HEALTH SYSTEMS AND POLICY ANALYSIS

POLICY BRIEF 42

Use of digital health tools in Europe

Before, during and after COVID-19

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A policy brief is a short publication specifically designed to provide policy makers with evidence on a policy question or priority. Policy briefs

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Acronyms

AI	application programming interface
app	application
CDC	Centers for Disease Control and Prevention
CFIR	Consolidated Framework for Implementation Research
COPD	chronic obstructive pulmonary disease
CT	computerised tomography
DHIS2	District Health Information Software 2
EHIF	Estonian Health Insurance Fund
EU	European Union
GDPR	General Data Protection Regulation
GP	general practitioner
HbA1c	glycated haemoglobin
ICT	information and communications technology
ISS	(Italian) National Institute of Health
MHRA	Medicines and Healthcare products Regulatory Agency
OECD	Organisation for Economic Co-operation and Development
SORMAS	Surveillance, Outbreak Response Management and Analysis System
SpTH	Spain Travel Health
WHO	World Health Organization

Key messages

- Digital health tools hold the potential to improve the efficiency, accessibility and quality of care.
- **Before the pandemic**, efforts had been made to support implementation across Europe over many years, but widespread adoption in practice had been difficult and slow.
- The greatest barriers to adoption of digital health tools were not primarily technical in nature, but instead lay in successfully facilitating the required individual, organizational and system changes.
- **During the COVID-19 pandemic** many digital health tools moved from being viewed as a potential opportunity to becoming an immediate necessity, and their use increased substantially.
- Digital health tools have been used during the pandemic to support four main areas: communication and information, including tackling misinformation; surveillance and monitoring; the continuing provision of health care such as through remote consultations; and the rollout and monitoring of vaccination programmes.
- Greater use of digital health tools during the pandemic has been facilitated by: policy changes to regulation and reimbursement; investment in technical infrastructure; and training for health professionals.
- **As the pandemic comes under control**, if health systems are to retain added value from greater use of digital health tools, active strategies are needed now to build on the current momentum around their use.
- Areas to consider while developing such strategies include:
    - Ensuring clear system-level frameworks and reimbursement regimes for the use of digital health tools, while allowing scope for co-design of digital health solutions by patients and health professionals for specific uses.
    - Combining local flexibility with monitoring and evaluation to learn lessons and ensure that digital health tools help to meet wider health system goals.

Executive summary

This policy brief takes stock of how digital health tools have been used during the COVID-19 pandemic, in order to review what has happened, assess how uptake and use of these tools has been facilitated, identify issues that are emerging, and learn lessons for the longer term to support the sustained use of digital health tools.

Digital health encompasses eHealth, mHealth and new sources and types of 'big data' and new technologies

Digital health is the use of digital technologies to improve health. Developments in this area initially focused on eHealth technologies that used information and communication technologies to improve existing processes of communication, such as through the use of electronic health records. The increasing power and prevalence of mobile devices later opened up new potential applications of mobile devices for health (mHealth), which seek to empower individuals and provide new services such as the remote monitoring of health status and wellbeing. More recently, substantial increases in the volume, velocity and variety of available health data and data-driven tools to analyse 'big data', including through machine learning, have emerged. The term 'digital health' has become a way of referring to the concepts of eHealth, mHealth and developments in big data and new technology.

Progress had been made in implementing digital health before COVID-19, but much unrealized potential remains across most European countries

In principle, digital health technologies hold the potential to bring about major improvements in the efficiency of the health system, both in terms of care provision and the administration of the system as a whole. In practice, realizing this potential in health care has proved to be a long, arduous and complex endeavour, with very mixed results. Prior to the pandemic, there was a wide discrepancy between countries in Europe in terms of policy and strategy development and the implementation of digital health. While countries such as Estonia, the Netherlands, Denmark and Sweden were relatively advanced in terms of having implemented many digital health tools as well as having appropriate financial, legal and regulatory, and institutional frameworks for digital health in place, others, such as Poland, Germany and France, had lagged behind. Much unrealized potential for digital health remains in all European countries.

