood pressure, temperature, O_2 saturation, concern, breathing indicator, chest pain, abdominal pain, gender **Response team:** Not reported. **Reference criteria:** In-hospital cardiac arrest (defined as CPR attempted).	MET activation criteria were grouped and weighted by a panel of experts and a cumulative scoring system developed. Score of 1 Sensitivity: 100% Specificity: 17% Score of 2-3 Sensitivity: 98 – 94% Specificity: 36 – 61% Score of 4 Sensitivity: 89% Specificity: 77% Score of 5-7 Sensitivity: 84 – 64% Specificity: 89 – 96% Score of 8 Sensitivity: 52% Specificity: 99%	Aim of study is to identify significant predictors of cardiac arrest to inform the development of MET calling criteria. Ward and critical care patients would have received different levels of monitoring and intervention. Parameters assessed from case-notes review. Graded clinical response outlined based on score. If a patient achieves a score of 8 or higher the MET team is called out. Case-control study designs result in inflated estimates of diagnostic test accuracy.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 259, Bell et al. (2006), Sweden Cohort study. Length of study: 2 days (4 months apart). Level of evidence: **(II)**	General wards (psychiatric wards and ICU excluded). Length of follow-up: 30 days. No of patients: 895	**TT system:** Single parameter system. Parameters (4): heart rate, respiratory rate, blood pressure, consciousness. If a patient triggers the chief ward nurse is informed. **Response team:** Not reported **Reference criteria:** 30 day mortality 6 month mortality	30 day mortality: Sensitivity: 33.3% specificity: 96.5% PPV: 33.3% NPV 33.3% LR+: 9.51 LR-: 0.69 6-month mortality: Sensitivity: 37.5% specificity: 87.3% PPV: 12.1% NPV: 96.8% LR+:2.96 LR-: 0.72	Study carried out during the planning phase before implementing a medical response (MET) team in the hospital. Patients were excluded if they were not on the ward at the time of data collection, they refused to participate, or ward nurse/doctor felt it was inappropriate. A more restricted and an extended set of criteria (based on broadening or shortening the normal ranges for heart rate, respiratory rate, and BP) were also evaluated, but full results not reported. Authors report that the original parameter levels (taken from Bellomo 2004, ID6) had the greatest accuracy.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 1022, Goldhill et al. (1999), UK Cohort study Study period: 6-months Level of evidence: **(III)**	Hospital wards 63 patients (69 assessments made) Length of follow-up: death or discharge.	**TT system:** PART calling criteria (based on MEWS). Multiple parameter system. Parameters (6): heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness. Response based on number and combination of parameters triggered. **Response team:** Patient at risk (PART) ICU outreach team. **Reference criteria:** ICU admission.	Patients with one abnormal observation: Sensitivity: 97% Specificity: 18% Patients with two abnormal observations: Sensitivity: 80% Specificity: 41% Patients with three abnormal observations: Sensitivity: 27% Specificity: 67%	Main criteria: Patient triggers if they have 3/6 abnormal physiological parameters Secondary criteria: patient triggers if they have reduced consciousness plus either increased heart or respiratory rate (cut-off values higher for latter two variables than for main criteria). 2x2 table data (a,b,c,d) not reported.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 296, Lam et al. (2006), Hong Kong Cohort Study length: 1 month. Level of evidence: **(II)**	Emergency department observation ward (EDOW). No. of patients: 427 (diagnostic accuracy results appear to be based on data from 94 patients admitted hospital ward or ICU). Length of follow-up: 30 days	**TT system:** Modified Early Warning Score (MEWS). Aggregate scoring system Parameters (5): Heart rate, respiratory rate, blood pressure, temperature, consciousness Critical score > 4. Patients highest MEWS score reached during EDOW admission was defined as 'ScoreMax'. **Response team:** Specialist emergency physicians who worked on the ward. **Reference criteria:** Serious outcome (defined as death and/or ICU admission).	ScoreMax >4 Sensitivity: 60% (95% CI =15-94%) Specificity: 97% (95% CI =95-98%) ROC curve analysis suggested that ScoreMax > 3 performed best Sensitivity:100% (95% CI =48-100%) Specificity: 97% (95% CI = 85-91%) ROC curves of different physiological parameters and ScoreMax were compared for predicting serious outcome. Area under curve highest for ScoreMax (0.96). ROC curves of different physiological parameters and ScoreMax were compared for predicting hospital admission (based on 425 patients) Area under curve highest for respiratory rate (0.77).	2 patients with incomplete epidemiological or discharge data were excluded. Ward physicians who decided whether patients should be admitted to wards or ICU were unaware of MEWS scores. Unclear whether 30-day mortality assessed in patients not admitted.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
ID 575, Garcea et al. (2006), UK Cohort study (retrospective) Study period: 3 years approx? (2002 to 'present'). Level of evidence: **(III)**	110 Patients admitted with acute pancreatitis Length of follow-up: episode of pancreatitis (no info about how this was defined)..	**TT system:** Early Warning Score (EWS). Aggregate scoring system. Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, consciousness. Critical score was ≥ 3. **Response team:** Not reported. **Reference criteria:** Mortality	Day 1 Sensitivity: 85.7% (95% CI 42.2-97.6%) Specificity: 28.3% (95% CI 19.7-38.2%) NPV: 94.3% Day 2 Sensitivity: 71.4% (95% CI 28.3-90.5%) Specificity: 67.4% (95% CI 57.1-76.5%) NPV: 98.3% Day 3 Sensitivity: 100% (95% CI 54.1-100%) Specificity: 77.4% (95% CI 67.6-85.4%) NPV: 100%	APACHE scores. ASA grade, Ranson score, Imrie score and CT grades also recorded for all patients. Length of patient follow up. Results also presented for "Adverse outcome", defined as death, necrosectomy, or critical care admission. ROC curve analysis found that EWS was the best predictor adverse outcomes in the first 24hrs of admission.

Study details & Level of evidence	Patients and setting	Tools evaluated and reference criterion	Results	Comments
ID 2501 Gao et al. (2007) Cohort study. Study length: variable by dataset Level of evidence: **(III)**	Acute NHS hospitals in England with critical care services. Patients < 12 were excluded. 15 datasets included.	**TT systems:** Single parameter systems (1) Combination systems (4) Aggregate scoring systems (10) **Parameters:** All TTs included heart rate, respiratory rate, systolic blood pressure, and level of consciousness, but varied in terms of other parameters, assignment of scores to physiological values, and trigger thresholds. Variation between datasets existed in the physiological measurements and outcomes. For tools with graded responses a trigger event was defined as any response involving informing a more experience member of staff. **Reference criterion:** Presence of established critical illness (defined as composite of death, admission to critical care, DNR, or CPR).	Median (IQR) sensitivity: 43.3 (25.4-69.2) Median (IQR) specificity: 89.5 (64.2-95.7) Median (IQR) PPV: 36.7 (29.3-43.8) Median (IQR) NPV: 94.3 (89.5-97.0) ROC curve analysis: area under the ROC curve ranged from 0.61-0.84 Meta-regression of 12 datasets: Differences in diagnostic accuracy among the datasets were not explained by the physiological parameters included in the TT.	Unclear whether some of the datasets were from critical patients only. Meta-regression done on datasets that included critical care follow-up, or all ward/MAU patients were identified. Currently unpublished.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
Updated search: ID: 3399, Cuthbertson et al. (2007), UK Comparative cohort study Study period: 7 weeks (1st July till 15th August 2003). Level of evidence: **(II)**	A teaching hospital in Scotland. All patients from the surgical high dependency units in Aberdeen Royal Infirmary (2 cohorts: 1 required ICU admission, 1 did not). Total no. of patients = 136 ICU group = 67 HDU group = 69	**TT system:** Individual physiological parameters (6): Heart rate, respiratory rate, systolic blood pressure, temperature, oxygen saturation, urine volume & consciousness level using Alert (AVPU scale). Multiple parameters & aggregate scoring systems (3): PART, EWS, MEWS. **Exclusions: (1) parameters that had less than 60% of complete data points, (2) urine volume was excluded due to large amount of missing data.* **Response team:** No response team. **Reference criteria:** ICU admissions.	<u>Differences in physiological parameters in the ICU and HDU groups:</u> Heart rate: p = 0.0001, AUC: 0.74, Sensitivity = 67, Specificity = 77, cut point = 90 Respiratory rate: p = 0.0001, AUC: 0.82, Sensitivity = 70, Specificity = 86, cut point = 20 Oxygen saturation: p = 0.0001, AUC: 0.79, Sensitivity = 66, Specificity = 86, cut point = 96 Systolic blood pressure: p = 0.77, AUC: 0.51 *[not significant]* Temperature: p = 0.81, AUC: 0.51 *[not significant]* EWS: p = 0.0001, AUC: 0.86, Sensitivity = 81, Specificity = 84, cut point = 3 MEWS: p = 0.0001, AUC: 0.83, Sensitivity = 72, Specificity = 84, cut point = 3 PART: p = 0.0001, AUC: 0.84, Sensitivity = 65, Specificity = 89, cut point = 2 <u>Discriminant analysis:</u> There were 3 canonical discriminant functions (*f*1 with 5 parameters, *f*2 with 3 parameters & *f*3 with 2	The findings of this study showed that HH, RR & SaO_2 were powerful physiological parameters for determining the difference between patients requiring ICU admission. Only 7 weeks study period. Only covered a cohort of surgical patients and the sample was small. One parameter (urine volume) was discarded due to large amount of missing data. This could have affected the outcomes of the discriminant analysis. The author commented that one of the weaknesses of this study is the use of ICU admission as the end point

			parameters) applied to every subject for all time periods. The area under ROC were *f*1 = 0.81, *f*2 = 0.80, *f*3 = 0.75 respectively. Consequently, *f*2 (HH, RR, SaO_2) was seen to perform as well as *f*1 despite containing fewer variables. When comparing differences in the 48 hours before ICU admission, HR & RR could differentiate between groups for up to 7 & 8 hours before ICU admission. However, *f*2 and SaO_2 could differentiate between groups for up to 48 hours before ICU admission. Function *f*2 was as powerful at differentiating between groups at 24 hours as it was at 2 hours. The existing scoring systems (EWS, MEWS, PART) were good discriminators but with larger number of parameters and large number of rules (24, 29 & 20 respectively).	rather than other ward based deteriorations as study end points such data was deemed to be unclean data and was not suitable to be analysed.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
Updated search: ID: 635 Goldhill et al. (2005), UK cohort study Study period: Between 17 August 2001 and 27 January 2003. Level of evidence: **(III)**	UK hospital. 2 groups of patients: Primary referrals from the wards of any patient causing concern or who triggered PART, and, patients discharged to a ward from ICU. Total no. of outreach service episodes = 1047	**TT system:** Patient-at-risk (7): Heart rate, respiratory rate, systolic blood pressure, temperature, oxygen saturation, urine volume & consciousness level **Response team:** Patient-at-risk team (PART) **Reference criteria:** Hospital mortality.	Association between PAR score (of > 0) and hospital mortality = chi-squared for trend, $p < 0.0001$ Ability of PAR to discriminate between patients who needed intervention from those who did not: area under ROC curve = 0.822	Study included only those patients already selected to receive outreach care, and therefore were likely to be among the sickest patients in the hospital. The author commented that selecting a suitable trigger score will determine the outreach service workload. Study findings might also have been different if other thresholds had been selected.

Study details & Level of evidence	Setting and patients	Tool evaluated and reference	Results	Comments
Updated search: **emergency paper* ID: 242 Subbe et al. (2006), UK Retrospective cohort study Study period: Group 1: 2 days Group 2: 7-month Group 3: 7-month Level of evidence: **(III)**	UK hospital. 3 groups of patients: Group 1 – unselected emergency department (ED) admissions. Group 2 – from ED to ICU. Group 3 – from ED to general wards then ICU. No. of patients: Group 1 = 53 Group 2 = 49 Group 3 = 49	**TT systems:** MEWS (5): systolic blood pressure, pulse rate, respiratory rate, temperature, level of consciousness. Critical score ≥ 3 ASSIST (5): systolic blood pressure, pulse rate, respiratory rate, level of consciousness, age (extra point with patient > 70 years old). Critical score ≥ 4 MET (5): blood pressure, heart rate, respiratory rate, level of consciousness. Critical score: single call-out parameter. **TT systems were compared with MTS (Manchester Triage System): blue, green, yellow, orange, red.* **Response team:** None. **Reference criteria:** ICU admissions.	<u>Sensitivity of scoring systems for ICU admission:</u> MTS (orange or red): Group 1 = 46 (96%) Group 2 = 32 (65%) MEWS (>2): Group 1 = 34 (77%) Group 2 = 24 (55%) ASSIST (>3): Group 1 = 11 (22%) Group 2 = 8 (16%) MET (=1): Group 1 = 1 (2%) Group 2 = 3 (7%) <u>Groups Comparisons:</u> *In group 2, MTS identified 42 sick patients; MEWS, ASSIST & MET would not have identified any additional sick patients. *In group 3, MTS identified 28 sick patients; MEWS would have identified an additional 7 patients; ASSIST & MET would not have identified any additional sick patients.	The findings suggested that the introduction of a physiological TT scoring system would have identified only a small number of additional patients as critically ill and added little to the triage system currently in use. Analysis on Specificity not reported. There was no actual utilization of the scoring systems, physiological data was retrieved from database and then was used to run the calculations of the three scoring systems and then analyses were carried out. The author commented that this is a small scale non-randomised study, and the study did not assess or score 'pain' as 'pain' could be a powerful

				confounding variable that influences the value of physiological parameters, and pain relief would have altered subsequent measurements.

Study details & Level of evidence	**Setting and patients**	**Tool evaluated and reference**	**Results**	**Comments**
Updated search: **reproducibility paper* ID: 7439 Subbe et al. (2007) Prospective cohort study Level of evidence: **(II)**	UK hospital. <u>Inter-rater reliability study:</u> 2 medical wards & 2 surgical wards = 114 patients, 424 datasets, 4 raters. Intra-rater reliability study: 1 medical ward & 1 surgical ward = 45 patients, 180 datasets, 4 raters.	**TT systems:** MET (5): blood pressure, heart rate, respiratory rate, level of consciousness. Critical score: single call-out parameter. MEWS (6): systolic blood pressure, pulse rate, respiratory rate, temperature, level of consciousness, urine. Critical score ≥ 3 ASSIST(5): systolic blood pressure, pulse rate, respiratory rate, level of consciousness, age (extra point with patient > 70 years old). Critical score ≥ 4 **Response team:**	MET achieved higher percentage agreement than ASSIST, and ASSIST higher than MEWS. <u>Level of agreement (inter-rater study):</u> (Trigger) MET: Kappa = -0.03 (95% CI: -0.05-0.00) MEWS: Kappa = 0.18 (95% CI: 0.09-0.27) ASSIST: Kappa = 0.20 (95% CI: 0.04-0.38) (Score) MEWS: Kappa = 0.20 (95% CI: 0.13-0.27) ASSIST: Kappa = 0.46 (95% CI: 0.38-0.55) <u>Level of agreement (intra-rater study):</u> (Trigger) MET: Kappa = -0.01 (95% CI: -0.02- -0.01) MEWS: Kappa = 0.64 (95% CI: 0.46-0.84) ASSIST: Kappa = 0.66 (95% CI: 0.04-0.38) (Score) MEWS: Kappa = 0.53 (95% CI: 0.39-0.68) ASSIST: Kappa = 0.59 (95% CI: 0.46-0.74)	The study suggested that there was significant variation in the reproducibility of physiological track and trigger warning systems used by different health care professionals. All three systems examined showed better agreement on triggers than aggregate scores. Simpler systems had better reliability. Repeated measurements were taken within an hour in this study and it did not assess whether there was systematic drift of figures between measurements. Approximately 5% of all

		None. **Reference criteria:** Reproducibility	Intra-rater reliability was better then inter-rater reliability. Using corrected calculations improved the level of inter-rater agreement but not intra-rater agreement. The systems examined showed better levels of agreement on triggers than on aggregate scores.	potential patients were not included in the study (consent not obtained). Urine output was excluded in the study due to large amount of missing data. The findings only represent the human element of reliability (as BP & temperature were measured with electronic devices).