Uptake of digital health before the pandemic was hindered by individual, organizational and systemic – rather than technical – challenges

While the implementation of digital health tools involves technical challenges, many of the barriers to implementation in practice are not actually technical in nature. Difficulties in facilitating wider individual, organizational and system changes have been critical to limiting adoption. Insufficient investment, lack of a supportive and clear legal framework governing the use of such tools, concerns over their use from health professionals, gaps in planning and support for implementation, as well as inadequate leadership have all played a critical role in stifling adoption in some countries.

COVID-19 provided the impetus for removing some of the barriers to uptake

The COVID-19 pandemic abruptly changed the motivation to make use of digital health; in many instances, using digital health tools went from being viewed as an interesting potential opportunity to becoming an immediate necessity. This has provided the impetus to make the necessary changes at the individual and organizational levels, with systems removing or suspending barriers. Thus, the pandemic has seen very rapid development and uptake of digital health tools in practice.

Digital health tools during COVID-19 have been used to support communications, monitoring and surveillance, provision of health services and vaccines rollout

Overall, there are four principal areas where digital health tools are being used in response to COVID-19: communications, for example to combat misinformation; monitoring and surveillance, such as through the use of contact-tracing apps or genomic surveillance; supporting provision of health services, notably though remote consultations or surge planning tools; and to facilitate the rollout of vaccination programmes and monitor adverse reactions to vaccines. In many countries, a more recent development is emerging related to the potential role of digital health tools to support certification of immune status or recovery.

Policies to facilitate the use of digital health tools during the pandemic focused on changing reimbursement, increasing investment and training health workers

While some of the digital health tools used were novel (in particular contact-tracing apps), much of the underpinning technology that has been used during the pandemic already existed. At the system level, most actions to support the use of digital health tools during the pandemic have concerned the relaxation of limiting mechanisms, in particular the opening up of financing and reimbursement for these services where that was not already the case, and increased direct investment in digital health tools and the infrastructure to support them. How far regulatory limits have been addressed is less straightforward, with relatively little formal adaptation of regulatory frameworks for digital health tools. At the individual level, some countries took steps to train health professionals in the use of digital health tools to improve their effectiveness.

To retain value from increased use of digital health, policies should focus more on creating a supportive environment for expanded use of these tools

If health systems are to retain added value from greater use of digital health tools as the pandemic comes under control,

active strategies are needed now to build on the current momentum around the use of digital health tools. So far, the primary focus of policy has been on removing limitations to the uptake of digital health tools, but the future focus should be on learning from the initiatives taken during this time and identifying policies and practices that can be put into place to create a supportive environment for the expanded use of digital health tools. This should combine a clear legal and financial framework at policy level, including scope for local adaptation and co-creation of solutions, with monitoring and evaluation embedded throughout to ensure that local solutions meet overall system goals.

Policies to promote the use of digital health should be underpinned by strategic investments and targeted research

Greater **strategic investment** is needed longer term to support developments in digital health, targeting both the development of infrastructure within the health setting and outside (e.g. internet provision), and research and development to ensure that technologies continue to evolve. Gaps in evidence on the impact, efficacy and cost-effectiveness of many tools utilized during the pandemic, as well as their impact on patients and health professionals, remain. Rapid reviews and evaluations of current digital health tool use, their benefits and issues are therefore needed to provide an evidence base for what to continue in the future as well as what adaptations are required. Increased understanding of digital inequalities across population groups and how to address these is also needed.

POLICY BRIEF

Introduction: What are the aims of this policy brief?

Digital health technologies hold the potential to bring about major improvements in the efficiency of health systems, both in terms of care provision and the administration of the system as a whole. After all, in other cases, whole sectors of the economy have been revolutionized by information and communication technologies. For many years, there have been efforts across European health systems to facilitate and promote their use. However, realizing the potential of digital tools in health care has proved to be a long, arduous and complex endeavour, with very mixed results (Chaudhry et al., 2006). While there are many examples of individual digital health innovations that have brought benefits in terms of accessibility, quality or efficiency, their widespread adoption in practice has been persistently difficult. Many of the biggest challenges to uptake have not been technical in nature, but instead stem from difficulties in making changes to wider processes of health and care. Insufficient investment, lack of a supportive and clear legal framework governing their use, concerns over their use from health professionals, gaps in planning and support for implementation, as well as inadequate leadership have all played critical roles in stifling adoption in some countries (Ross et al., 2016).

The unique challenges generated by COVID-19 have nevertheless created different needs and a new willingness to adopt digital health technologies, resulting in their use accelerating during the pandemic. Digital health tools have become an integral part of pandemic responses across the region in supporting communication and monitoring, the continued provision of health services, as well as transitions from pandemic-related restrictions. Many of these initiatives have been created very rapidly and on an exceptional basis. Policy actions have been required to facilitate use of these technologies, such as new or modified regulations, adjustments to financing mechanisms, investment in technical infrastructure and the training of health workers. However, many of these actions are temporary. While digital health tools can help deliver more efficient and patient-centred care, we cannot guarantee that the increased use and acceptance that we have seen during the pandemic will continue as health systems return to a more 'normal' situation.

There is thus now a need for consolidation of evidence from the use of digital health during the pandemic in order to provide an evidence base for making best use of digital health tools in the medium and longer term. Learning lessons from the rapid adoption of many digital health tools during the pandemic can help to highlight key steps that have been taken to facilitate their use, and rapid research can now provide a better evidence base for considering longer-term strategies as the pandemic subsides. This policy brief aims to provide a first rapid stocktake of those developments in order to enable policy-makers to review what has happened, identify issues that are emerging, and begin to learn lessons for the longer term. Policy options are also provided on actions that can be taken to maximize the potential of digital health tools to inform an effective pandemic response, and to help facilitate the implementation of digital health tools to support longer-term sustainability of health systems in Europe.

In the following section, we start by providing an overview of developments in digital health, including the shift in focus from e-health to m-health to digital health, and the many dimensions of action needed to realize the potential of these technologies. In section 3, the brief then reviews how digital health tools have been used during the pandemic. In section 4, we link this to policy, and what steps have been taken to facilitate the use of digital health tools during this crisis. The brief concludes in section 5 by analysing what policy lessons are emerging at this stage; how the issues are different in comparison to the situation with digital health before COVID-19, and what could be done now in order to facilitate effective use of digital health in the next phases. For example, as normal health services begin to resume, they are likely to face additional pressures for some time to come, and digital health tools may be used in new ways to help address this.

Background: what advances had been made in digital health before COVID-19?

What is digital health?

Digital health means the use of digital technologies to improve health

How we refer to the use of information and digital technologies in relation to health has evolved over time as their use has changed. For the purposes of this brief, we define the term *digital health* as the use of digital technologies to improve health (WHO, 2021). This is similar to related terms such as *eHealth* (the use of information and communication technologies for health) and *mHealth* (emphasizing mobile technologies), with an additional emphasis not only on the technologies but also on the data they create, share and use.

These different terms and concepts themselves reflect changes in how information and communication technologies are being used to support health (Stroetmann, Artmann & Stroetmann, 2011b; Meier, Fitzgerald & Smith, 2013). This section briefly reviews the evolution of the ways in which information and communication technologies have been used for health and how this is reflected in the terms that are used.