INTERVENTION STUDIES

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 154, Hillman et al. (2005), Australia Cluster-RCT Study period: 6-months Level of evidence: **(Ib)**	General wards (including coronary care unit, and HDU not under supervision of intensive care specialist). Intervention: 12 hospitals. Median no. of admissions 18512 (range 2667-33 115) Control: 11 hospitals. Median no. of admission 17555 (range 5891-22338)	**TT system:** Parameters (8): Heart rate, respiratory rate, blood pressure, consciousness, concern, cardiac arrest, respiratory arrest, repeated/extended seizures **Response team:** Medical emergency team (MET) including at least one doctor and nurse from the emergency dept or ICU. Staffing varied between hospitals, but study protocol required that the team be at least the equivalent of the pre-existing cardiac arrest team. **Response algorithm:** Staff call out the MET when patient triggers. **Other intervention:** 4-month education strategy for clinical and medical staff about calling criteria and how to call MET, including lectures, video, and booklets (did not include treatment of critically ill or unstable patients). Reminders (prior to introduction of system)	'Usual care'. Cardiac arrest teams	Incidence of cardiac arrests (per 1000 patients) Defined as arrest without a pre-existing DNR order. Unplanned ICU admissions (per 1000 patients). Unexpected deaths (per 1000 patients) Defined as death without a pre-existing DNR.	Int: 1.31 Comp: 1.64 p value: 0.306 Int: 4.19 Comp: 4.68 p value:0.899 Int: 1.06 Comp: 1.18 p value: 0.564	Before-and-after analysis also carried out, using on baseline data collected during a 2-month period before the study began. A significant reduction in rate of cardiac arrests and unexpected deaths was seen for both groups combined. Investigators observed low rates of MET calls preceding unplanned ICU admissions and unexpected deaths where MET criteria were documented, suggesting implementation could have been improved.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 3, Priestley et al. (2004), UK Cluster-RCT Length of study period: 12-weeks. Level of evidence: **(II)**	16 adult wards (8 surgical, 5 medical and 3 elderly care) 2903 patients. Length of follow-up: discharge or death.	**TT system:** 'patient at risk' score. Aggregate scoring system Parameters (5): Heart rate, respiratory rate, blood pressure, urine, consciousness **Response team:** Critical care outreach team (CCOT). 24-hr cover. Nurses only. Responses included support and advice for ward staff, individual care of patient during crisis period, facilitation of ICU admission. **Response algorithm:** Trigger score referred to CCOT and patient's consultant. Level of involvement of CCOT determined by discussion with ward staff and admitting team. Ward staff could also seek CCOT guidance in absence of trigger score if they were concerned about the patient. **Other intervention:** 4 weeks training for all nurses and doctors on ward prior to introduction of CCOT. Care of critically ill patients, and use of scoring tool.	'Usual care' (not described).	In-hospital mortality: (Logistic regression analysis) Length of stay (defined as from study ward admission to discharge from hospital).	Intervention vs control: OR = 0.52 (95%CI 0.50-0.97) Intervention vs control: Hazard ratio: 0.90 (95%CI 0.84-0.97).	Phased introduction of the CCOT using matched pairs of wards. In each ward 4 weeks of training were given prior to introduction of team. One from each pair randomised to earlier phase of introduction. Possibility of contamination between wards. PAR is a simplified version of Subbe (2001, ID 22). No information on frequency of monitoring.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 2, DeVita et al. (2004), US Before and after study (retrospective) Level of evidence: **(III)**	All hospital sites, except ICU, emergency dept, and recovery. 3269 MET responses. Control period: 5 years. Intervention period: 1.75 years.	**TT system:** Single parameter system. Parameters (12): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, colour change, pain, respiratory difficulty, suicide attempt, uncontrolled bleeding, unexplained agitation **Response team:** Medical emergency team (MET). 8 members, including physicians, nurses and a respiratory therapist. Lead by ICU physician. **Response algorithm:** Any hospital staff member who witnesses grave clinical deterioration, operator pages MET. **Other intervention:** Audit and feedback of adherence to protocol for calling MET team.	**Response team:** As for intervention **Response algorithm:** As for intervention	Incidence of MET responses: (per 1000 admissions) Incidence of cardiopulmonary arrest: (per 1000 admissions) determined by hospital records of 'code' team activation Proportion (%) of arrests that were fatal: -Death on same day as arrest -Arrest without survival to discharge.	Int: 25.8 Comp: 13.7 p value: p<0.01 Int: 5.4 Comp: 6.8 p value: p=0.016 Int: 33.3% Comp: 33.3% p value: n.s. Int: % Comp: 33.3% p value: n.s.	Time period during which death (fatal cardiopulmonary arrest) was analysed prior to the introduction of the TT system was 23 months. No info on frequency of monitoring or who should be monitored. No info on MET hours of operation. Analysis for secular changes found no significant trends.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 6, Bellomo et al. (2004), Australia Before and after study Control period: 4-months Intervention period: 4-months Level of evidence: **(III)**	All wards. Acute hospital. 2436 Patients who had major surgery (hospital stay >48 hrs) Control: 1116 pts. (1369 ops.) Intervention: 1067 pts. (1313 ops.) Length of follow-up: discharge or death	**TT system:** Single parameter system Parameters (7): Heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, concern. **Response team:** Medical emergency team (MET). Intensive care fellow and intensive care nurse. ICU specialist available and would attend, if requested between 08.00 – 20.00. outside of these hours, intensive care specialist would attend within 15-30 mins if required. MET carried drugs and equipment for resuscitation and endotracheal intubation. If patient not transferred to ICU, visit was treated as a formal consult and concerns, advice, and suggestions were verbally communicated to parent unit, and recorded in patient's chart **Response algorithm:** If patient triggers, MET is called to attend. *(continued over)*	**Response team:** Emergency response system based on cardiac arrest team.	All adverse events: Acute myocardial infarction: (chest pain, ECG changes, at least one elevated CK concentration) Pulmonary embolism: Clinical suspicion confirmed by V/Q scan. Respiratory failure: (need to institute mechanical breathing in ICU)	All reported as % of patients Int: 17% Comp: 30.1% p value: < 0.0001 Int: 1% Comp: 1.9% p value: n.s. Int: 0.01% Comp: 0.04% p value: n.s. Int: 1.4% Comp: 6.7% p value: <0.0001	No information on how often patients were monitored. Same study as Bellomo et al. (2003) (ID 10), which reports data for cardiac arrests only (no of arrests, fatal arrests, and no. of post-arrest bed days).

		Other intervention: Presentations and discussions with medical staff to introduce MET system, followed by 2 month 'run-in' period.		Stroke: (clinical symptoms and neurological exam, confirmed by CT or MRI Severe sepsis: (clinical suspicion, hypotension, positive blood culture). Acute renal failure: (acute need for continuous renal therapy) Emergency ICU admissions. Death Length of stay (mean):	Int: 0.3% Comp: 1.7% p value: 0.0026 Int: 0.3% Comp: 1.6% p value: 0.0044 Int: 0.02% Comp: 2.4% p value: 0.0001 Int: 4.5% Comp: 8% p value: 0.01 Int: 4% Comp: 6.5% p value: 0.0178 Int: 18.9 days (±35.3) Comp: 23.8 days (±56.5) p value: 0.092	

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 12, Pittard (2003), UK Before and after study Control period: 6-months. Intervention period: 6-months Level of evidence: **(III)**	Three surgical wards and surgical high dependency unit	**TT system:** Aggregate scoring system. Parameters (7): Heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, respiratory support/oxygen therapy. Tool used by ward staff as part of routine observations. **Response team:** Critical care outreach service comprising senior critical care nurses and medical staff. Available 09.00-17.00 Mon-Fri. Team review patient and facilitate appropriate management, of arrange admission to ICU. Team also carry out daily ward round to see patients discharged from ICU. **Response algorithm:** Graded response based on severity of score and time elapsed from identification. Initially call junior member of ward and outreach staff, then call more senior staff, then call consultant, outreach team and contact ICU	'Usual care' (not described).	Unplanned admission to ICU rate: Mean length of ICU stay for unplanned admissions Readmissions to ICU	% of patients Int: 43% Comp: 58% p value: =0.05 Int: 4.8 days Comp: 7.4 days p value: n.s. Int: 3.3% Comp: 5.1% p value: 0.05	Scoring tool based on MEWS (Stenhouse . No information about frequency of monitoring required. Total number of patients on the wards during the study periods are not reported. 273 patients were seen by the outreach team during the intervention period.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 13, Subbe et al. (2003), UK Cohort study (with historical control) Intervention period: 3-months Control period: 1-month Level of evidence: **(III)**	Medical admissions unit. Patients >15 yrs referred by GP or A&E. (exclusions – coronary care, palliative care only, or admitted directly to other wards). No of patients: Int:1695 Control: 659 Length of follow-up: death or hospital discharge	**TT system:** Aggregate scoring system. Parameters (5): Heart rate, respiratory rate, blood pressure, temperature, consciousness **Response team:** Critical care outreach team (not described) **Response algorithm:** Patients with score >4 were referred for urgent medical and critical care outreach team review. **Other intervention:** All unit nursing staff were trained by investigators and outreach team to collect bedside observations and calculate MEWS score.	Usual care (includes possibility of referral to critical care outreach team). No early warning system.	% Admission to ICU % Admission to HDU % in-hospital mortality (within 30 days) % cardiopulmonary arrests length of stay on ICU ICU mortality APACHEII scores on ICU admission	Int: 0.5% Comp: 0.9% p value: n.s. Int: 4.6% Comp: 3.2% p value: n.s. Int: 9.7% Comp: 8% p value: Int: 2.3% Comp: 0.6% p value: not reported Int: 2 (IQ-range 1-30) Comp: 4 (IQ-range 1-8) p value: 0.3 Int: 33% Comp: 67% p value: 0.21 (very small sample size) Int: 15 (s.d.8) Comp: 23 (s.d.7) p value: <0.06	Historical control data obtained in from the same unit in the previous year (Subbe 2001, ID 22). TT system based on the MEWS score. Patients were classified, based on score as low (0-2), medium (3-4), or high (>4) risk. Respiratory rate was the best discriminator in predicting high-risk scores.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 14, Foraida et al. (2003), US Before and after study Control period: 2 years Intervention period: 1 year Level of evidence: **(III)**	Entire hospital (no paediatric, obstetric, or gynaecology services) Length of follow-up: N/A	**TT system:** Single parameter system. Parameters (19): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, bleeding into airway, breathing difficulty, colour change, lethargy/difficulty walking, naxolone use without response, pain, seizure, sudden collapse, sudden loss of movement, suicide attempt, trauma/chest pain/stroke, uncontrolled bleeding, unexplained agitation **Response team:** Medical emergency team (Condition C). Multidisciplinary team. **Response algorithm:** When patient triggers, caregiver calls crisis number and operator pages the response team, who respond within 90 secs. **Other intervention:** Reviews of sequential stat pages (disorganised responses);	**Response team:** Medical emergency team (Condition C). Multidisciplinary team. Caregiver contacts operator to call-out the response team.	Monthly average no of condition Cs Incidence of cardiopulmonary arrests (per 1000 pts). Incidence of fatal cardiopulmonary arrests (per 1000 pts).	Control: 32.3 (95% CI 27.0-37.7) Intervention: no of condition Cs increased by 19.2 (95% CI 12.1-26.3). Actual values not reported p value: < 0.0001 Int: 5.2 Cont: 6.0 p value: n.s. Int: 4.3 Cont: 2.2 p value: <0.0001	Hospital also has a condition A (arrest – cardiopulmonary) response. Condition C (crisis) refers to any other crisis situation. Feedback about disorganised responses and inappropriate delays was being given before introduction of the TT system but analyses suggested these initiatives did not affect outcomes.

		feedback to caregivers regarding delays in crisis team activation; dissemination of calling criteria through e-mail, posters, and oral presentation.				

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 17, Odell et al. (2002), UK Before and after study Control period: 7-months Intervention period: 3-months Level of evidence: **(III)**	Surgical wards (including an emergency surgical admissions unit). Length of follow-up: N/A	**TT system:** Aggregate scoring system Parameters (5): Heart rate, respiratory rate, blood pressure, urine, consciousness. Incorporated into observation charts. **Response team:** Outreach service run by 1.2 G grade sisters, and facilitated by critical care nurse consultant. Operating hours 08.00-16.00 Mon-Fri. Outside of hours ICU offers limited ward service. Outreach activities include advising about therapeutic interventions, observation, medication, nursing issues and optimum positioning for the patient. **Response algorithm:** High score (>3) triggers referral to patient's medical team and outreach staff. Patient should be seen within 30 mins. **Other intervention:** None	**Response team:** As described for intervention period.	Number of outreach visits	Int: 976 (mean 139/month) Comp: 546 (182/month) p value: Not reported (Study does not report how many pts passed through the wards during each period, therefore p value could not be calculated)	Scoring tool based on MEWS. Outreach service already in place, before the implementation of the scoring tool. Concern about respiratory rate (52%) and heart rate (24%) generated most of the outreach calls.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 19, Buist et al. (2002), Australia Before and after study Control period: 1 year (1996) Intervention period: 1 year (1999) Level of evidence: **(III)**	Entire hospital No. of pts. Cont: 19317 Int: 22847 Length of follow-up: death or discharge	**TT system:** Single parameter system Parameters (14): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, concern, agitation/delerium, airway threatened, difficulty speaking, failure to respond to treatment, repeated/prolonged seizures, respiratory distress, unable to get prompt assistance, uncontrolled pain **Response team:** Medical emergency team (MET) comprising two doctors (medical registrar and intensive care registrar) and one senior intensive care nurse. Attend patient immediately with resuscitation drugs, fluid, and equipment. **Response algorithm:** MET called immediately if the patient has a trigger score. **Other intervention:** Formal education, audit and feedback.	'Traditional' system of response. Nurse contacts most junior member of medical team, who reviews patient and institutes treatment. If patient continues to be unstable, junior doctor contacts next most senior member of team.	Incidence of unexpected cardiac arrests (per 1000 pts). Defined as staff member concerned enough about patient to make a cardiac arrest call (excluded DNR patients) % of cardiac arrests that were fatal No. of unplanned admissions to ICU (per 1000 patients)	Int: 2.05 Comp: 3.77 p value: <0.001 Int: 55.3% Comp: 76.7% p value: <0.001 Int: 3.4 Comp: 2.3 p value: n.s.	MET team and scoring system introduced gradually from 1997. Formal education, audit and feedback carried out in 1999.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID 25, Bristow et al. (2000), Australia Cohort study Study period: 6-months Level of evidence: **(III)**	Adults (>14) admitted to hospital. Intervention: 1 hospital Control: 2 hospitals	**TT system:** Single parameter system Parameters (8):Heart rate, respiratory rate, blood pressure, consciousness, concern, cardiorespiratory arrest, repeated/prolonged seizures, threatened airway. **Response team:** Medical emergency team (MET), consisting of ICU registrar and senior nurse, and medical registrar. **Response algorithm:** MET team called if patient triggers **Other intervention:** Education programme to explain the METs role.	Conventional cardiac arrest team. Team (consisting of ICU registrar, medical registrar, and ICU or coronary care nurse) called out when patient has cardiorespiratory arrest.	Cardiac arrest Unanticipated ICU/HDU admission: (Defined as admission to ICU/HDU for reason other than the reason for hospital admission).	Control 1 vs intervention: OR = 1.24 (95%CI 0.87-1.78) p value: n.s. Control 2 vs intervention: OR = 1.05 (95%CI 0.82-1.33). p value: n.s. Control 1 vs intervention: OR = 2.17 (95%CI 1.65-2.78) p value: significant (n.r.) Control 2 vs intervention: OR = 2.35 (95%CI 1.82-3.04) p value: significant (n.r.)	Odds ratios adjusted for case-mix differences within the hospitals. Intervention hospital is the reference for the Odds ratios. P values not reported.

Study details & Level of evidence	Setting and patients	Intervention	Comparison	Outcomes	Effect size	Comments
ID260 Paterson et al. (2006), UK Before and after study Control period: 11 days Intervention period: 11 days Level of evidence: **(III)**	Emergency medical and surgical admissions to a combined assessment area (CAA) Intervention: 435 pts. Control: 413 pts.	**TT system:** Aggregate scoring system. Parameters (6):Heart rate, respiratory rate, blood pressure, temperature, O_2 saturation, consciousness. **Response team:** Not reported. **Response algorithm:** Escalating response prompting more frequent observation and urgent medical assessment. **Other intervention:** Education program for staff prior to introduction. Simple patient management guidelines on reverse of score sheet for first responders.	Use of existing conventional observation charts.	In-hospital mortality Length of hospital stay: median and IQ range. No of critical care admissions:	Int: 13/434 (3%) Comp: 24/413 (5.8%) p value: =0.046 Int: 2 (1-6) Comp: 2 (1-6) p value: n.s. Int: 11 (2.5%) Comp: 11 (2.6%) p value: n.s.	Scoring tool modified from MEWS, to include Oxygen saturation. Effect of introduction of SEWS chart on standard of documentation also examined. Overall documentation of physiological parameters significantly improved following introduction of SEWS (p<0.001)

DESCRIPTIVE STUDIES

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 7, Lee et al. (1995). Australia Level of evidence: **(III)**	To describe the utilisation and outcome of medical emergency team (MET) interventions.	375-bed teaching hospital. All wards, emergency dept, and critical care areas.	Single parameter system. Staff may alert the MET using any one of three pre-defined criteria: 1. specific conditions (cardiovascular, respiratory, shock, poisoning/trauma, neurological, obstetric, surgical) 2. physiological (6) /pathological abnormalities (5) (heart rate, respiratory rate, blood pressure, temperature, urine, consciousness, base excess, blood sugar, pH, potassium, sodium) 3. “any time urgent help required”.	Not a comparative study. One year study period. 522 MET calls recorded. Emergency dept (62%), ward (29%), critical care areas (9%). Cardiopulmonary arrest accounted for 28% of MET calls. Specific condition criteria used to alert MET in 48% of cases. Physiological or pathological criteria in 23% cases. Main alerting physiological abnormalities were decreased level of consciousness (42%) and blood pressure (29%).