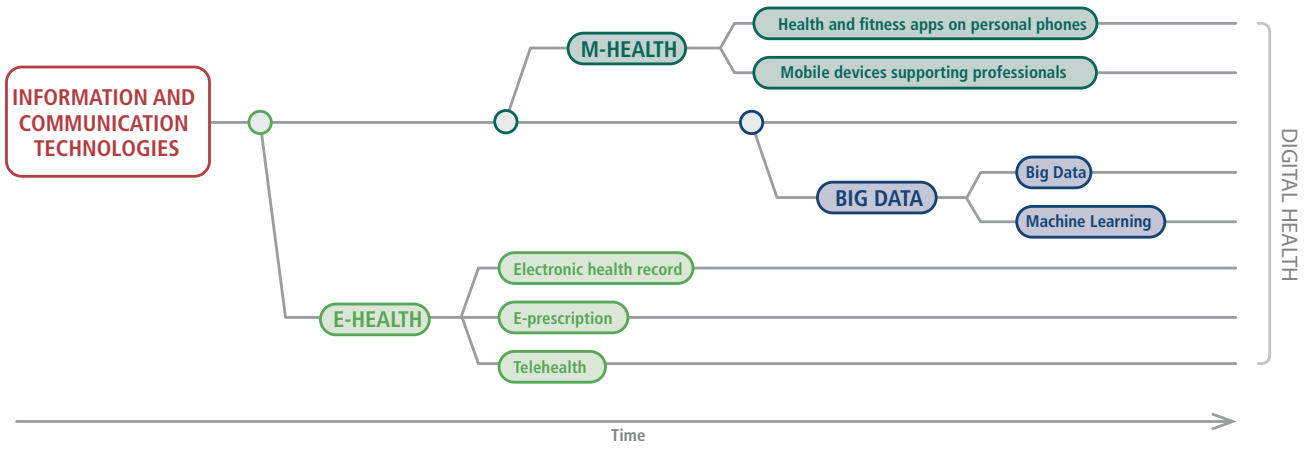
eHealth focuses on the use of information and communication technologies

The initial focus of eHealth was on using information and communication technologies to improve existing processes of communication (such as electronic prescriptions, or sharing lab results electronically) and recording information, in particular moving towards electronic health records and electronic databases to underpin information systems such as registries (Figure 1).

Key fields of activity in eHealth (Stroetmann, Artmann & Stroetmann, 2011a) include:

- **Electronic health records (full record or summary):** While there have been visions of single electronic records of health for patients unified across a whole national health system, in many instances this has proved impractical despite strenuous efforts, with the complexity of the changes involved in organizations, systems and behaviour making it an enormous challenge. Successful use of electronic health records has thus so far principally been within organizations or other sub-parts of the system, leading to a shift in focus towards enabling different systems to work together, or 'interoperability', which we will discuss further below.
- **E-prescription:** Although this seems simple on the surface, as with electronic health records, implementation has proved challenging in practice, raising issues that extend far beyond the technologies concerned to the wider health system. Those e-prescription systems that are in place are principally within primary care, and typically do not include medicines dispensed in hospitals.
- **Telehealth:** Telehealth includes remote provision of care for patients in isolated areas, or remote monitoring for patients with chronic conditions, using tools such as remote video consultations. Uptake of telehealth prior to COVID-19 remained limited in most countries due to technological challenges, professional scepticism and financial and legal barriers to providing consultations.
- **Identifiers for patients, professionals and other actors:** Work to establish unique electronic identifiers (to ensure accurate linkage of records to the right person) focused initially on patient identifiers. However, it is also important to be able to identify other actors within the health and care system, such as clinicians, pharmacists or providers. While in some countries patient identifiers are linked to physical cards, in most instances these do not directly carry the health records of that person; rather, they act as a route of identification and access to data stored in other systems.
- **Standards:** Using eHealth technologies has also required extensive work in establishing standards, linked to the challenge of ensuring interoperability between different systems – not just clinical systems but administrative systems as well. These are not only technical standards; sharing information effectively requires, for example, recording it in mutually understandable ways, which is frequently not the case between different professions, specialities or organizations.

Figure 1: Digital health has evolved over time to encompass eHealth, mHealth and big data



Note: This diagram contains some examples of digital health tools in the areas of eHealth, mHealth and big data, but is not an exhaustive list.
Source: *Authors*.

mHealth makes use of mobile devices and apps to provide new services and to help empower individuals

The increasing power and prevalence of mobile devices has opened up new potential applications of mobile devices for health, or mHealth. Where much of the initial focus of eHealth was on technologies within and specific to the health system, the concept of mHealth focused more on the potential of consumer technologies to also support health. Or, in other words, just as other areas have made use of phones and mobile apps to provide new services and empower individuals, mHealth sought to do the same for health.

mHealth applications do not necessarily require complex smartphones. Indeed, the most widely used mHealth services are those like health call centres and helplines, along with relatively simple extensions such as appointment or treatment reminders by text message (WHO Global Observatory for eHealth & WHO, 2011). The increasing prevalence of smartphones does offer the potential to also provide more complex services, but evidence is still emerging about which are the most useful.

A recent review (Rowland et al., 2020) looked at evidence for clinical value from mHealth and identified four categories of mHealth functionalities:

- **Support for clinical diagnosis or decision-making**, such as for self-triage or screening data, such as photographs, although issues still remain with many of the specific applications.
- Improving clinical outcomes from existing treatment pathways through **supporting patient adherence**, such as with personalized reminders and social comparisons, in particular for use of medication.
- Acting as **standalone digital therapeutics**, such as cognitive behavioural therapy
- **Providing education**, such as before attending a clinic to support effective shared decision-making, or to provide support to patients during long and complex processes of treatment.

Similarly, evidence about what influences the use of mHealth tools in practice has been emerging and highlights the importance of not just technological solutions but also the need for action at policy level and active support for processes of change, as well as cultural and organizational shifts (Jacob, Sanchez-Vazquez & Ivory, 2020).

More recent applications of digital health encompass new sources and types of 'big' data and technologies

Just as the rise of mobile technologies introduces a new dimension to eHealth, so different potential sources and types of data have opened up yet another dimension, taking advantage of new sources of data such as genomics. As both health systems and wider society have become increasingly digitized, this has also created huge increases in the volume, velocity and variety of data; this is referred to as 'big data' (Renner, Bobek & Ostermann, 2016). New data-driven tools to analyse this data have emerged such as machine learning, as well as computerized tools such as robot-assisted surgery, including, in some instances, a degree of automation.

The term 'digital health' has become a way of referring to the concepts of eHealth and mHealth also incorporating developments in big data and technology. Many of these newer applications remain primarily conceptual, with limited practical application so far. These technologies nevertheless have the potential to generate entirely new tools and opportunities for improving health. For example, a recent review of the use of machine learning in real-life health care found only a limited number of interventions, but initial evidence of benefits in most of these cases (Triantafyllidis & Tsanas, 2019). The review determined that the most promising interventions in terms of positive clinical benefits were machine learning applications to deliver personalized, motivational messages for health behaviour change.

For the purposes of this brief, we will use digital health as our overall term for information and communication technologies and data for health, and refer to eHealth and mHealth where they are specifically relevant to the discussion.