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 21, Parr et al. (2001), Australia Level of evidence: **(III)**	To describe the reasons for, and immediate outcomes following Medical Emergency Team (MET) activation	Entire hospital (excluding emergency areas, and those who were not in-patients)	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern	Retrospective analysis of MET calls over a 12-month period. 713 MET calls to 559 patients made. Three most common reasons for calling MET were GCS>2 (n=155), systolic BP <90mmHg (n=142) and respiratory rate >35 (n=109). 'Worried' accounted for 12% (n=83) of MET calls. 252 patients admitted to ICU. Most common criterion associated with admission to ICU was respiratory rate >35 (n=42).
ID 24, Salamonson et al. (2001), Australia Level of evidence: **(III)**	To determine whether the introduction of a MET team changed the pattern of ICU transfers from wards and improved hospital survival rates	All wards, critical care areas, emergency dept, and theatres.	Single parameter system Parameters (9): Heart rate, respiratory rate, blood pressure, O_2 saturation, consciousness, concern, airway threatened, repeated/prolonged seizures, respiratory arrest	Three year review of MET calls and unanticipated ICU transfers. MET team implementated at start of year one, study has no 'before' data for comparison. Frequency of calls for cardiac arrest remained constant, but the percentage of total calls to the MET for arrest fell over the 3-year study period. A small (and non-significant) decrease in the percentage of hospital deaths was seen from year 1 to year 3.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 26, Dodek et al. (2000), Canada Level of evidence: **(III)**	To determine whether timeliness of care would improve following introduction of a team approach in trauma management	Emergency department	Single parameter system. Parameters (15): Heart rate, respiratory rate, blood pressure, concern, and 11 trauma-specific criteria.	Before and after study assessing the impact of the introduction of a trauma team on elapsed time from assessment in the emergency dept (ED) to arrival of the trauma surgeon, discharge from ED, and arrival of patient in operating room (for urgent or emergent surgery). After implementation of the team, median elapsed time from assessment to arrival in operating room decreased (p=0.05), but there were no significant differences in any other measures of timeliness, crude mortality or adjusted mortality.
ID 30, Lee et al. (1998), Australia Level of evidence: **(III)**	To examine risk factors of early post-operative emergencies that required medical emergency team intervention	Surgical patients	Single parameter system. Parameters (8): Heart rate, respiratory rate, blood pressure, consciousness, threatened airway, cardiac arrest, pulmonary arrest, repeated/prolonged seizures.	Case-control study (34 cases, 126 controls) comparing incidence of post-operative emergencies (within 48hrs). Major physiological changes for MET were hypotension and decreased consciousness. High ASA status and surgery performed out of normal working hours were significant predictors of emergencies.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 4, Sharpley et al. (2004), UK. Level of evidence: *Not able to be assessed by current checklist.*	Describe the introduction of an early warning scoring system (EWSS)	Surgical unit of a district general hospital	Combination system. Includes aggregate score, also triggers if maximum score on any individual parameter. Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness. Graded response: ward nurses first line treatment, reviewed by ward doctor, senior medical staff, call critical care outreach nurse.	Describes the approach used to introduce the EWSS to a general mixed surgical ward, including training ward nurses to use the scoring system, and a survey of nursing staff. EWSS well received, some clarification requested on scoring items on urine output and systolic BP. Implementation assisted by multidisciplinary support, and collaboration between acute ward and critical care staff.
ID 8 Cioffi (2000), Australia Level of evidence: *Not able to be assessed by current checklist.*	To describe patient characteristics and nurses' recognition process of patients who require emergency assistance.	32 registered nurses interviewed. Setting not reported.	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern.	Study aimed to explore nurses' perceptions of patients considered to meet the MET criterion "seriously worried about". Four patient characteristics identified: feeling 'not right', colour, agitation, observations marginally changed or not at all. Subjective evaluation based on touching, observing, listening, feeling, and "knowing". Nurses relied heavily on past experiences and knowledge to detect differences in patient condition.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 9, Hillman et al. (2003), Australia Level of evidence: *Not able to be assessed by current checklist.*	To provide an overview of the challenges for health services research into medical emergency teams	Entire hospital (including all wards, critical care areas and recovery).	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern	Research into critical care has predominantly been around the evaluation of drugs or procedures. Evaluation of MET teams involves implementing changes in health service delivery and cuts across geographical, functional and professional silos. Evaluation of the MET team involved evaluating validity of calling criteria, identifying antecedents to serious events, and studying the impact on the institution and outcomes. Also describes a cluster-RCT being developed to evaluate the effectiveness of METs.
ID 11, Day (2003), UK Level of evidence: *Not able to be assessed by current checklist.*	Audit of doctors response times to calls for assistance triggered by use of the Derby Modified Early Warning System (DMEWS)	Step down unit (SDU), for higher risk surgical patients, who do not fulfil ICU admission criteria.	Aggregate scoring system: Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness. If score>4, advice should be sought immediately from SHO or registrar, who should review the patient within 30 min.	45 calls for medical evaluation were made over the 2-month study period. Doctors were more likely to respond faster, and within the maximum response time if the call was received from a member of the Critical Care Outreach Team, than if the call came from a ward nurse.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 15. Carberry (2002), UK. Level of evidence: *Not able to be assessed by current checklist.*	To outline experiences of implementing a modified early warning system (MEWS) and the results of a one-week pilot study.	Five surgical wards in three acute hospitals	Aggregate scoring system: Parameters (6): Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness. Score of ≥4 indicates that patient should be reviewed by medical staff urgently, within 10 min if possible.	Describes the development of the scoring system, teaching sessions for staff using the tool, and secondment of a critical care nurse to support ward staff. Concludes that the MEWS is a simple scoring system that can be easily adapted and implemented to identify clinical deterioration.
ID 16, Sterling and Groba (2002), UK. Level of evidence: *Not able to be assessed by current checklist.*	Audit of the Lewisham patient-at-risk trigger scoring system (PAR-T).	Five acute wards in a teaching hospital	Aggregate scoring system: Parameters (8): Heart rate, respiratory rate, blood pressure, temperature, urine, O_2 saturation, consciousness, pain. Score >5 indicates that senior medical/surgical staff should review patient.	70 of 619 admissions triggered the warning system over the 2 month study period, 16% of whom were transferred to HDU or ICU. 14 patients were admitted to ICU during study period, all had scores >5 prior to admission. Audit of random sample of 55 observation charts found that 40% of observation had missing parameters or PAR-T score. Medical patients triggered most frequently, particularly those with chronic disease (cause of some negative feedback from ward staff).

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 20, Fox and Rivers (2001), UK Level of evidence: *Not able to be assessed by current checklist.*	To describe the introduction of a critical care outreach team	Surgical and orthopaedic wards	Aggregate scoring system Parameters (6), Heart rate, respiratory rate, blood pressure, temperature, urine, consciousness	Describes the initial implementation of a new critical care outreach team on surgical and orthopaedic wards. The team is multidisciplinary, but the nurses will rotate back to HDU/ICU enabling them to keep their critical care skills up to date. Scoring tool used has been modified from MEWS. In the first months of the team's operation, there has been a reduction in the incidence of cardiac arrests.
ID 23, Hillman et al. (2001), Australia Level of evidence: *Not able to be assessed by current checklist.*	Describe the concept of the medical emergency team, for cardiopulmonary resuscitation.	Entire hospital	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern	Most patients have identifiable deterioration prior to cardiac arrest. General wards of acute hospitals have been identified as particularly dangerous areas where cardiac arrest and CPR are associated with poor outcomes. Ward staff may lack the relevant skills and knowledge in critical care. MET team replaced the cardiac arrest team, and was based on a trauma system model, where the team is called to patients based on criteria. The MET teams scope of resuscitation is broader than simply CPR.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 28, Crispin and Daffurn (1998), Australia Level of evidence: *Not able to be assessed by current checklist.*	To assess the responses of nurses in the presence of clinical antecedents (MET criteria) to acute severe illness	Entire hospital	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern.	Retrospective review of medical records of 178 patients who required MET assistance. MET calls occurred in general wards (50%), emergency dept (42.3%), and other areas (7.7%). Four main categories of emergency were cardiac arrest (25.6%), airway/breathing problems (22%0, decreased consciousness (20.8%). A common initial response in ward areas was to call junior medical staff, which sometimes prolonged initiation to treatment.
ID 29 Daly et al. (1998), Australia Level of evidence: *Not able to be assessed by current checklist.*	To describe the application of a MET to a general hospital	Entire hospital (except theatre, recovery and emergency dept).	Single parameter system. Parameters (6): Blood pressure, consciousness, active seizures, cardiac chest pain, cardiopulmonary arrest, severe respiratory arrest. MET activated when there is a perceived imminent life-threatening problem. Upon activation, orderly takes resuscitation equipment to ward site.	68 MET calls were made for 63 patients over 12-month period. 48% occurred between 08.00 – 18.00 hours. Most common conditions leading to MET activations were chest pain(19.1%), cardiopulmonary arrest (14.7%), seizures (14.7%) and respiratory distress (13.2%). Audit of the MET activations identified six (9%) cases of late activation, and nine (13%) cases judged retrospectively to be non-life threatening.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 31, Sugrue et al. (1995), Australia Level of evidence: *Not able to be assessed by current checklist.*	To assess the performance of trauma team leaders in trauma patient resuscitations	Emergency department	Single parameter system. Parameters (20): Heart rate, blood pressure, consciousness, and 17 trauma-specific criteria	50 consecutive trauma resuscitations were assessed over a two-month period. Medical tasks were uniformly performed well by trauma team leaders. Some deficiencies in communication and delegation were observed.
ID 32, Hartin et al. (2002), UK Level of evidence: *Not able to be assessed by current checklist.*	To describe the patient emergency response team (PERT) algorithm	Not reported	Single parameter system. Parameters (8): heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, concern, repeated hypoglycaemia. First responder is the PERT nurse who assesses the patient and determines the level of intervention required.	Algorithms to support the PERT nurse have been drawn up, which refer directly to the call criteria or are specific to potential causes of the problems identified. Paper describes an algorithm drawn up to support the PERT nurse when assessing a patient with a heart rate > 125.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 33, Hillman et al. (1996), Australia Level of evidence: *Not able to be assessed by current checklist.*	To identify the incidence of clinical criteria that are antecedents of cardiac arrest	General wards	Single parameter system. Parameters (4): Heart rate, respiratory rate, blood pressure, consciousness	Medical records for 5 randomly selected 24hr periods were reviewed to identify signs known to be antecedents to cardiac arrest. Data collected included age, sex, admission category, and presence of abnormal physiological variables. Nine patients (of 1027 cases reviewed) had abnormal physiology. Tachypnoea and hypotension were the most common physiological indicators.
ID 34, Hourihan et al. (1995), Australia Level of evidence: *Not able to be assessed by current checklist.*	To describe the use of a medical emergency team (MET) following the introduction of standardised calling criteria.	Entire hospital	Single parameter system. Parameters (5): Heart rate, respiratory rate, blood pressure, consciousness, concern.	Data collected on all MET calls over a six-month period. 294 calls made, from wards (53%), Emergency dept (31%), critical care areas (13%). Cardiorespiratory arrest accounted for 24% of calls, 60% resulted from evidence of abnormal physiological values. Decreased level of consciousness was one of the main alerting signs, followed by hypotension.

Study details & Level of evidence	Study aim	Setting and patients	Tool described	Overview and main findings
ID 35, Goldhill (2000), UK Level of evidence: *Not able to be assessed by current checklist.*	To provide an overview of medical emergency teams	All wards	Multiple parameter system. Parameters (7): Heart rate, respiratory rate, blood pressure, urine, O_2 saturation, consciousness, concern Senior ward nurse contacts patients doctor if the patient triggers. If immediate management does not improve the patients condition, contacting the team should be considered	Most arrests on the wards are preceded by physiological deterioration. Patients who arrest in hospital outside of critical areas have poorer outcomes. Early recognition improves outcomes. Gives an overview of the Patient at risk team (PART) used at the Royal London Hospital. An early warning score, based on physiological abnormalities is used for the identification of critically ill ward patients. Experiences with PART suggest that early intervention decreases the number of ward arrests and is likely to decrease mortality.
ID 36, Welch (2000), UK Level of evidence: *Not able to be assessed by current checklist.*	To outline how nurses can identify patients at risk of critical illness	Not reported	Aggregate scoring system. Parameters (8): Heart rate, respiratory rate, blood pressure, temperature, urine, O_2 saturation, consciousness, pain.	Not a scoring tool. Provides an overview of useful physiological indicators that might cause concern, and gives an overview of research in the area.

5.4.2 Topic 1 References

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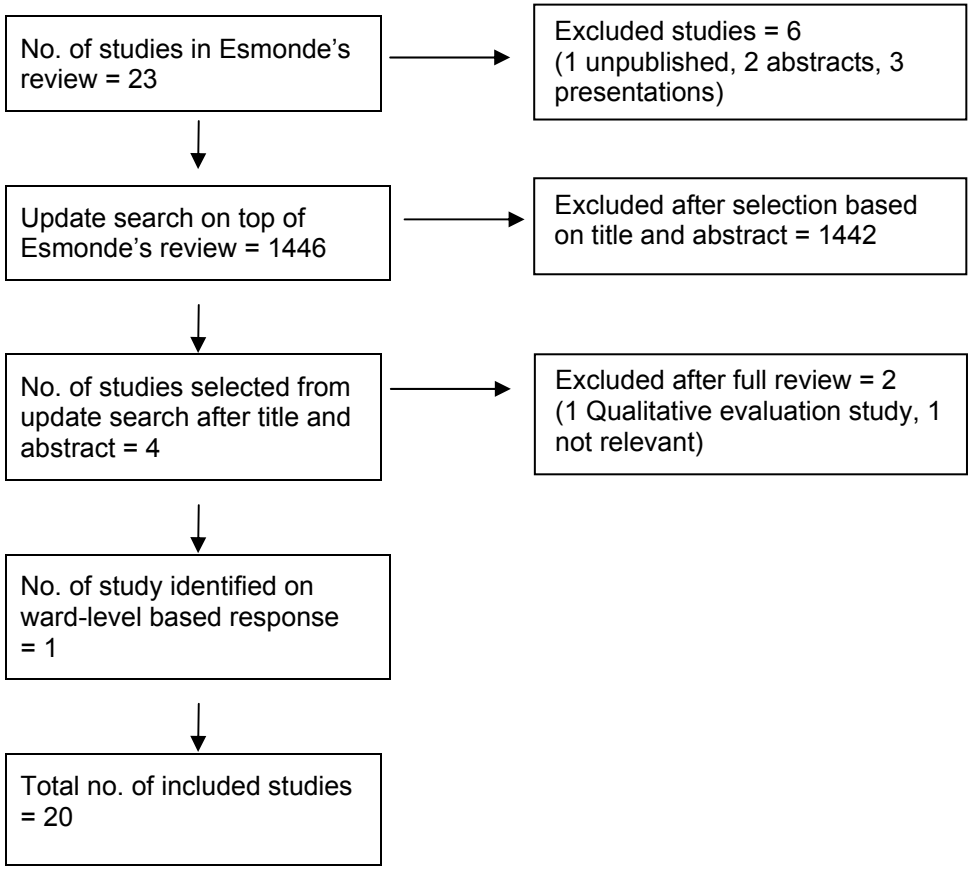
5.4.3 Topic 2: Response strategies for patients identified as having a deteriorating clinical condition

Volume of Evidence



Type of study

Total no. of studies = 20	Cluster RCT = 2 Observational study = 16 (uncontrolled before-and-after) Service evaluation = 1 Ward-level based response study (uncontrolled before-and-after) = 1

Acutely Ill Patient

Topic 2: Response strategies for patients identified as having a deteriorating clinical condition.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
154 Hillman et al. (2005) MERIT; Intro of the Medical Emergency Team (MET) system: a cluster-RCT.	Cluster RCT	1+	Total no. of hospital = 23 I = 12 C = 11 Inclusion: Public hospital with 20,000 estimated admissions/yr, with an ICU & emergency department, did not already have a MET. Covered: Patients > 14 of age; General wards; No hospital drop-out.	Patient characteristics were only assessed during 2-month baseline prior to study period. At baseline: (C Group) N = 11 *[8 teaching hospitals; 9 metropolitan based]* Mean age = 56.9 ; SD (20.8) Male = 47% Female = 53% (I Group) N = 12 [*9 teaching*	1) Education to staff (over 4 month period prior to introduction of MET) using lectures, MET videotape and books. It included: identification of patients at risks, the use of calling criteria, the need to call quickly if criteria were met & how to call MET. 2) Implementation of MET. Composition of MET varied. It	Control hospitals: 1) No MET 2) operation of existing CAT to continue 3) No educational intervention	6-month study period (pre-study: 2-month baseline & 4-month implementation period)	Primary outcome: Composite incidence of cardiac arrest, unplanned ICU admission (without NFR) & unexpected death (without NFR) Secondary outcomes: Cardiac arrest;	*per 1000 admissions:* C = 5.86 I = 5.31 Difference = -0.264 (-2.449 to 1.921) Adj p = 0.640 Adj OR = 0.98 (95% CI: 0.83-1.16) *per 1000 admissions:* C = 1.64 I = 1.31 Difference = -0.208 (-0.620 to 0.204) Adj p = 0.736 Adj OR = 0.94 (95% CI: 0.79-1.13)	Australian National Health; MRC; Australian Council for Quality & Safety in Healthcare; Australian & New Zealand Intensive Care Foundation	A well conducted study addressing a focused question with an appropriate design. A negative result, however, as far as primary outcome concerned. Process variables showed a significant difference. There was a significantly greater incidence of calling out the MET in intervention group. *Potential biases:* Setting – the inclusion of coronary care units & HDU that was not under the supervision of an intensivist as "general wards" (quality of care likely to be higher)

			No. of total patients not reported for the study phase but only assessed during 2-month baseline: **(C Group)** Total patients = 56756 **(I Group)** Total patients = 68376 <u>Setting:</u> Australian Public Health System.	*hospitals; 9 metropolitan based]* Mean age = 55.4 ; SD (19.9) Male = 50% Female = 50%	was required to be at least the equivalent of the pre-existing cardiac arrest team (CAT) & to consist of at least 1 doctor & 1 nurse from emergency department or ICU.			Unplanned ICU admission (without NFR); Unexpected death (without NFR) <u>Primary outcome during baseline, study period and combined baseline & study period:</u>	C = 4.68 I = 4.19 Difference = -0.135 (-2.330 to 2.060) Adj p = 0.599 Adj OR = 1.04 (95% CI: 0.89-1.21) C = 1.18 I = 1.06 Difference = -0.093 (-0.423 to 0.237) Adj p = 0.752 Adj OR = 1.03 (95% CI: 0.84-1.28) <u>*per 1000 admissions:*</u> C baseline = 7.07 C study = 5.86 Difference = -1.41 p = 0.030 I baseline = 6.58 I study = 5.31 Difference = -0.39 p = 0.612 C+I baseline = 6.82 C+I study =		Variability of intervention delivered by unit - composition of MET varied from setting to setting (although standardised calling criteria). - likely variability of implementation strategy as MET is a complex intervention. Possible contamination of control group. Hospital safety and MET system were highlighted and reported in the media during the study period. Could minimize differences between groups. Whether CATs & ICU staff act as informal METs in control hospitals is Unknown. <u>*Potential type 2 error:*</u> Sample size calculation appears to be inadequate (lower incidence of adverse events in control arm & higher intrahospital variability and ICC). Wide confidence interval on adverse event rate. Could explain negative finding. 6-month study period might not be long enough