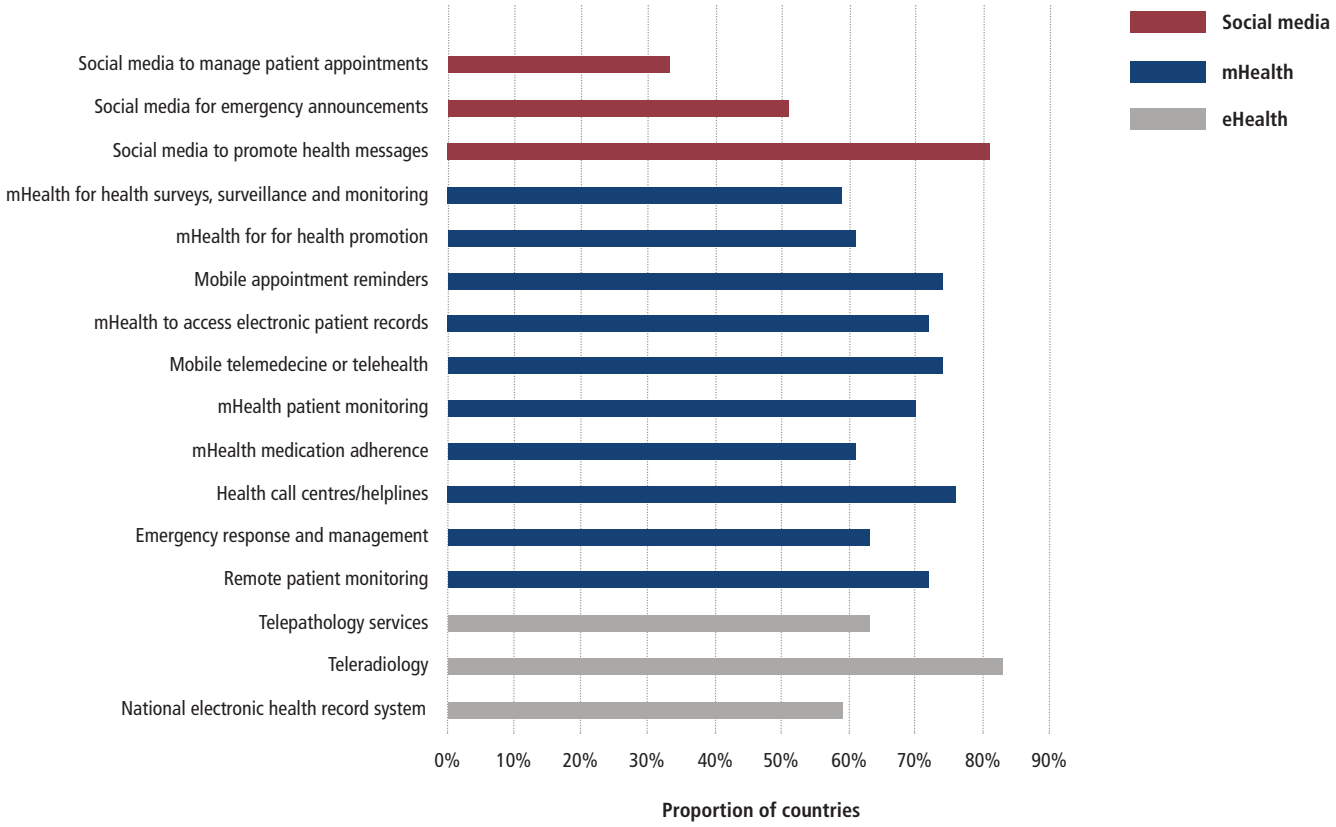
What was the status of digital health regulation and implementation in Europe before COVID-19?

Gaps in policies and regulation for digital health existed in many countries before the pandemic

Before the COVID-19 pandemic there was a wide discrepancy across Europe in terms of policy and strategy development according to digital health area and by country. According to the 2015 World Health Organization (WHO) global survey on eHealth, 70% of reporting countries in the WHO Europe region had an eHealth policy or strategy in place, but only 27% had one for telehealth (WHO/Euro, 2016). Nordic countries were reported to be further ahead in developing digital health policies and strategies than elsewhere (WHO/Euro, 2016).

Many gaps also remain in regulatory frameworks for digital health. Only 43% of reporting countries had policies or legislation defining medical jurisdiction, liability or reimbursement of eHealth services, 53% had no legislation allowing individuals to access their electronic health records, and just 13% had policies on regulating the use of big data in the health sector (WHO/Euro, 2016). In addition, only 11 reporting countries had a national authority to regulate mobile devices and software for mHealth for quality, safety and reliability. Moreover, while 69% of countries in the WHO European region overall had legislation governing the use of electronic health records, this varied from close to 90% in European Union (EU) Member States to less than 30% in the Commonwealth of Independent States and countries of the Central Asian Republics Health Information Network (WHO/Euro, 2016). In another cross-country comparison of health care digitalization strategies in 14 EU countries plus Australia, Canada and Israel, Estonia was ranked first in terms of politics and policies for digital health, including having appropriate financial, legal and regulatory, and institutional frameworks in place (Thiel et al., 2018). Canada, Netherlands, Denmark and Sweden were also ranked as top performers, with Poland, Germany and France deemed to have a less enabling policy environment.