									5.57 Difference = 0.089		to detect effects on outcomes.
								<u>Process measures</u>:	<u>*per 1000 admissions:*</u>		
								Calling rate of MET/CAT	C = 3.1 (1.3 SD) I = 8.7 (3.5 SD) P=0.0001		
								Mean number of calls not associated with an event	C=1.2 (0.8SD) I=6.3 (2.4SD) P<0.0001		
								Number of calls not associated with an event (% of total calls)	C=194/528 (37%) I=1329/1886 (70%) P<0.0001		
								Documentation of MET criteria			

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
3 Priestley et al. (2004) Introducing critical care outreach: a ward randomised trial of phased introduction in a general hospital.	Cluster-RCT with phased introduction **Randomised at ward level (dataset 2)* **Embedded within the study were two observational analyses:* *a) all patients (dataset 1);* *b) before and after analysis (dataset 3).* *These*	1+	Total no. of patients eligible for primary comparison = 2903 Mortality: C = 1336 I = 1456 Length of stay: C = 1291 I = 1442 Inclusion: All patients admitted to the 16 acute adult wards over a 32-week period. Setting: 800 bed acute general hospital in the north of England (UK). 16 study wards (average 30 beds each): 8 surgical; 5 medical and 3 medicine for the elderly	(C Groups): Mean age = 57.4 (95% CI: 56.3-58.5) Male = 43.1% Female = 56.9% SAPS II mean = 17.3 (95% CI: 16.8-17.8) (C Groups): Mean age = 65.2 (95% CI: 64.3-66.2) Male = 54.7% Female = 45.3% SAPS II mean = 19.9 (95% CI: 19.4-20.3)	1) Introduction of the intervention (CCOT) was preceded with a 4 week training period by the CCOT for nurses and doctors. Involved: **formal & informal sessions on the use of an "in-house" PAR 'patient-at-risk' score as calling criteria.* 2) Implementation of CCOT. Composition of CCOT: 24-hour services with 1 nurse consultant & a team of experience nurses. Interventions by CCOT: Ward staff used PAR to trigger referral to CCOT and involvement of the admitting	1) No educational intervention 2) No CCOT Very limited description of care provided on control wards	32-week study	In-hospital mortality (logistic regression) Length of stay in hospital (Cox regression)	Primary analysis: Matched-randomised: (Cluster level) OR 0.523 (95% CI: 0.322-0.849) Matched-randomised: Hazard ratio = 0.907 (95% CI: 0.835-0.985) Allowance for clustering considered likely to render this finding non-significant. *Secondary analysis:* 1) Mortality: datasets 1 & 3 both showed a reduction in mortality in patients in the intervention wards. 2) Length of stay: Dataset 1 showed intervention	York Research Innovation Fund (York Hospitals NHS Trusts)	A reasonably well conducted study addressing a focused clinical question. Chief findings: 1) A significant reduction in mortality in patients in the intervention wards 2) Possible increased length of stay for patients in the intervention wards. *Potential biases:* This is a pragmatic design. Randomisation was at ward level within a single hospital rather than at hospital level. Likely to increase risk of contamination between groups (although likely to reduce effect size) Due to the design of sequential introduction of intervention, there was no standardised intervention period: the intervention periods of different wards ranged from 4 weeks to 28 weeks. No concealment of allocation or blinding of either participants or investigators.

	are treated as second ary analyse s and reporte d only briefly here.				team's consultant. Score a 'guide', CCOT to be called if concern about patient, irrespective of PAR score. Level of CCOT involvement determined by ward staff & admitting team. As circumstances required, CCOT might support and advise ward staff, remain with the patient and provide individual nursing care on the ward during crisis period, or facilitate the admission to ICU. Emphasis on 'sharing skills'.				increased patients' mean LOS; dataset 3 reduced patients' mean LOS.		CCOT collected much of the data. There was no appropriate baseline measure. Possible 'Hawthorne effects'. *Potential confounders:* Observational data used for secondary analysis likely to exhibit this. <u>*Potential Type I error:*</u> Matched-randomised analysis resulted in a greater estimated advantage in mortality but a 20% wider CI. Unclear to what extent clustering has been accounted for in prior power calculation. A cluster-RCT with high statistical validity would have required participation of a very large number of hospitals. Generalisability: - both patient group and use of acute general hospital make study participants typical of patients in the NHS

											- 'trigger' system used is a multiple parameter system (PAR) widely used in the NHS - Only one hospital site used

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
25 Bristow et al. (2000) Rates of in-hospital arrests, deaths & intensive care admissions: the effect of a MET.	Observational study (after case-mix adjustment) *Stepwise multivariate analysis was used to model the probability of an event occurring, adjuste*	2-	Total no. of hospitals = 3 (1 intervention, 2 controls) <u>No. of admission:</u> I = 18338 C1 = 13059 C2 = 19545 <u>Inclusion:</u> All patients (age ≥ 14) admitted to 3 Australian public hospitals from 08/07/1996 to 31/12/1996. <u>Setting:</u> All 3 hospitals were similarly sized	Characteristics of admissions: *(I hospital)* Male admissions = 44.9% Female admissions = 55.1% Age distribution: 14-24 = 9.7% 25-34 = 14.9% 34-44 = 14.3% 45-54 = 12.4% 55-64 = 18.1% 65-74 = 20.5% ≥75 = 10.0% *(C1 hospital)* Male admissions = 42.9% Female	1) An education programme explained the MET's role was given to all staff. The length of educational period not reported. 2) Implementation of MET. However, calling the MET when criteria were met was not compulsory. *MET triggered by standardised calling system. A Single Parameter*	2 control hospitals: 1) No educational programme 2) No MET 3) Operation of existing cardiac arrest team (CAT) to continue. CAT was paged for cardiorespiratory arrest.	6-month	1) Case-mix adjusted rates of cardiac arrest 2) Case-mix adjusted rates of hospital mortality	I = 69 (crude rate: 38/10000) Adj OR = 1 C1 = 66 (crude rate: 51/10000) Adj OR = 1.14 (95% CI: 0.81-1.61) *[not significant]* C2 = 99 (crude rate: 51/10000) Adj OR = 1.00 (95% CI: 0.73-1.37) *[not significant*] I = 243 (crude rate: 133/10000) Adj OR = 1 C1 = 240 (crude rate: 184/10000)	Commonwealth Department of Health & Family Services Research & Development Grant.	A reasonably well conducted quasi-experimental study with case-mix adjustment that addresses a focused question. <u>Findings:</u> There are significant reductions in unanticipated admissions to ICU/HDU in both comparisons (I vs. C1 & I vs. C2). No significant differences in the rates of cardiac arrest, hospital mortality and non-DNR mortality. <u>Methodology:</u> This is an uncontrolled study, there is no proper matching of cases and controls.

	d for patient demographics & diagnostic characteristics.		Australian public hospitals with bed capacities in the range of 380-530. MET was introduced with education programme to the intervention hospital while the 2 control hospitals have cardiac arrest team.	admissions = 57.1% Age distribution: 14-24 = 8.6% 25-34 = 15.2% 34-44 = 9.6% 45-54 = 9.8% 55-64 = 18.5% 65-74 = 22.2% ≥75 = 16.0% *(C1 hospital)* Male admissions = 42.8% Female admissions = 57.2% Age distribution: 14-24 = 7.8% 25-34 = 13.1% 34-44 = 11.1% 45-54 = 10.4% 55-64 = 14.4% 65-74 = 22.1% ≥75 = 21.1%	*'trigger' system* <u>Composition of MET:</u> 1 ICU registrar, 1 senior nurse & a medical registrar. <u>Interventions by MET:</u> Not stated.	<u>Composition of CAT:</u> 1 ICU registrar, 1 ICU or coronary care nurse & a medical registrar.		3) Case-mix adjusted rates of Non-DNR mortality 4) Case-mix adjusted rates of unanticipated admission to ICU/HDU	Adj OR = 1.08 (95% CI: 0.89-1.30) *[not significant]* C2 = 295 (crude rate: 151/10000) Adj OR = 0.83 (95% CI: 0.70-1.00) *[not significant]* I = 55 (crude rate: 30/10000) Adj OR = 1 C1 = 86 (crude rate: 66/10000) Adj OR = 1.68 (95% CI: 1.19-2.36) *[not significant]* C2 = 88 (crude rate: 45/10000) Adj OR = 0.94 (95% CI: 0.67-1.33) *[not significant*] I = 118 (crude rate: 64/10000) Adj OR = 1 C1 = 146 (crude rate: 112/10000) Adj OR = 1.59 (95% CI: 1.24-		The limitation of case-mix adjustment methodology:- multiple methods of case-mix adjustment are possible and these may give divergent results. <u>Potential confounding factors:</u> No special efforts regarding staff education in the study period were made. Lack of education might contribute to less MET calls (MET calls of this study is low compared to other studies). This might contribute to the non-significant findings. Calling for MET was not compulsory when criteria were met. This might also contribute to the non-significant findings. *<u>Generalisability:</u>* This is an Australian study of 3 hospitals with single parameter TT system, which is very different from most UK hospitals.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
								*Odd ratios were adjusted for patient characteristics and diagnostic categories.	2.04) *[significant reduction]* C2 = 234 (crude rate: 120/10000) Adj OR = 1.73 (95% CI: 1.37-2.16) *[significant reduction]*		

1022 Goldhill et al. (1999) The PART: identifying & managing seriously ill patients.	Observational study	2-	Total no. of patients not reported. *N*s were reported as No. of admissions. Total no. of admissions = 97 Admissions seen by PART (I) = 28 Admission not seen by PART (C) = 69 <u>Inclusion:</u> Not clear. Presume all hospital wards. <u>Setting:</u> Single hospital – Royal London Hospital.	<u>(I Group):</u> Mean age = 55 (SD: 21.1) Male = 54% Female = 46% Previous ICU = 29% Median pre-ICU APACHE II = 14 (IQR: 11-20) <u>(C Group):</u> Mean age = 53 (SD: 17.8) Male = 54% Female = 46% Previous ICU admission = 17% Median pre-ICU APACHE II = 16 (IQR: 9-20)	1) PART protocol (multiple parameter) was introduced onto all wards. Laminated copies of the protocol were placed on the ward notice boards & information about PART was circulated to nurses & doctors within the hospital. 2) ICU admissions seen by PART within 48 hours of admission. <u>Composition of PART:</u> Consists of 1 ICU consultant or deputy, 1 senior ICU nurse & the duty medical or surgical registrar as appropriate. <u>Interventions by PART:</u> Patients were transferred	1) PART protocol was introduced onto all wards. Laminated copies of the protocol were placed on the ward notice boards & information about PART was circulated to nurses & doctors within the hospital. 2) ICU admissions NOT seen by PART.	6-month study	1) ICU mortality (No. & %) 2) Hospital length of stay before ICU admission (median: days) 2) ICU length of stay (median: days) 3) No. of CPR in acute wards before ICU admission (No. & %)	I = 7 (25%) C = 31 (44.9%) *p = 0.07 (NS)* I = 5.5 (IQR: 1-17.5) C = 6 (IQR: 1-16) **p-value not reported* I = 5.5 (IQR: 1-9.25) C = 2 (IQR: 1-6) **p-value not reported* I = 1 (3.6%) C = 21 (30.4%) *p < 0.005*	Not reported.	An observational study looks at both identification of 'at risk' patients and an intervention (management by PART team). Only the CPR rate has significant results suggesting that PART appeared to be successful in preventing the need for CPR. (CI not reported). *<u>Potential biases/confounding factors:</u>* This study has a number of biases. In particular, there is no proper matching of cases and controls. Informal education/training for staff. The author has suggested that despite the availability of PART, the majority of patients were not assessed before admission to ICU and there is possibility that some doctors and nurses were unaware of the system. At assessment, many patients were already monitored and treated with high quality of care (eg: the use of oximetry, oxygen supply, ECG, etc.)

					directly to ICU. If patient remained on the ward, PART would advise on management (primarily in the management of respiratory problems & hypovolaemia) & decide whether regular review was necessary. <u>Protocol of review by PART:</u> - Admit immediately - Within 4-hour - After 4-hour - DNR						Some patients the PART would like to have admitted were managed on the ward because of lack of ICU beds. <u>*Generalisability:*</u> This is a single hospital study with unusually high number of emergency, trauma & seriously ill patients.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
24 Salamonson et al. (2001) The evolutionary process of MET implementation: reduction in unanticipated ICU transfer.	Observational study	2-	Total no. of patients not reported. *N*s were reported as No. of MET ICU transfers *(I)* & No. of unanticipated ICU transfer *(C)* over 3 years period. Total ICU transfers = 240 I = 100 C = 140 <u>Inclusion:</u> Not clear. Presume all hospital wards. <u>Setting:</u> Single hospital - A suburban non-teaching metropolitan hospital in Australia (200-bed).	Patient characteristics for I group not reported. <u>Patient characteristics for C group:</u> *Mean age = 61.6 (range: 9-90 years)* *Female = 52%* *Male = 48%* *Patient characteristics for all 299 MET calls over 3 years: mean age = 60.5 (range: 0-97years) Female = 51% Male = 49%	1) Formal training in all aspects of advanced resuscitation. 2) The utilisation of MET by staff which resulted in ICU transfers. *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> 24-hour system consists of 1 physician, 1 nursing staff from ICU/CCU, 1 registrar from emergency department, 2 non-clinical staff. <u>Interventions by MET:</u> Bag-mask ventilation, Endotrachael intubation, Cardiac massage, Cardiac defibrillation.	1) Formal training in all aspects of advanced resuscitation. 2) Unanticipated ICU transfers without the utilisation of MET by staff.	3 years.	In-hospital mortality <u>Process measures:</u> 1) No. of MET calls 2) Reduction in unanticipated ICU transfers	<u>Year 1:</u> I = 17 (71%) C = 44 (76%) <u>Year 2:</u> I = 27 (79%) C = 35 (76%) <u>Year 3:</u> I = 31 (74%) C = 26 (72%) *Differences between I and C are not significant, but p-values not reported. Year 1 = 54 Year 2 = 115 Year 3 = 130 *No analysis on differences Yr 1 = 58 (71%) Yr 2 = 46 (58%) Yr 3 = 36 (46%) $X^2 = 9.969$, df = 2, p = 0.007	Not reported.	Study design difficult to determine. Study addresses a focused question. The results are not significant (p-value and CI not reported). Process variables showed a trend of increased MET calls with decreased unanticipated ICU transfers. However, the reduction in unanticipated ICU transfers over the study period was likely a factor of increase MET ICU transfers. The demand for ICU beds with the implementation of MET system remained fairly constant. The author also suggested that the MET system being called increasingly for less acute patients. <u>*Potential biases/confounding factors:*</u> This study has significant biases. In particular, there is no proper matching of cases and controls. It is not known if the intervention group differs from the control group in terms of demographic details & type of illness or illness severity.

											It is not known if time trends are taken into account. Training was provided to all staff. The utilisation of MET was influenced by staff's subjectivity. For example, the author has suggested that some ward staff were still opting not to use the MET system for patients who fulfilled the predetermined MET calling criteria. This is a single hospital study, issue on generalisability. There is no clear inclusion/exclusion criteria. Information on severity of illness was not collected.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
10 Bellomo et al. (2003) A prospective before-and-after trial of a MET.	Observational study, uncontrolled before & after study	2-	Total no. of consecutive patients admitted to hospital = 42011 *(C group) Pre-MET = 21090* *(I group) Post-MET = 20921* <u>Inclusion:</u> Consecutive patients admitted to hospital during 4-month pre-period (May-Aug 1999) and during 4-month post- period (Nov 2000-Feb 2001). <u>Setting:</u> Single hospital (teaching hospital) – Austin & Repatriation Medical Centre, Australia.	*Patient characteristics of the 85 cardiac arrest cases and the 42011 consecutive patients were not provided.*	1) 1 year preparation & education period to introduce the MET. Extensive and repeated presentations and discussions were held with all members of the medical, nursing & paramedical staff. 2) Implementation with 2-month 'run-in' period. 3) Intervention period (data collected over 4 months) *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> The duty intensive care fellow & a designated intensive care	A 4-month 'pre-MET' period 1) No preparation nor education on MET. *<u>Seasonal control:</u> Data was also collected at the same seasonal period as the intervention period 2 years ago (Nov 98 – Feb 99)*	Total study period = 8 months *Pre-MET = 4-month* *Post-MET = 4-month*	<u>Primary outcome:</u> No. of cardiac arrest. <u>Other outcomes:</u> 1) Mortality from cardiac arrest 2) LOS in ICU after cardiac arrest (days) 3) LOS in hospital after cardiac arrest (days)	C = 63 I = 22 Diff = 41 (95% CI: 23-59) RRR = 0.35 (95% CI: 0.22-0.57) p < 0.001 C = 37 I = 16 Diff = 21 (95% CI: 7-35) RRR = 0.43 (95% CI: 0.26-0.70) p = 0.005 C = 163 I = 33 Diff = 130 (95% CI: 110-150) RRR = 0.20 (95% CI: 0.13-0.33) p < 0.001 C = 1353 I = 159 Diff = 1194 (95% CI: 1119-1269) RRR = 0.11 (95% CI: 0.09-0.13) p < 0.001	Quality Improvement Branch of the Acute Health Care section of the Victorian Department of Human Services, Australia.	A prospective uncontrolled before & after study with appropriate seasonal control design that addresses a focused question. <u>Findings:</u> Positive results for both primary outcome (cardiac arrest and other outcomes (mortality from cardiac arrest, hospital & ICU LOS after cardiac arrest and inpatient mortality). *<u>Potential biases/confounding factors:</u>* This is not a RCT nor Quasi-experiment, the study has significant biases. In particular, there is no proper matching of cases and controls. Positive findings may have been due to high cardiac arrest rates in the control period or an abnormally low seasonal incidence in the intervention period compared to Australia national average. A possible seasonal bias against the MET: the 4-month post-MET period was parallel to the 3-month immediately after the start of new interns.