Figure 2: The level of uptake of digital health prior to the pandemic varied by type of application



Notes: % of reporting countries in WHO Europe utilizing digital health applications, 2015.
Source: Authors' compilation based on WHO/EURO, 2016.

The extent of digital health use before the pandemic varied between countries, with much unrealized potential across Europe

The level of uptake of digital health in practice before COVID-19 also varied by type of application and by country. While 83% of responding WHO Europe Member States reported using teleradiology and 81% the use of social media for health promotion campaigns, only 59% had a national electronic health record system in place (Figure 2). A government-sponsored mHealth programme was present in 22 Member States.

The above figures may not necessarily capture the true extent of digital health uptake; while a country may utilize a specific application, it may only be available for use in certain health care sectors (e.g. electronic health records for inpatient care), regions or providers. In a cross-country comparison that aimed to take some of these issues into account, Thiel and colleagues ranked Estonia as the top performer of 17 Organisation for Economic Co-operation and Development (OECD) countries in terms of use of digital health in practice, followed by Denmark, Israel, Canada and Spain; Belgium, France, Germany and Poland were ranked as some of the less well-advanced countries on this indicator.

What have been the key challenges to implementing digital health?

A great deal of work has been done over many years to facilitate and promote the use of digital health tools. However, implementation and uptake of these tools in many countries in the region has generally been slow and much unrealized potential remains.

In this section we review challenges to implementing digital health at the individual, organizational and system levels, as well as potential difficulties posed by digital inequalities.

Challenges to implementing digital health technologies exist at the individual, organizational and system levels and are not primarily technical

This implementation challenge is not primarily about the technology itself, but predominantly about the wider individual, organizational and system changes involved (Greenhalgh et al., 2010). Although eHealth systems do involve technical challenges in developing the necessary technologies, it has also become clear that the challenges of adopting these systems in practice have not been purely technical – or even, in many cases, mostly technical. Adopting e-health technologies is not merely a question of slotting in a different technological solution within existing

processes. Introducing new technologies also involves making changes to wider processes of health and care, and the costs and benefits of such change processes are distributed differently. For example, shifting to electronic record keeping requires additional effort for data entry from clinical staff, in particular nurses, resulting in benefits that are principally felt by others within the system, such as managers, administrators and payers.

While the technological dimension of digital health is of course vital, and constantly evolving, putting this into practice is a challenge that requires the involvement and support of all relevant stakeholders, just as would any other major system change. Barriers to adopting digital health exist at the levels of the system, the organizations involved, and the professionals and patients themselves – and action is required at all these levels to help support the implementation of digital health (Lennon et al., 2017). In other words, the focus has been increasingly shifting from a focus on the technologies involved to the health system changes that can be achieved and how this process of change can be managed. A central challenge has been generating the broad motivation to take this on and to invest time and energy in meeting the wider challenges of making best use of digital health tools.

This is not to underestimate the technical challenges involved though. Digital health systems have evolved dramatically in their potential and usability, including as a result of extensive investment through programmes at the national and international levels, such as the EU's eHealth programmes. However, it is vital to be aware of the wider challenges in making effective use of eHealth at the individual, organizational and system levels.

Only some of the factors influencing implementation of digital health can be changed directly by policy

The implementation of digital health tools can be seen as a particular case of the wider challenge of implementation of change within health and care, which is the focus of the academic field of implementation science. Within implementation science, a widely used framework for understanding the challenges of implementation is the Consolidated Framework for Implementation Research (CFIR) developed by Damschroder and colleagues (Damschroder et al., 2009). Ross and colleagues have taken this framework as a structure for reviewing factors that influence the implementation of eHealth, as set out in Table 1 below (Ross et al., 2016).