					nurse (also the receiving medical registrar if available and the ICU consultant if requested). <u>Interventions:</u> A total of 27 types of interventions were carried out by the MET. Interventions that were most carried out: Nasopharyngeal/ oropharyngeal suctioning & additional oxygen; Administration of IV fluid bolus; Administration of IV frusemide bolus; Initiation of non-invasive positive pressure ventilation by mask; Nebulised salbutamol. *<u>*Timing of response:</u>* *- MET attended each call within a mean (SD)*			4) Inpatient mortality	C = 302 I = 222 Diff = 80 (95% CI: 37-123) RRR = 0.74 (95% CI: 0.70-0.79) p = 0.004 *<u>*Seasonal control period:</u>* *All results comparisons of pre-MET vs. seasonal control are non-significant.* *All results comparisons of post-MET vs. seasonal control are significant.*		The positive results could be associated to the highly skilled MET that carried out extensive interventions compared to other negative studies with less skilled team? <u>*Generalisability:*</u> This is a single hospital study in Australia with single parameter TT system, which is very different from most UK hospitals.

					period of 4.5 mins (2.2). *- MET was in attendance for a mean (SD) period of 19 mins (18).*						
ID 6 Bellomo et al. (2004) Prospective controlled trial of effect of MET on post-operative morbidity and mortality rates. ***Note: This is the same study as above (ID 10), the authors simply published another paper analysing*	As above.	2-	Total no. of consecutive patients admitted to hospital for 'major surgery' = 2183 *(C group) Pre-MET = 1116* *(I group) Post-MET = 1067* <u>Inclusion:</u> Consecutive patients admitted to hospital for 'major surgery' during 4-month pre- period (May-Aug 1999) and during 4-month post- period (Nov 2000-Feb 2001). <u>Setting:</u>	<u>Patient characteristic of the surgical patients:</u> (C group) Age = 60.7 ±19.7 Male = 58.4% Female = 41.6% (I group) Age = 60.1 ±19.5 Male = 57.4% Female = 42.6%	As above.	As above. *BUT, no seasonal control analysis was carried out.*	As above.	1) Unplanned ICU admissions 2) Surgical mortality 3) LOS after major surgery 4) Surgical ICU readmissions	C = 89 I = 48 Relative Risk Reduction = 44.4% p = 0.001 C = 73 I = 45 Relative Risk Reduction = 36.6% p = 0.0178 C = mean 23.8 ±56.5 days I = mean 18.9 ±35.3 days p = 0.0092 C = 33/1116 (2.9%) I = 20/1067 (1.8%) *[not significant]*	As above.	A reasonably well conducted prospective uncontrolled before & after study that addresses a focused question. <u>Findings:</u> Positive results for three outcomes (unplanned ICU admissions, surgical mortality & LOS after major surgery) but not on 'surgical ICU readmissions'. <u>*Potential biases/confounding factors:*</u> See above as it's the same study. <u>*Generalisability:*</u> This is a single hospital study in Australia with single parameter TT system, which is very different from most UK hospitals.

different variables from the study (ie. focused on surgical patients)			Single hospital (teaching hospital) – Austin & Repatriation Medical Centre, Australia.								

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1023 Garcea et al. (2004) Impact of a critical care outreach team on critical care readmissions and mortality.	Observational study, Retrospective uncontrolled before & after study	2-	Total no. of patients with critical care 'readmission' = 128 C = 49 I = 79 <u>Inclusion:</u> All readmissions to critical care between July 1999 and September 2003. <u>Setting:</u> Single hospital (teaching hospital) – The Leicester General Hospital.	<u>(C Group: pre-outreach)</u> Mean age = 65.2 Male = 29 (59%) Female = 20 (41%) APACHE scores (median) = 20.1 (IQR: 5-35) <u>(I Group: post-outreach)</u> Mean age = 63.4 Male = 38 (48%) Female = 41 (52%) APACHE scores (median) = 19.1 (IQR: 6-32)	Post-outreach: 1) CCOT provided education to ward staff in assessing deteriorating patients using MEWS (aggregate scoring system). 2) Implementation of the CCOT with MEWS. *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT:</u> 2 senior grade nurses, 1 consultant nurse specialist & 1 consultant intensivist as lead clinician for the team. <u>Intervention by CCOT:</u> Not stated.	Pre-outreach: 1) No education on CCOT or MEWS. 2) No implementation of CCOT.	Total study period = 51-month *Pre-outreach = 21 months* *Post-outreach = 30 months*	1) Critical care mortality in 'readmissions'. 2) 30-day critical care mortality in 'readmissions' 3) Hospital mortality amongst readmitted patients. 4) LOS on critical care following readmission. 5) LOS in-hospital following readmission.	C = 36.7% I = 22.8% (95% CI: -2.4% to 30.3%) *[not significant]* C = 53.1% I = 32.6% (95% CI: -1.4% to 33.5%) *[not significant]* C = 49.6% I = 32.6% (95% CI: 2.8% to 37.6%) *[significant]* <u>(C group):</u> mean days = 6.2 (range: 3-19 days) <u>(I group):</u> mean days = 8.3 (range: 4-17 days) **Not Significant but CI & p-value not reported.* <u>(C group):</u> mean days = 16.9 (range: 10-38 days) <u>(I group):</u> mean days = 17.1 (range: 8-34 days) **No further analysis carried*	Not reported.	<u>Findings:</u> There is a reduction in hospital mortality amongst readmitted patients, although 95% CIs are wide. There is also a reduction in critical care mortality and 30-day critical care mortality in 'readmissions' but these findings do not reach statistical significance. . <u>*Potential biases/confounding factors:*</u> This is a retrospective uncontrolled before and after study conducted over 51 months. It is difficult to exclude or control hidden biases or confounding variables retrospective study eg: there may be many other possible changes within the hospital during those 51 months on clinical practices and management that were not accounted for in this study. As the study is uncontrolled, it is not possible to allow for secular trend (e.g., a reduction in mortality over time independent of intervention). No matching cases and control and no blinding was possible in the study. Sample size is likely to be

								6) Pre- and post-readmission rates.	*out.* C = 7% I = 6% *[not significant]*		too small, with high risk of type 2 error. The 95% CIs are very wide. Due to lack of control of confounding variables, the author suggested that no causative factors can be identified from this study. The decrease in mortality rates might not be the direct result of the introduction of CCOT, it could be due to chance or other factors such as: • Changes in the administration of critical care services • Variation in the case-mix discharged from critical care • The effect of the clinical training and education itself • Introduction of appropriate intravenous fluid resuscitation, intravenous antibiotics & oxygen therapy on the ward awaiting transfer <u>*Generalisability:*</u> 1) It is a single hospital study in the UK. 2) 'TT' system used is an aggregate scoring system (MEWS) which is widely

											used in the NHS. 3) The CCOT only covered 3 surgical wards, surgical admission unit & the surgical acute care unit.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1027 Ball et al. (2003) Effect of the CCOT on patient survival to discharge from hospital and readmission to critical care: non-randomised population study.	Observational study, Retrospective uncontrolled before & after study	2-	Total no. of patients (discharged after 1st or only admission to ICU) = 570 C = 201 I = 269 <u>Inclusion:</u> Patients discharged from the critical care unit after their first or only admission for 2 study periods: 26/02/2000 to 25/02/2001 (pre-outreach) and 26/02/2001 to 25/02/2002 (post-outreach)	<u>(C Group: pre-outreach)</u> Mean age = 51.6 (95% CI: 49.1-54.1) Male = 118 (59%) Female = 83 (41%) No. with APACHE II scores = 44 (22%) Mean APACHE II scores = 16.4 (95% CI: 15.5-17.3) <u>(I Group: post-outreach)</u> Mean age = 49.6 (95% CI: 47.5-51.8) Male = 160 (59%) Female = 109 (41%) No. with	Post-outreach: 1) Implementation of the CCOT with EWS 12 hours daily. (aggregate scoring system) **Note: no mention of pre-education or training.* *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT:</u> 5 senior critical acre nurses led	Pre-outreach: 1) No implementation of CCOT.	Total study period = 2 years *Pre-outreach = 1 year* *Post-outreach = 1 year*	1) Hospital mortality after ICU discharge 2) No. of readmissions to critical care	C = 162/201 (81%) I = 235/269 (87%) Risk Ratio = 1.08 (95% CI: 1.00-1.18) *[significant]* C = 25/201 (12%) I = 16/269 (6%) Risk Ratio = 0.48 (95% CI: 0.26-0.87) *[significant]*	None.	A retrospective uncontrolled before & after study with clear inclusion/exclusion criteria, checked data reliability & detailed information that attempts to address clinical questions. <u>Findings:</u> There are positive results on hospital mortality after ICU discharge (although the 95% CI includes 1.00, which raises concerns about the clinical significance of the finding) and number of readmissions to critical care. <u>*Potential biases/confounding factors:*</u> Confounding variables cannot be controlled in retrospective before and after study with historical

			Exclusion: - Patients who died in critical care. - Patients who were admitted pre-outreach but discharged in post-outreach period. - Patients who admitted pre-outreach but readmitted in post-outreach period. Setting: Single hospital (tertiary referral teaching hospital) – Royal Free Hampstead Hospital, London (has 1200 beds including 20 critical beds).	APACHE II scores = 45 (17%) Mean APACHE II scores = 16.1 (95% CI: 15.3-16.8)	by a consultant nurse, service available 12 hours daily. Interventions by CCOT: Guiding tracheostomy management; tracheal suction & chest physiotherapy; guiding management of continuous positive airway pressure; optimising patient positioning; requesting prescription or administration of nebuliser therapy; requesting repeat blood testing; increase the frequency of CVS/respiratory observations; starting hourly fluid balance monitoring; requesting samples be sent for microculture & sensitivity.						controls. As the study is uncontrolled, it is not possible to allow for secular trend (e.g., a reduction in mortality over time independent of intervention). No matching of cases and control; and no blinding was possible in the study. Author commented that: - Due to lack of control of variables, a concomitant innovation (not necessary the CCOT) in the hospital could have produced the same results. - The interventions undertaken by team members did vary depending on individuals & on a particular day. - The use of routine audit data, rather than specific data collected for research purposes, may also have produced erroneous results. *Generalisability:* 1) It is a single hospital study in the UK. 2) 'trigger' system used is a aggregate scoring

											system (EWS) which is widely used in the NHS.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1028 Leary and Ridley (2003) Impact of an outreach team on readmission to a critical care unit.	Observational study, Retrospective uncontrolled before & after study	2-	Total no. of patients with critical care 'readmission' = 100 C = 49 I = 51 <u>Inclusion:</u> All readmissions to critical care between April 2000 and November 2001. **Note: critical care = ICU + HDU* <u>Setting:</u> Single hospital (teaching hospital with 1000-bed) – Norfolk & Norwich Hospital.	<u>(C Group: pre-outreach)</u> Mean age = 62.0 (SD: 15.2) Male = 36 (74%) Female = 13 (26%) <u>(I Group: post-outreach)</u> Mean age = 62.3 (SD: 15.8) Male = 31 (61%) Female = 20 (39%)	Post-outreach: 1) Implementation of the CCOT during 'normal working hours'. **Note: no education/ training was mentioned; composition of the CCOT & intervention protocol were not reported.* **Type 'TT' system used not stated either.*	Pre-outreach: 1) No implementation of CCOT.	Total study period = 20-month *Pre-outreach = 10 months* *Post-outreach = 10 months*	1) Critical care mortality in 'readmissions'. 2) LOS 1st critical care admission (median) 3) LOS between discharge on general ward and 2nd admission (median) 4) LOS 2nd critical care admission (readmission) (median)	C = 6 (12.2%) I = 10 (19.6%) X^2 = 1.18, df = 1, p = 0.28 *[NS]* C = 1.68 (IQR: 0.69-3.18) I = 1.80 (IQR: 0.96-4.03) *[not significant*] C = 2.93 (IQR: 1.32-6.05) I = 2.25 (IQR: 1.06-6.32) *[not significant]* C = 2.68 (IQR: 0.94-5.79) I = 2.02 (IQR: 0.91-6.32) *[not significant]*	Not reported.	A poor retrospective uncontrolled study with no proper matching of cases and controls or information that attempts to address a focused question. <u>Findings:</u> All outcome measures are negative. Although the author commented that the assumed benefits of CCOT are difficult to quantify scientifically. Lack of information on the type of 'TT' system used, the composition of CCOT and what kind of intervention provided by the CCOT. *<u>Potential biases/confounding factors:</u>* This is a poorly design retrospective uncontrolled study over 20 months. Many possible

											confounding factors were not taken into account. There was no proper matching of cases and controls Sample size too small. Possible Type II error. *Generalisability:* This is a single UK hospital study but not much information was provided for generalisation.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
19 Buist et al. (2002) Effects of a MET on reduction of incidence of and mortality from unexpected cardiac arrest in	Observational study, Retrospective before & after study (adjustment for case-mix)	2-	Total no. of patients = 42164 (Pre-MET) C = 19317 (Post-MET) I = 22847 Inclusion: All patients admitted to the hospital in 1996 (pre-MET) and 1999	*(C group)* Mean age = 36.6 (SD: 26.0) Male = 44.4% Female = 55.6% Mean APACHE II score = 18.4 *(I group)* Mean age = 36.4 (SD: 26.0) Male = 44.6% Female = 55.4% Mean APACHE	1) Implementation of a formal education and audit process directed at junior medical staff and nursing staff. The process included interactive audiovisual presentations to small groups, attachment to all staff	1) No implementation of education. 2) No MET. 3) Operation of existing 'traditional' system of response.	12-month pre-MET 12-month post-MET	1) Hospital mortality 2) No. of Cardiac arrest	C = 380 (19.67/1000 patients) I = 393 (17.20/1000 patients) p < 0.001 C = 73 (3.77/1000 patients) I = 47 (2.05/1000 patients) p < 0.001	Australia, Department of Human Services	A poor retrospective uncontrolled study with no proper matching of cases and controls or information that attempts to address a focused question. Findings: There are significant reductions in hospital mortality, no. of cardiac arrest, cardiac arrest mortality and hospital LOS. However, there is no significant difference between pre-MET and

hospital: preliminary study.			(post-MET). <u>Setting:</u> A 300-bed general metropolitan teaching hospital in Australia. The hospital has over 20000 inpatients and there are 500 to 600 admissions to ICU.	II score = 18.9	identification badges of the criteria for calling the MET, and strategic placement of posters throughout the hospital. 2) Implementation of MET. *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> 1 medical registrar, I intensive care registrar, 1 senior intensive care nurse. <u>Interventions by the MET:</u> The MET is equipped with resuscitation drugs, fluids and equipment.			3) Cardiac arrest mortality 4) Unplanned ICU admissions 5) Hospital LOS (mean days)	C = 56 (76.7%) I = 26 (55.3) p < 0.001 C = 45 (2.3/1000 patients) I = 78 (3.4/1000 patients) *[not significant]* C = 3.6 (SD: 6.3) I = 3.9 (SD:14.8) p < 0.001		post-MET on unplanned ICU admissions. *<u>Potential biases/confounding factors:</u>* Possible 'Hawthorne effect' as the as the research project had a high profile within the hospital. This is a multiple comparison study. This study design is prone to type 1 errors (multiple significance testing). But the use of a significance level at 0.001 might be sufficient to overcome this problem. The employment of a full time research nurse to facilitate the implementation of the system may have improved the ward management of patients with clinical instability rather the effectiveness of the MET itself. *<u>Generalisability:</u>* This is an Australian study with different 'TT' system compared to UK hospitals.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
2 DeVita et al. (2004) Use of MET responses to reduce hospital cardiopulmonary arrest.	Observational study, Retrospective before & after study **the study looked at before and after the 'increased' use of MET, NOT pre- and post-implementation*	2-	Total no. of patients = 254272 (4565 MET calls) C = 199024 (3269 MET calls) I = 55248 (1296 MET calls) <u>Inclusion:</u> All hospital admissions over 6.8 years (Before 'increased' use of MET: Jan 1996 to Dec 2000; after 'increased' use of MET: Jan 2001 to Sep 2002). <u>Setting:</u> A tertiary care university hospital complex consists of 622 beds in United	<u>Analysis from the total of 4564 MET calls:</u> Mean age = 61 Male = 52% Female = 48%	1) Implementation of MET with a protocol delineating objective criteria for when the MET should be activated (single parameter). *MET triggered by standardised calling system. A Single Parameter 'trigger' system* <u>Composition of MET:</u> 1 ICU physician & 2 ICU nurses, 1 floor nurse, 2 anesthesia or critical care physicians. <u>Interventions by MET:</u> Prepare medications, equipment, defibrillator for	2) Implementation of MET 'without' an objective calling criteria.	5 years (before 'increased' use of MET) *[control]* 1.8 years (after 'increased' use of MET) *[intervention]*	1) Mean monthly incidence of cardiopulmonary arrest 2) Cardiac arrest mortality (on day of cardiac arrest) 3) In-hospital mortality (after cardiac arrest) <u>Process:</u> No. of MET calls before and after the introduction of objective criteria (per 1000 hospital admissions)	<u>Per 1000 admissions:</u> C = 6.5 I = 5.4 p = 0.016 C = 33.3% I = 33.3% *[not significant]* C = 52.2% I = 58.9% *[not significant]* Before = 13.7 After = 25.8 p < 0.001 **However, no data on no. of ICU admissions after MET calls was provided.*	Not reported.	A poor retrospective uncontrolled study with no proper matching of cases and controls with unequal time periods trying to address some clinical questions. <u>Findings:</u> Positive result on mean monthly incidence of cardiopulmonary arrest but not on mortality (neither death on day of cardiac arrest nor in-hospital death after cardiac arrest). It is difficult to exclude or control hidden biases or confounding variables in retrospective study. <u>Methodology & analysis:</u> Big discrepancy between the 2 study periods: 5 years control vs. only 1.8 years intervention. Although mean monthly incidence was used to run analysis, the smaller number of data during intervention period may lack power to detect real differences compared with larger control data.

			States.		delivery of patients; deliver medications, obtain vital signs, verify IV function; oxygen supply, suction, assess circulation, deliver chest compressions. Obtain arterial blood for analysis, thoracostomy, central venous access.						This is a study that looked at before- and after- the introduction of an 'objective calling criteria', not pre- and post implementation of MET. Lack detailed information on statistical analysis. A minority of unidentified discharge data was imputed based on contemporaneous MET responses for which outcome data were available. *Generalisability:* This is an Australian study with different 'TT' system compared to UK hospitals.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
12 Pittard (2003) Out of our reach? Assessing the impact of introducing a critical care outreach service.	Observational study, Retrospective before & after study	2-	The study does not mention No. of patients for both control group and intervention group. The study only mentions during the 6 months post-CCOT period, there are 273 patients who were seen by the CCOT. <u>Inclusion:</u> Not clear. The study only mentions data was collected from June to November 2000 (audit pre-CCOT) and from June to November 2001 (post-CCOT) from 3 surgical wards. <u>Setting:</u> Single UK hospital – The General Infirmary,	Not provided.	1) Implementation of CCOT with MEWS (aggregate scoring system). Service available 09.00-17.00, Monday-Friday. **No pre-education was mentioned.* *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT:</u> Senior critical care nurses and medical staff (exact number of staff not reported). <u>Interventions by CCOT:</u> - Avert admissions by identifying patients who are deteriorating and instituting treatment early	2) No implementation of CCOT	<u>12-month study period:</u> 6-month pre-CCOT 6-month post-CCOT	1) No. of admissions to ICU 2) Unplanned ICU admissions 3) All ICU LOS (mean) 4) LOS of unplanned ICU admissions (mean) 5) Overall ICU mortality 6) ICU mortality for unplanned admissions 7) No. of ICU readmissions (n)	C = 328 I = 297 *[not significant]* C = 58% I = 43% p = 0.05 C = 3.4 days I = 3.7 days *[not significant]* C = 7.4 days I = 4.8 days p > 0.05 *[not significant]* C = 27.8% I = 27.7% *[not significant]* C = 28.6% I = 23.5% p = 0.05 C = 15 I = 11 p = 0.05	Not reported.	A very poor retrospective uncontrolled study with no proper matching of cases and controls and no information on no. of patients. <u>Findings:</u> There are positive results on unplanned ICU admissions, ICU mortality for unplanned admissions & no. of readmissions. <u>*Potential biases/confounding factors:*</u> It is difficult to exclude or control hidden biases or confounding variables in retrospective study. No inclusion/exclusion criteria. No. of patients, no. of cases & controls and patient characteristics were not reported. The study covered the surgical high dependency unit where quality of care should be good anyway? <u>*Generalisability:*</u> This is a UK study with commonly use 'TT' system

			Leeds.		or by ensuring timely admission to an area where they can be treated to ensure the best outcome. - Support the continued recovery of previously critically ill patients discharged to the ward and after discharge from hospital. Share critical care expertise and experience.						but it only covered 3 surgical wards and the surgical high dependency unit.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
13 Subbe et al. (2003) Effect of introducing the MEWS on clinical outcomes,	Observational study, Mixed prospective & retrospective before & after study	2-	Total no. of patients = 2354 C = 659 I = 1695 <u>Inclusion/Exclusion:</u> *(I group)* All medical admissions	*(C group)* Mean age = 63 (SD: 20) Male = 45% Female = 55% *(I group)* Mean age = 64 (SD: 19) Male = 45% Female = 55%	1) All medical admissions unit nursing staff were trained by the investigators and the CCOT to collect bedside observations and to calculate MEWS.	Data from previous MEWS validation study was used as control.	I = 3-month (post-MEWS) C = 1-month (pre-MEWS, data from previous	1) Hospital mortality (n) 2) ICU mortality 3) ICU LOS	C = 53 I = 166 *[not significant]* C = 67% I = 33% p = 0.21 C = 4 (IQR: 1-8)	North-East Wales NHS Trust Research & Development Fund.	A very poor uncontrolled study with no proper matching of cases and controls. <u>Findings:</u> All results are negative or not been further analysed. <u>*Potential biases/confounding*</u>

cardio-pulmonary arrests and intensive care utilisation in acute medical admissions.	**This a study that looked at the effectiveness of MEWS with already existing CCOT.*		from 1st Feb to 31st April 2001 aged above 15 years. Patients admitted for palliative care only and patients admitted directly to other wards were excluded. *(C group)* Data from a prospective observational study (MEWS validation study) published previously was used as a control group. This control group was admitted to the same admissions unit during February 2000. <u>Setting:</u> Single hospital in Wales.		2) All medical staff caring for emergency medical admissions were briefed concerning the MEWS, its interpretation and their role in the management of a patient identified as being at risk of deterioration. The nursing staff were instructed to alert appropriate medical staff and the CCOT if MEWS was 5 or more. 3) Implementation of MEWS with CCOT. *MEWS is an aggregate scoring TT system.* <u>Composition of CCOT and Interventions by CCOT:</u> Not stated.		published study)	4) Cardiac arrest 5) ICU/HDU admission	days I = 2 (IQR: 1-30) days p = 0.3 C = 4 (0.6%) I = 40 (2.3%) *[no further analysis]* C = 27 (4%) I = 85 (5%) *[no further analysis]*		*<u>factors:</u>* The study has used data from another previous study as control group. There are unequal time periods for pre- and post-MEWS. *<u>Generalisability:</u>* This is a UK study with commonly use 'TT' system.

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1025 Story et al. (2004) The effect of critical care outreach on post-operative serious adverse events.	Observational study, Mixed prospective & retrospective before & after study **A study looked at additional critical care outreach on top of MET for surgical patients.*	2-	Total no. of patient = 664 C = 319 I = 345 <u>Inclusion:</u> All surgical patients between April 2001 and April 2002 <u>Setting:</u> Single hospital with already established MET - Austin Health Hospital, Australia	*(C group)* Age > 75 = 160 (50%) Male = 152 (48%) Female = 167 (52%) Patients with comorbidities = 140 (44%) *(I group)* Age > 75 = 176 (51%) Male = 179 (52%) Female = 166 (48%) Patients with comorbidities = 162 (47%)	1) MET with additional critical care outreach (1 critical care nurse, only weekdays) <u>Composition of critical care outreach:</u> 1 critical care nurse <u>Interventions by critical care nurse:</u> Oxygen therapy, aggressive fluid management, patient education for deep breathing, acute pain service called, patient controlled analgesia education, patient specific education of nursing & medical staff, direct MET call.	1) MET with no critical care outreach	13-month study period *Pre-outreach = 5.5-month* *Post-outreach = 7.5-month*	1) 30-day surgical patient mortality	C = 29 (9.1%) I = 24 (7.0%) (95% CI: -6% to 2%) *[not significant]*	The Victoria Department of Human Services	A very poor uncontrolled study with no proper matching of cases and controls. <u>Findings:</u> Negative result on 30-day surgical patient mortality. **A study that looked at various different adverse events which are not quite fitted into this review eg: sepsis, renal impairment, myocardial infarction, pulmonary oedema, stroke, reintubation, etc.*

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1024 Norwood et al. (2004) Evaluation of the role of a specialist tracheostomy service. From critical care to outreach and beyond.	Observational study, Mixed prospective & retrospective before & after study **This study looked at the effectiveness of CCOT within the specialist tracheostomy care service.*	2-	Total no. of patient = 170 C = 51 I = 119 <u>Inclusion:</u> *(C group)* All patients receiving a tracheostomy from April 1998 to March 1999. *(I group)* All patients that had had placement of tracheostomy from April 2001 to April 2003. <u>Setting:</u> Single UK hospital with 8 ITU beds, 4 HDU beds, 4 level 1 care beds, 83 acute surgical beds & 175 acute medical beds – Leicester General Hospital.	Not reported.	1) New tracheostomy service with an ITU outreach sister. <u>Composition:</u> 1 ITU sister. <u>Interventions by outreach:</u> Not clear, only mentioned the roles of the sister include education of the ward nursing staff in the ongoing care of patients with tracheostomy tubes.	1) Existing tracheostomy service without outreach service.	3-year study period. *1-year pre-outreach* *2-year post-outreach*	1) ITU mortality with tracheostomy tube in situ	C = 22 (43%) I = 19 (16%) p = 0.006	Not reported.	A very poor uncontrolled study with no proper matching of cases and controls. <u>Findings:</u> Positive result on ITU mortality with tracheostomy tube in situ <u>*Potential biases/confounding factors:*</u> There are unequal time periods for pre- and post-MEWS. Patient characteristics no reported. <u>*Generalisability:*</u> A very specific patient population: patients with tracheostomy

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1026 Kenward et al. (2004) Evaluation of a MET one year after implementation.	Observational study, Retrospective before & after study **A UK hospital that uses MET.*	2-	Total no. of patients pre- & post-MET not reported. No. of patients (post-MET) = 130 <u>Inclusion for post-MET:</u> All adult admissions (age: >15 years) receiving intervention from the MET during a 12-month period, who were not in cardiac arrest at the time of call (from 1 Oct 2000 to 30 Sept 2001) <u>Exclusion for post-MET:</u> Day Care Units and Emergency Department.	<u>Post-MET:</u> Mean age = 73 (median: 76, range 20-97) Male = 57 (44%) Female = 73 (56%) **Patient characteristics of pre-MET not reported.*	1) Implementation of MET <u>Interventions by MET:</u> DNR decision; oxygen and IV fluid; oxygen and medication airway, breathing and circulatory support. **Composition of MET not reported.*	1) No MET **Further information on pre-MET not reported.*	Post-MET = 12-month **study period for pre-MET not reported.*	1) Hospital mortality 2) Cardiac arrest rate	Pre-MET = 20 *per 1000 admissions* Post-MET = 1.97 *per 1000 admissions [not significant]* Pre-MET = 2.6 *per 1000 admissions* Post-MET = 2.4 *per 1000 admissions [not significant]*	Not reported.	A very poor uncontrolled study with no proper matching of cases and controls. Information on control group (pre-MET) was not reported in the study. <u>*Findings:*</u> Negative results on both hospital mortality and cardiac arrest rate. <u>*Methodology:*</u> Study design is very poor There is no information o control, and no informatio on study period of control group. <u>*Generalisability:*</u> Poorly designed study, lack generalisability.

			***Inclusion & exclusion criteria for pre-MET not reported.* <u>Setting:</u> Single UK hospital – Selly Oak Hospital, Birmingham (a 700-bed DGH with approximately 53500 admissions per year).								

Updated Search:

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1072 Jones et al. (2005) Long term effect of a MET on cardiac arrests in a teaching	Observational study, Prospective uncontrolled before-and-after	2-	*Ns reported as No. of admissions and cardiac arrest* <u>Pre-MET (control):</u> Admissions = 16246 Cardiac arrest	**based on patients with cardiac arrest.* <u>Pre-MET (control):</u> Mean age = 73.4 Male = 41 Female = 25	1) Detailed education & information sessions for all members of hospital staff provided preceding the implementation of the MET.	1) No education 2) Traditional 'Code Blue' call system (intended for cardiac arrests &	Pre-MET = 8-month Education = 12-month Post-MET = 4yrs 2 months	<u>Primary outcomes:</u> 1) Cardiac arrest	*<u>Per 1000 admissions:</u>* Pre-MET = 4.06 Education = 2.45 OR = 0.60 (95% CI: 0.43-0.86) p = 0.004 Education = 2.45 Post-MET = 1.90 OR = 0.47 (95%	Not reported.	A poor uncontrolled study with no proper matching of cases and controls. *<u>Findings:</u>* There were significant reductions in cardiac arre between pre-MET and education phase; and between education phase and post-MET. However,

hospital.			= 66 <u>Education Phase:</u> Admissions = 25216 Cardiac arrest = 62 <u>Post-MET:</u> Admissions = 104001 Cardiac arrest = 198 <u>Inclusion/Exclusion:</u> All emergency calls for the period 01/01/1999 to 31/10/04 except calls from coronary care unit, operating room & emergency room, as well as calls in which patient had a documented 'DNR'. <u>Setting:</u> Single teaching hospital in Australia – Austin Hospital (400-bed, 21-	<u>Education Phase:</u> Mean age = 70.5 Male = 44 Female = 7 <u>Post-MET:</u> Mean age = 70.8 Male = 104 Female = 58	2) Implementation of MET <u>Composition of MET:</u> 1 ICU fellow, 1 ICU nurse, 1 medical fellow. Interventions by MET not reported. <u>*Note:*</u> *There was ongoing education to all existing staff & new staff members after the implementation of the MET.*	other sudden life-threatening medical emergencies. <u>Composition of 'Code Blue':</u> 1 anaesthetic fellow, 1 coronary care fellow & nurse, 1 ICU fellow & nurse, 1 medical fellow.		2) Survival rate following a cardiac arrest Correlation analysis between levels of MET activation (per 1000 admissions in each calendar year) & cardiac arrest rate (per 1000 admissions over the corresponding period) (Spearman-rank):	CI: 0.35-0.62) p < 0.0001 OR for survival = 0.60 (95% CI: 0.30-1.21) p = 0.15 *[not significant]* <u>Inverse correlation:</u> r^2 = 0.84, p = 0.01 The gradient of regression line = -0.061 **suggesting that for every 17 MET calls there was an associated decrease of 1 cardiac arrest.*		there was no significant reduction in survival rate. <u>*Potential biases/confounding factors:*</u> The study was not randomised, blinded or placebo-controlled. Not sure time trends were taken into account. 'Insufficient data' were included as true cardiac arrests for the education and post-MET implementation. There was ongoing education after the implementation of MET. It is possible that the observed reduction may be due to the education of staff alone. <u>*Generalisability:*</u> This is an Australian study (single hospital) with different 'TT' system compared to UK hospitals

			bed ICU, approx. 2000 admissions per year)								

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
1141 Jones et al. (2006) Effect of an education programme on the utilization of a MET in a teaching hospital.	Service evaluation study. **An evaluation study of the utilization of MET.*	3	Total no. of patients = 2270 Total no. of MET calls = 2270 <u>Inclusion:</u> All medical and surgical admissions (from August 2000 to April 2004) <u>Setting:</u> Single teaching hospital in Australia – Austin Health Hospital (400 beds with 'closed' ICU model)	Not reported.	1) Implementation of MET was preceded by a preparation period (lectures & tutorial to all nursing staff; formal presentations to Divisions of Medicine & Surgery) 2) Implementation phase (notification and informed all doctors of the theory & purpose of MET and hospital policy) 3) After implementation (ongoing education & information	N/A	3.5 years	1) Overall use of the MET 2) Differences in MET usage	(Aug 2000) = 12.3 calls/1000 admissions (Apr 2004) = 40.6 calls/1000 admissions $p < 0.0001$ <u>By Apr 2004:</u> Surgical = increased 1.13 calls/1000admissions/month Medical = increased 0.23 calls/1000admissions/month $p < 0.0001$	Not reported.	This is a service evaluation study looking at the utilization of MET after introducing an education programme. The positive findings of this study suggest that a detailed nursing and medical education programme will have an effect on the utilization of the MET service. This study does not exclude other factors that might have contributed to the observed increased o MET calls (eg: word of mouth among staff members). The effect of the increase utilization of the MET service on reducing cardiac arrests or other adverse events are unknown.

					sessions were provided for new nursing & medical staff)						

Ward-Level Based Response

ID	Study type	Evid. Level	No. of patients	Patient characteristics	Intervention	Comparison	Length of follow up	Outcome measures	Effect size	Source of funding	Additional comments
260 Paterson et al. (2006) Prediction of in-hospital mortality and length of stay using an early warning scoring system: clinical audit.	Observational, Before & after study	2-	Total no. of patients = 848 *Pre-SEWS = 413* *Post-SEWS = 435* <u>Inclusion:</u> Documentation on the observations made immediately on admission for all emergency referrals to the Combined Assessment Area (CAA) (medical & surgical assessment unit): 11days in October 2003	<u>Pre-SEWS:</u> Median age = 67 (interquartile range: 44-80) Male = 186 (45%) Female = 227 (55%) <u>Post-SEWS:</u> Median age = 69 (interquartile range: 43-79) Male = 197 (45%) Female = 228 (55%)	1) A standardised educational programme for nursing & medical staff before utilization of SEWS. Education programme included the rationale behind the SEWS and emphasised the need to alert the appropriate medical professional if the patient triggered a score of 4 or more. Staff education was delivered in lecture format and through completion of a self-directed	1) No education. Data was obtained from existing conventional observation charts.	22-day study period. *Pre-SEWS = 11-day* *Post-SEWS = 11-day*	1) Overall in-hospital mortality 2) No. of critical care admissions 3) Hospital LOS (median)	C = 24/413 (5.8%) I = 13/434 (3.0%) p = 0.046 C = 11/413 (2.6%) I = 11/435 (2.5%) **p-value not reported.* C = 2 days (interquartile range: 1-6) I = 2 days (interquartile range: 1-6) **p-value not reported.*	Not reported.	An uncontrolled before an after study that looked at the effectiveness of a aggregate scoring system on patient outcomes. <u>Findings:</u> There was significant reduction in hospital mortality after the introduction of SWES. There was reduction in th number of critical care admissions but p-value no reported. Hospital LOS were the same before and after the introduction of SEWS, again p-value not reported. <u>*Potential biases/confounding factors:*</u> No matching of cases and control; and no blinding was possible in the study

			& 11 days in November 2003. <u>Setting:</u> Single hospital in Scotland – Royal Infirmary of Edinburgh.		learning pack. 2) Utilization of the SEWS <u>Composition:</u> This is a ward level based study on the introduction of SWES, a scoring system, there was no CCOT. <u>Interventions:</u> **No specific education on patient care management, but ward staff were encouraged to refer to the guidelines on the reverse of the chart.* <u>Note:</u> Threshold for MEWS = ≥ 5 Threshold for SWES = 4 *SWES includes oxygen saturation as a physiological parameter.						Very short study period (2 days). <u>The author suggested tha</u> The explanation for the significant reduction in hospital mortality is unclear. The intensive sta education programme might have been an important contributory factor. <u>*Generalisability:*</u> SWES is similar to MEWS (only with lower threshold and oxygen saturation wa added as physiological parameter) which is widel used in the UK.

5.4.4 References – Topic 2

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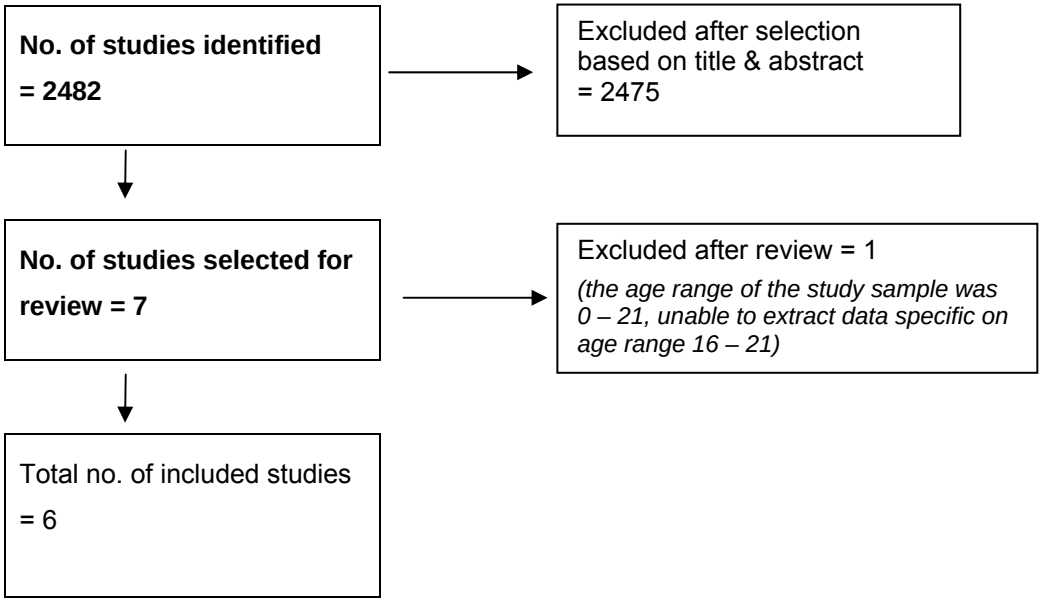
5.4.5 Topic 3: Discharge of patient from Critical Care Areas (CCAs) - Timing of Transfer

*** Does not include decision to discharge a patient from CCA. It starts at the point at which the decision has been made that the patient can be discharged***

Volume of Evidence



Type of study

Total no. of studies = 6	Observational study = 6 (Cohort Study)

Topic 3: Discharge of patients from Critical Care Areas (CCAs) - Timing of Transfer

*** Does not include decision to discharge a patient from CCA. It starts at the point at which the decision has been made that the patient can be discharged***

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2562 Level of evidence: (2+) Retrospective cohort study Goldfrad and Rowan (2000) Consequences of discharges from intensive care at night. **Case-mix adjustment was carried out using the APACHE II method.*	*<u>UK national databases:</u>* 1) UK APACHE II study database (1988-1990) = 10806 admissions to 26 ICUs 2) CMPD (1995-1998) = 21295 admissions to 62 ICUs. After case-mix adjustment: Day discharges = 15747 Night discharges = 1009 *Note: Only data 2) was used to investigate the consequences of discharge at night.*	*<u>CMPD (1995-1998) after case-mix adjustment:</u>* <u>Day discharges:</u> Mean age = 58.2 (95% CI: 57.9-58.5) Mean APACHE II score = 14.6 (95% CI: 14.5-14.7) <u>Night discharges:</u> Mean age = 57.5 (95% CI: 56.4-58.7) Mean APACHE II score = 15.5 (95% CI: 15.1-16.0)	CMPD: Investigation of the consequences of discharge at night = 4 years	*<u>'Night' was defined as:</u>* *- From 2200 to 0659* *- From 0000 to 0459* 1) Ultimate ICU mortality 2) Ultimate hospital mortality 3) Odds of hospital death (night discharges "2200-0659") compared with day discharges 3a) Crude (unadjusted) 3b) Case-mix adjusted 3c) After adjustment for premature discharge	 Night was 2.5-fold greater than Day (X^2 = 21.96, p = 0.00) Night was 1.4-fold greater than Day (X^2 = 23.05, p = 0.00) OR = 1.46 (95% CI: 1.18-1.80) Adj OR = 1.33 (95% CI: 1.06-1.65) Adj OR = 1.17 (95% CI: 0.92-1.49)	Not reported.	A well designed cohort study with case-mix adjustment. <u>Chief findings:</u> Night discharges had a higher crude (unadjusted) and case-mix adjusted hospital mortality compared to Day discharges. When looking at the data on 'direct discharge to the wards', Night discharges also had a higher crude and case-mix adjusted hospital mortality compared to Day discharges. For both groups the findings were statistically non-significant once additional adjustment was made for "premature discharge". <u>The author suggested that:</u> - The main reason why Night discharges did worse than Day discharges in this study is that

	Exclusion criteria: - Patients age < 16 years. - Deaths in ICUs. **CMPD: Intensive Care National Audit & Research Centre's Case Mix Programme Database.*			4) Odds of hospital death (night discharges "0000-0459") compared with day discharges 4a) Crude (unadjusted) 4b) Case-mix adjusted 4c) After adjustment for premature discharge ***After adjusting for a possible cluster effect of ICUs, night discharges remained significant with p = 0.036* 5) Odds of hospital death *for discharges direct to the ward* night discharges ("2200-0659") compared with day discharges 5a) Crude (unadjusted) 5b) Case-mix adjusted 5c) After adjustment for premature discharge 6) Odds of hospital death *for discharges direct to the ward* night discharges ("0000-0459") compared with day discharges 6a) Crude (unadjusted) 6b) Case-mix adjusted 6c) After adjustment for	 OR = 1.62 (95% CI: 1.19-2.21) Adj OR = 1.53 (95% CI: 1.11-2.13) Adj OR = 1.33 (95% CI: 0.95-1.87) OR = 1.42 (95% CI: 1.11-1.82) Adj OR = 1.37 (95% CI: 1.06-1.78) Adj OR = 1.18 (95% CI: 0.90-1.56) OR = 1.73 (95% CI: 1.21-2.48) Adj OR = 1.73 (95% CI: 1.19-2.53) Adj OR = 1.47		they are more likely to be premature in the view if the clinicians involved. - Other factors that might account for a worse outcome for Night discharges in this study included poorer quantity and quality of care available at night both during transfer and at the destination. - Transfers in the middle of the night may be traumatic both physically and psychologically for patients. Methodological limitations: The use of UK APACHE II method for case-mix adjustment – can never be certain that all potential risk factors have been taken into account, although the model was developed and extensively validated in the UK. There could be still unknown confounders such as will-to-live or genetic predisposition, and this uncertainty can only be resolved by a randomised trial. Retrospective collection of data relies on the accuracy of medical records. The definition of "premature discharge" is open to bias. However, The study was based on UK national databases which means the results apply to UK hospitals.

				premature discharge "Premature discharge" was based on an analysis of the data collected under the heading of "reason for discharge from ICU" and was based on a clinician's subjective assessment of a patient's readiness for discharge in the light of the needs of other patients for the ICU beds. No attempt was made to impose standard explicit criteria for this variable. ***Premature discharge and Night discharge were significantly correlated.*	(95% CI: 0.97-2.17) r = 0.53, p < 0.01		

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2540 Level of evidence: (2+) Retrospective Cohort Study Beck et al. (2002) Waiting for the break of dawn? The effects of discharge	Patients admitted consecutively to ICU from 01/01/1996 to 31/03/2000. *Total no. of ICU patients after exclusion = 1654* Exclusion: - Admissions with a diagnosis of primary burn injury. - ICU stay of less	All 1654 admissions: Mean age = 57 (SD: 19) Female = 634 (38.3%) Male = 1020 (61.7%) Mean APACHE II = 18.3 (SD: 18.7)	4 years & 4 months.	Definitions: Early discharge: 0800-1959 Late discharge: 2000-0759 Crude (unadjusted) post-ICU mortality rates Adjusted overall mortality risk	 Early discharge = 11.2% Late discharge = 18.8% X^2 = 13.1, p = 0.0003 Late discharges compared with Early discharges: Adj RR = 1.70 (95% CI: 1.28-2.25)	Departmental funds.	A reasonably well designed cohort study. Chief findings: The results suggested that Late discharges from ICU would increase the mortality risk of patients. Potential Confounding factors: For discharged to HDU, the CI was relatively wide. This suggests that the sample size of this group may have simply been too small to estimate precisely the magnitude of this association.

time, discharge TISS scores and discharge facility on hospital mortality after intensive care. **Adjusted for disease severity (APACHE II).*	than 4-hour. - Aged under 16 years old. - Patients who died in ICU. - Data on subsequent ICU readmissions - Patients directly discharged home. <u>Setting:</u> UK single district hospital – Portsmouth Hospitals NHS Trust			Adjusted mortality risk for patients discharged directly to wards Adjusted mortality risk for patients discharged directly to HDU	Late discharges compared with Early discharges: Adj RR = 1.87 (95% CI: 1.36-2.56) Late discharges compared with Early discharges: Adj RR = 1.35 (95% CI: 0.77-2.36)		Retrospective collection of data relies on the accuracy of medical records. This is a UK study which is generalisable.

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2503 Level of evidence: (2+) Retrospective Cohort Study	<u>Data extracted from the Canadian national database:</u> Critical Care Research Network's Minimum Dataset (MDS) between September 2003	Day-time discharge: Mean age = 61.7 (SD: 17.5) Male = 57.4% Female = 42.6% APACHE II = 15.0 (SD: 7.4) Night-time	12-month	<u>Definitions:</u> Day-time: 0700-2059 Night-time: 2100-0659 0000-0659 <u>Primary outcome:</u> Crude (unadjusted) In-hospital mortality rate	Day = 9.0% Night = 11.8% P < 0.001	Not reported.	A reasonably well designed cohort study. <u>Chief findings:</u> The results indicated that patients discharged from ICU at night have an increased risk of dying in hospital compared with those discharged during the day.

Priestap and Martin (2006) Impact of intensive care unit discharge time on patient outcome. **Adjusted for severity of illness (APACHE II)*	and August 2004. Total no. of Day-time discharges = 42290 Total no. of Night-time discharges = 4772 <u>Inclusion Criteria:</u> All patients admitted to the ICUs who were discharged to the ward were eligible for inclusion in this study. <u>Exclusion criteria:</u> - Patients ≤ 16 years of age - Admitting following cardiac surgery - Admitted following the initial admission for patients readmitted to the ICU within the same hospital stay - Admitted due to a lack of available ward or specialty care beds - Transferred to another acute care facility <u>Setting/Participating Hospitals:</u>	discharge: Mean age = 61.6 (SD: 17.7) Male = 58% Female = 42% APACHE II = 15.7 (SD: 7.7)		Adjusted OR in-hospital mortality – 2100-0659 (multiple logistic regression) Adjusted OR in-hospital mortality – 0000-0659 (multiple logistic regression) <u>Secondary outcomes:</u> Crude (unadjusted) Median ICU LOS Crude (unadjusted) Median hospital LOS Adjusted ICU LOS Crude (unadjusted) Unplanned readmission within 48hrs of ICU discharge	Adj $OR_{2100-0659}$ = 1.22 (95% CI: 1.10-1.36) Adj $OR_{0000-0659}$ = 1.26 (95% CI: 1.07-1.49) Day = 2.14 days (IQR: 1.09-4.36) Night = 2.30 days (IQR: 1.23-4.60) P = 0.008 Day = 11 days (IQR: 7.0-22) Night = 12 days (IQR: 7.0-23) P = 0.011 Night discharges had a significantly shorter ICU LOS than Day discharges: p < 0.001 Day = 1.7% Night = 2.4% P< 0.001		<u>Methodology Limitations:</u> - The Hosmer-Lemeshow goodness-of-fit test was significant, suggesting poor correspondence between the expected probability of mortality produced by the model and the actual mortality in the study population. - The study did not adjust for advanced directives (Ads) and DNR. - The admissions excluded from the regression analyses due to missing data were significantly different from those included ie. on mean age, sources, admission diagnosis, operative status, time of discharge. Although these data only accounted for 2% of all admissions. Severity of illness at the time of ICU discharge may be a more important adjustment on post-ICU mortality than severity of illness on admission. Retrospective collection of data relies on the accuracy of medical records. This is a Canadian study that may have limited generalisability to UK settings.

	31 Canadian hospitals Community hospital = 23 Teaching hospital = 8						

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2517 Level of evidence: (2+) Prospective Cohort Study Duke et al. (2004) Night-shift discharge from intensive care unit increases the mortality-risk of ICU survivors. **Adjustment for severity of illness, LMT status, premature or delayed ICU discharge.*	Total no. of ICU admission between 01/01/1999 and 30/04/2003 = 2247 Total no. of included ICU admission = 1870 *Day = 878* *Evening = 700* *Night = 292* <u>Inclusion:</u> Only the first admission to ICU was included, not readmissions. <u>Exclusion:</u> - Death in ICU - mAge < 16 - Were transferred to another hospital - Had an ICU LOS < 8 hours <u>Setting:</u> Single Australian teaching hospital – Northern Hospital, Melbourne.	<u>Of total of 2247 admissions:</u> Median age = 62 (IQR: 42-73) Median APACHE II score = 15 (IQR: 10-21) Median APACHE II $_{pm}$ = 0.13 (IQR: 0.05-0.30)	52-month	<u>Definitions:</u> Day = 0730-1500 Evening = 1500-2200 Night = 2200-0730 Crude (unadjusted) Case-fatality rate Crude (unadjusted) Unplanned ICU readmission Logistic regression analysis – after adjustment for severity of illness (significant predictors of hospital death at the time of ICU discharge) Variables included: times of discharge, delayed discharge, premature discharge, LMT.	Night (8.2%) compared to Day (4.6%) & Eve (4.0%), p = 0.016 Day (3.5%) compared to Eve (5.1%) & Night (7.5%), p =0.015 APACHE II $_{pm}$ Adj RR = 3.3 (95% CI: 1.3-7.6), p < 0.001 LMT order Adj RR = 5.1 (95% CI: 2.2-12), p < 0.001 Night discharge Adj RR = 1.7 (95% CI: 1.03-2.9), p = 0.03	Not reported.	A reasonably well designed cohort study. <u>Chief findings:</u> The study suggested that the timing of ICU discharge, in addition to the (initial) severity of illness and LMT order, influenced the outcome of ICU survivors. The case-fatality rate in ICU survivors was higher for those discharged during the night-shift discharge, even after the adjustment of possible confounding factors. <u>The author suggested that:</u> The possible reasons for the finding in this study were – - Staff availability and nurse: patient ratios in the general wards were lower during night shift. - Medical staff: patient ratios in the general wards fell by at least 80% overnight in this particular hospital. - There may be insufficient time for adequate handover and for regular patient assessment and observations. Communication errors during handover may lead to adverse patient events. <u>Potential biases:</u> - The study population was an uncontrolled and heterogeneous group from one institution. - Though not statistically significant, patients discharged during evening and night shifts have greater

							severity of illness (APACHE II $_{pm}$) and older in age. - Severity of illness at the time of ICU discharge may be a more important adjustment on post-ICU mortality than severity of illness on admission. - The CI for the RR of timing for discharge was close to unity and therefore a Type I error due to an institutional or methodological bias is possible. This is an Australian single hospital study that may have limited generalisability to UK settings.

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2507 Level of evidence: (2+) Retrospective Cohort Study Tobin and Santamaria (2006) After-hours discharges from intensive	10903 patients discharged alive from ICU to hospital wards between 01/01/1992 and 31/12/2002. <u>Setting:</u> Australia - Single hospital – a 400-bed tertiary referral hospital associated with a university.	*<u>All 12079 patients admitted to ICU (1992-2002):</u>* Male = 65% Female = 35% Median age = 64 (range: 13-98) Median APACHE II = 13 (range: 0-53) <u>Health Units:</u> General medicine =	The cohort was analysed for 2 periods: 1992-1994 & 2000-2002.	<u>Definitions:</u> Morning shift (07:00-14:59) Afternoon shift (15:00-21:59) Night shift (22:00-06:59) *<u>Primary outcome:</u>* <u>Hospital mortality after discharge from ICU (discharge alive):</u> Morning shift (reference): Afternoon shift (unadjusted)	(1992-1994) = 7.18% (2000-2002) = 21.92% OR = 3.63 (95% CI: 3.05-4.30)	Not reported.	Retrospective cohort design with limited descriptions of inclusion/exclusion criteria. <u>Chief findings:</u> Afternoon and night discharges were associated with higher post-ICU mortality. <u>The author commented that:</u> - Several factors might explain these results. Transfer from the ICU to a ward is associated with a significant reduction in clinical observation and monitoring, with

care are associated with increased mortality **Adjusted for severity of illness (APACHE II) and origin of admission.*		15% Special medicine = 10% General surgery = 10% Special surgery = 65%		Night shift (unadjusted) <u>Multivariate analysis (predictor of mortality after ICU discharge):</u> Morning shift (reference): Afternoon shift Night shift	(1992-1994) = 1.36% (2000-2002) = 5.86% OR = 4.52 (95% CI: 3.15-6.64) Adj OR = 1.36 (95% CI: 1.08-1.70) Adj OR = 1.63 (95% CI: 1.03-2.57)		the ratio of nurses to patients varying from 1:4 to 1:10. - This study did not have information to suggest premature discharge at night shift. - A proportion of patients discharged at night may be those for whom continued ICU care is judge futile or for whom palliative care has been instituted (palliative discharges may have skewed the mortality rates when defined by nursing shifts). <u>Potential biases/confounding factors:</u> In analysis of after-hours discharges, no attempt was made to differentiate between premature discharge and delayed discharge. Similarly, whether the patient was discharged for active management or for palliative care was not coded in the ICU database and was not included in the analysis. Retrospective collection of data relies on the accuracy of medical records. Single hospital study in Australia – case-mix, patient-to-staff ratios may vary in other hospitals. No inclusion/exclusion criteria for study population.

Study Type & Level of Evid.	No. of Patients & Setting	Patient Characteristics	Length of follow-up	Outcome measures	Effect size	Source of Funding	Additional Comments
ID: 2525 Level of evidence: (2+) Retrospective Cohort Study Uusaro et al. (2003) The effects of ICU admission and discharge times on mortality in Finland. **Adjusted for SAPS II, TISS and whether restrictions were set for future care (eg: DNR).*	Consecutive series of 23134 emergency admissions from Jan 1998 to June 2001. *No. of patients for crude analysis = 20636* *No. of patients for logistic regression analysis (after adjustment) = 14308* <u>Setting:</u> 18 ICUs in Finland: 16 in central hospital, 2 in university hospitals.	Mean SAPS II for the entire population was = 34±17 (mean±SD)	30-month	<u>Definitions:</u> Weekend = from 1600 Friday to 2400 Sunday 'Out of office hours' = 1600-0800 'Office hours' = 0800-1600 Crude (unadjusted) hospital mortality rate Logistic regression analysis – hospital mortality (after adjustment) Crude (unadjusted) hospital mortality rate Logistic regression analysis – hospital mortality (after adjustment)	Office-hour discharge = 9.8% Out of office-hour discharge = 11.5% p = 0.002 Adj OR with Out of office-hour discharge = 1.11 (95% CI: 0.93-1.31), p = 0.24 *[not significant]* Weekday discharge = 10.2% Weekend discharge = 9.2% p = 0.09 *[not significant]* Adj OR with Weekend discharge = 0.88 (95% CI: 0.73-1.07) *[not significant, p-value not reported]*	Not reported.	Retrospective cohort design with limited descriptions of inclusion/exclusion criteria. <u>Chief findings:</u> No association between the time of discharge from the ICU and further hospital mortality after taken into account of SAPS II, TISS and whether restrictions were set for future care. <u>Potential biases/confounding factors:</u> The 'Out of office-hour' was considerable wide (16 hours) compared to other studies that used more specific 'night-time'. The study has high ICU mortality (10.9%) and high hospital mortality (20.7%) in the first place. Retrospective collection of data relies on the accuracy of medical records. This is a study from Finland, thus there is the issue of generalisability to UK settings.

5.4.6 Topic 3 References

Beck DH, McQuillan P, Smith GB (2002) Waiting for the break of dawn? The effects of discharge time, discharge TISS scores and discharge facility on hospital mortality after intensive care. *Intensive Care Medicine* 28 (9) : 1287-1293.

Duke GJ, Green JV, Briedis JH (2004) Night-shift discharge from intensive care unit increases the mortality-risk of ICU survivors. *Anaesthesia & Intensive Care* 32 (5) : 697-701.

Goldfrad C, Rowan K (2000) Consequences of discharges from intensive care at night. *Lancet* 355 (9210) : 1138-1142.

Priestap FA, Martin CM (2006) Impact of intensive care unit discharge time on patient outcome. *Critical Care Medicine* 34 (12) : 2946-2951.

Tobin AE, Santamaria JD (2006) After-hours discharges from intensive care are associated with increased mortality. See comment. *Medical Journal of Australia* 184 (7) : 334-337.

Uusaro A, Kari A, Ruokonen E (2003) The effects of ICU admission and discharge times on mortality in Finland. *Intensive Care Medicine* 29 (12) : 2144-2148.

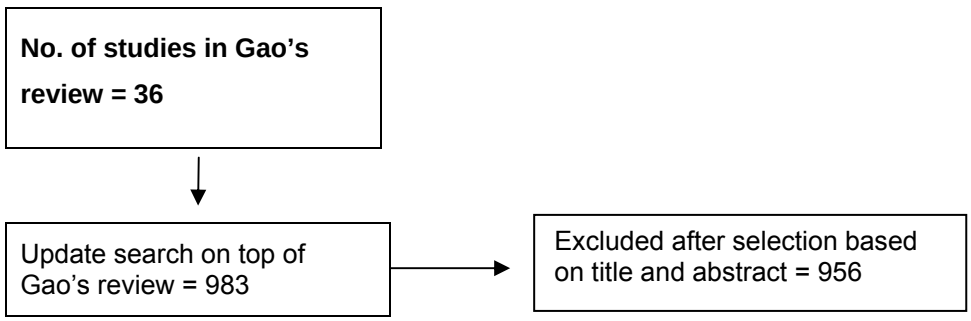
5.5 Inclusion and Exclusion Criteria

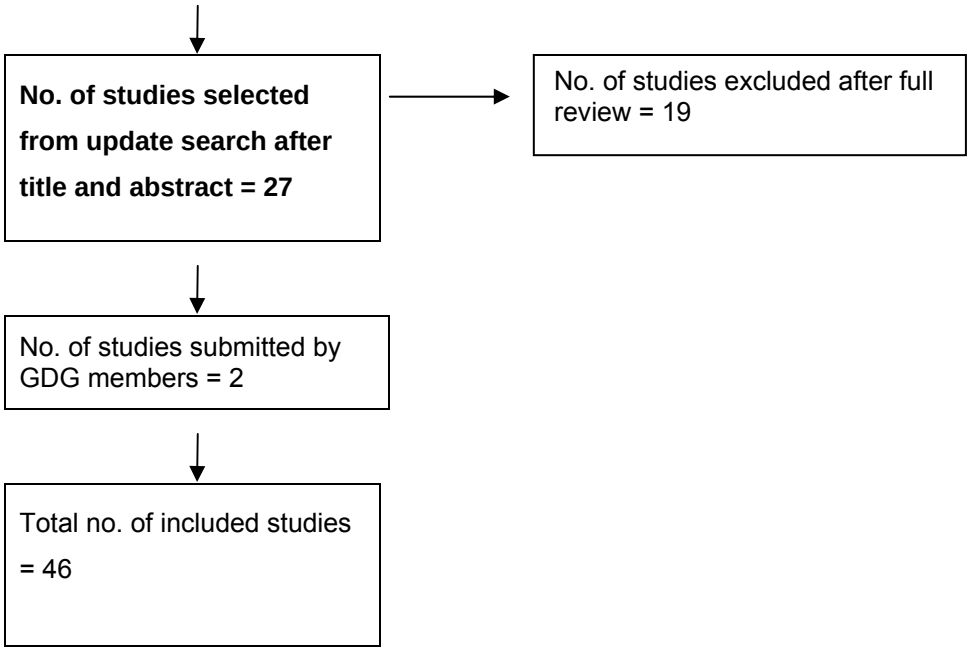
Clinical Evidence: Inclusion and Exclusion Criteria

Chapter 1: Identification and evaluation of risk scoring tools

Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	All adult patients in hospital, including patients in the emergency department but excluding patients in critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies describing the development of a tool which triggers a mandated response to predetermined patterns of physiological derangements and includes 'periodic observation' of three or more of the following: • Respirations • Blood pressure • Heart rate • Urine output • O2 saturation • Body temperature • Level of consciousness 2. Studies testing any aspect of reliability or validity of tools which meet the above criteria e.g. sensitivity, specificity, predictive validity. 3. Studies testing the utility of tools which meet the above criteria e.g. acceptability to staff and patients, completion time. 4. Papers describing the use of a tool which meets the above criteria.
Note:	Search strategy for Chapter 1 was based on Gao et al's systematic review. The technical team had re-run an update search based on Gao et al's review and specifically looked at studies in emergency department that were excluded by Gao et al's original study.

Flow-chart 1: volume of evidence for Chapter 1

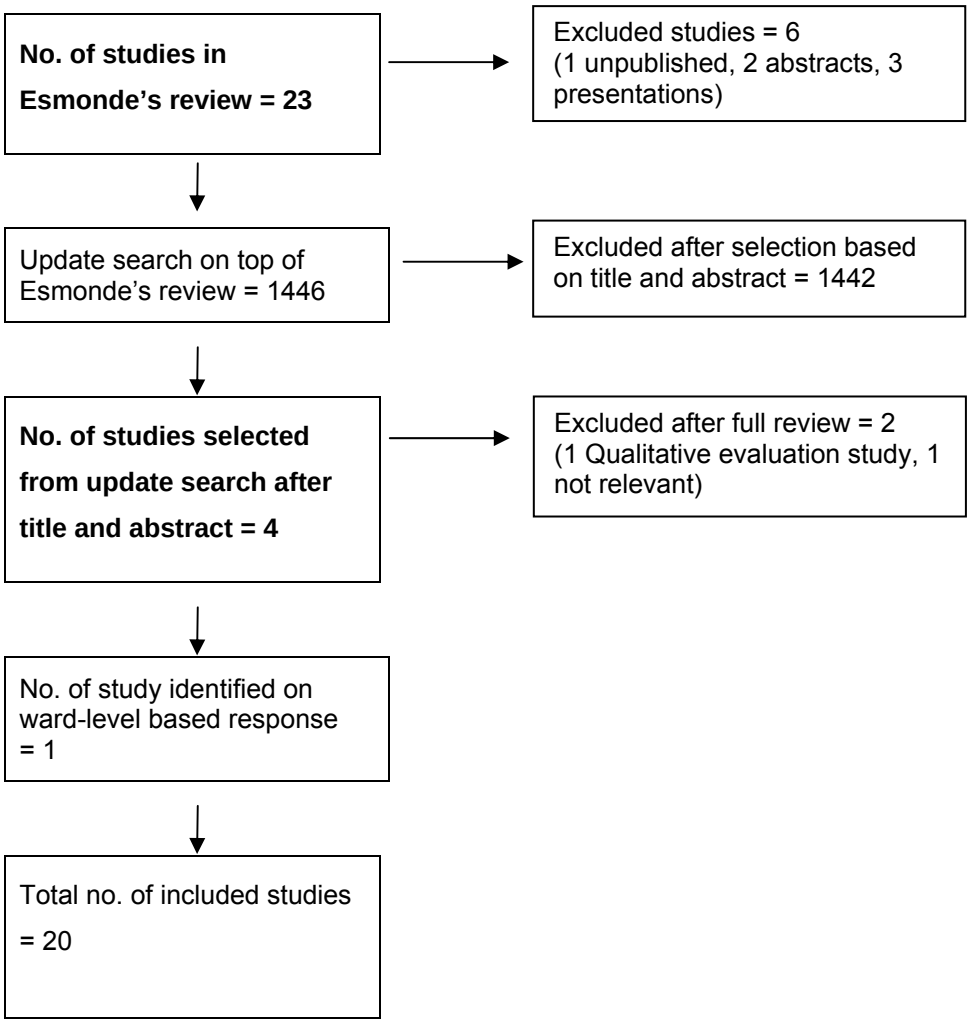



No. of studies selected from update search after title and abstract = 27
No. of studies excluded after full review = 19
No. of studies submitted by GDG members = 2
Total no. of included studies = 46

Chapter 2: Response strategies for patients identified as having a deteriorating clinical condition

Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	All adult patients in hospital, excluding patients in emergency department and critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies describing or exploring the impact of critical care outreach services on patient and service outcomes; and studies introducing critical care outreach services in hospital. Critical care outreach services encompassed a wide range of activities such as Critical Care Outreach Team, Patient-At-Risk Team, Medical Emergency Team, Rapid Response Team, ward-level response or any other similar configurations. The outcomes were any measures of patient health outcomes such as: • Mortality rate • Frequency of cardiac arrests • Hospital/ICU length of stay • Unplanned ICU admission • ICU re-admission 2. Studies exploring the impact of ward-level based response on patient and service outcomes. 3. Studies describing or evaluating the utility or implementation of critical care outreach services/activities which meet the above criteria e.g. effect of an education programme on the utilization of critical care outreach services/activities.

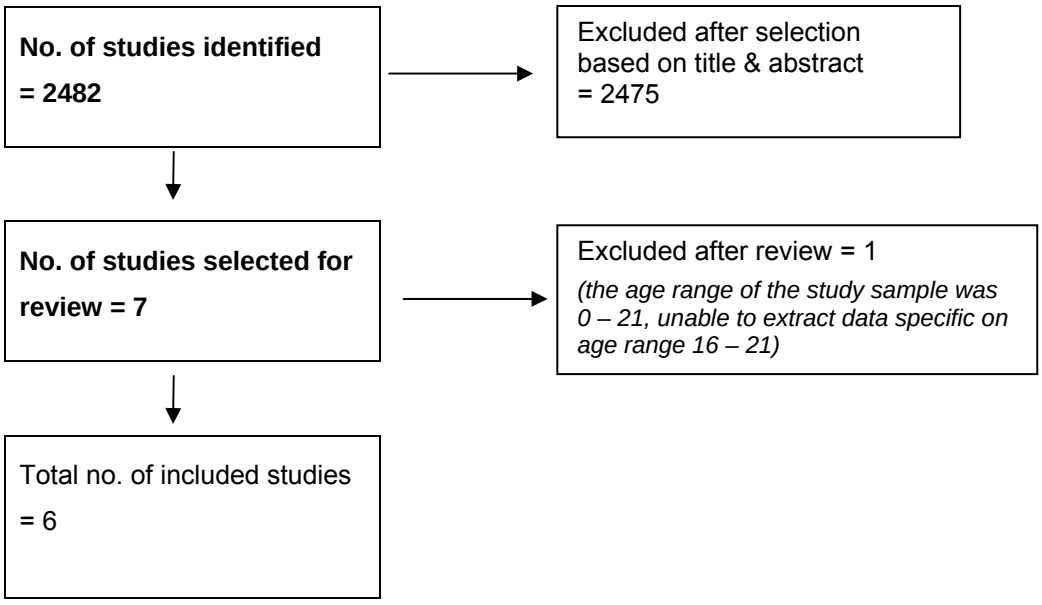
Flow-chart 2: volume of evidence for Chapter 2



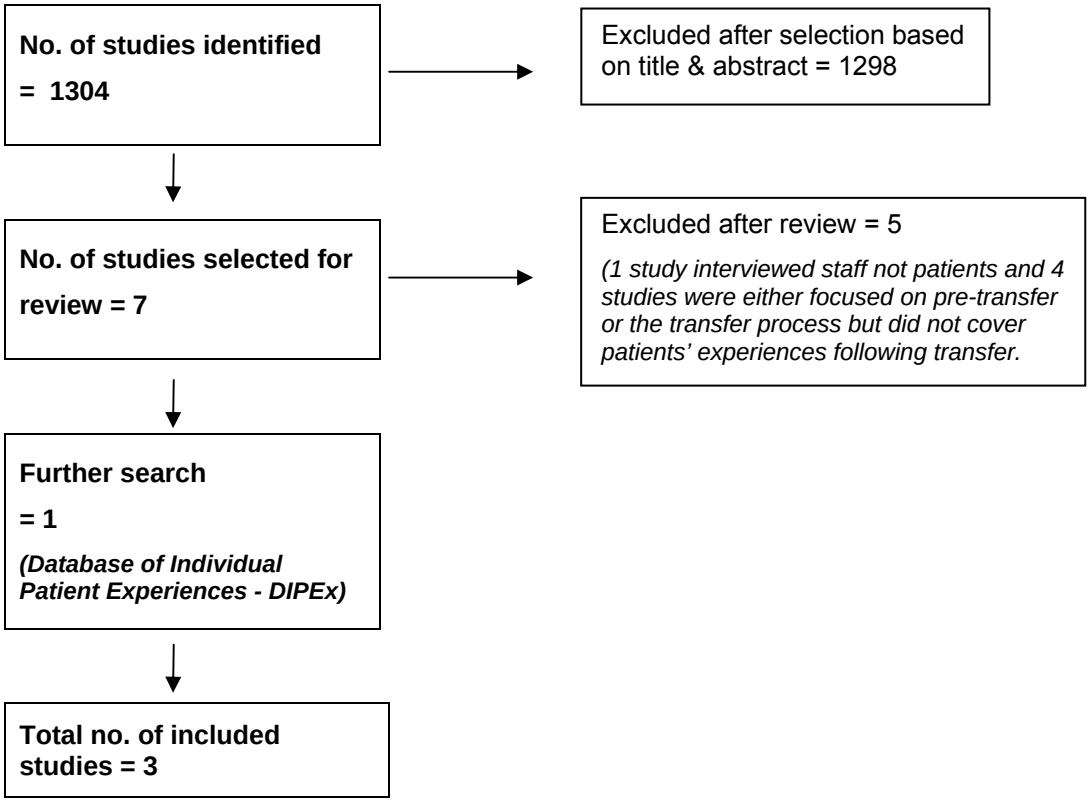
Chapter 3: Discharge of patients from critical care areas

Sub-question 1.	Timing of transfer
Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	Adult in-patients in critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies exploring the impact of 'out of office hours' transfer compared to 'office hours' transfer on patient outcomes such as: • Mortality rate • Re-admission to critical care areas • Adverse events 2. Selection did not include the study on decision to discharge a patient from critical care areas. It started at the point at which the decision had already been made.
Sub-question 2.	What interventions can be delivered to patients on general wards following discharge from Critical Care Areas to improve health outcomes?
	Please refer to Chapter 2. • Studies exploring interventions delivered in the immediate post discharge phase. Does not cover rehabilitation.
Sub-question 3.	What elements of care on the general ward are viewed as important by patients in the immediate period following discharge from critical care areas?
Language	English
Status	Published papers (full papers only), papers in-press (full papers only).
Study Design	All study types.
Population	Adult in-patients on general wards following discharge from critical care areas.
Content of papers *(inclusion/exclusion criteria)*	1. Studies describing patient's experiences and views on care provided on general ward following discharge from critical care areas. 2. Selection did not include factors causing relocation stress and provision of rehabilitation. 3. Selection did not include experiences and views of patient's family or carers. 4. Selection did not include healthcare professional's views on patient's experiences and what they need.

Flow-chart 3a: volume of evidence for Chapter 3 (sub-question 1.)



Flow-chart 3c: volume of evidence for Chapter 3 (sub-question 3.)



Health Economics Evidence: Inclusion and Exclusion Criteria

Partial and full economic evaluations (evaluations that consider both costs and consequences) published in English linked with the clinical questions covered in this guideline. No directly relevant published studies were identified, save for a book chapter that cited limited information on the direct costs of outreach services. Unpublished, ongoing research (see chapter 3.3.10 for details) however was identified, and used to inform the appropriate sections of the guideline.