Table 1: Key factors for the implementation of eHealth tools

AREA OF THE CONSOLIDATED FRAMEWORK	FACTORS INFLUENCING IMPLEMENTATION OF EHEALTH
Characteristics of the eHealth tool	• Adaptability of the technology to fit the local context • Interoperability of systems • Simplicity and ease of use • Cost (both initial and ongoing)
Individuals involved	• Attitudes and beliefs towards eHealth • Professional concerns about loss of autonomy, liability, patient privacy, and worse relationships between patients and professionals • Computer skills
Inner setting (where it is being implemented)	• Compatibility and good fit of eHealth tool with workflows and other systems • Risks from disruption of existing roles and responsibilities • Leadership and engagement • Available resources (including information, training and support)
Outer setting (the wider system)	• Supportive and clear legal framework • Standards addressing areas of concern, such as data protection and liability • Incentives for adoption or for outcomes enabled by the technology • Availability of relevant infrastructure
Process of implementation	• Clear planning, responsibilities and ongoing support • Engagement and leadership • Reflection and evaluation

Source: Adapted from Ross et al. (2016).

As this illustrates, many of the factors influencing implementation are specific to the particular technology, application and setting where it is being applied, and the process through which it is being used. Only some of these can be changed directly by policy, principally those shaping the 'outer setting' of the health system overall. The 'inner setting' is typically determined by the specific organization involved, such as a hospital or primary care practice. The characteristics of the technological tools involved might be similar across all settings, but how well they fit with local needs will depend on each local situation; having technology that can be changed and adapted to different situations helps with its implementation in practice. Professional concerns can be addressed somewhat at the policy level, such as through national guidance and evidence, but each different group of individuals will have their own attitudes and beliefs that require engagement. Patients themselves will vary in their openness to using digital health tools. Similarly, the process of implementation is a change process that depends on effective leadership and engagement, and is different in each local case.

This illustrates the complex policy challenge of adopting digital health tools. Many of the challenges involved cannot be resolved by the system at policy level, but depend on the engagement and action of individuals and organizations at the local level. Action at policy level, such as providing a supportive environment and resources to enable these factors to be addressed as part of local implementation, is still vital, but this is only part of the story. Success also depends on more local and context-specific factors. Providing adaptable support mechanisms can help with resolving each of the different factors involved in each case, but this requires considerable investment to make an appreciable difference.

Digital health disparities in terms of resources or skills may widen existing health inequalities

Before turning to the policy mechanisms used to address these challenges, it is useful to highlight the underlying issue of how digital health tools relate to health inequalities.

Although digital health tools may help to address some kinds of inequality (such as enabling access for those who have difficulty in accessing local services), they can also create or exacerbate other inequalities (such as disparities in resources or skills to make use of new technologies). The challenges, costs and benefits of digital health are not distributed equally across the health system, with specific challenges in ensuring accessibility for vulnerable groups. Vulnerable groups, including low-income people, some older adults, and people facing language and cultural barriers, may face greater challenges in utilizing digital tools (Torous et al., 2020). Some patients, especially those with a physical or mental impairment, may also need help from another person to perform parts of the medical examination (Szmuda et al., 2020). This may create privacy issues that need to be addressed, for instance within the context of the EU's General Data Protection Regulation (GDPR).

Existing inequalities thus affect the accessibility of digital health services and the capacity of people to use them. This in turn risks becoming a reinforcing process; if those with more resources are better able to access services through digital health, then their greater access may serve to widen existing inequalities. There is evidence of this pattern of innovative digital tools widening inequalities, although there is also evidence that such tools can help to reduce inequalities in the longer term as their benefits become more widely realized.

Ensuring equity of access to digital health tools for these groups is therefore critical to promoting uptake and use (Ben-Pazi, Beni-Adani & Lamdan, 2020; Xie et al., 2020). This is particularly important in the light of the COVID pandemic, with the risk of the large-scale increase in use of digital health tools exacerbating existing inequalities (Beaunoyer et al., 2020). Building on a framework first developed by Penchansky and Thomas (1981), Sieck et al. (2021) propose that more equitable access to telehealth, and by extension other digital health tools, can only be achieved by addressing the Five As of access to health care: availability, accessibility, accommodation, affordability and accessibility (see Table 2). Using this framework, access to

Table 2: The five As of access to ensure equity in use of digital health

DIMENSION	DEFINITION
Availability	The relationship between existing telehealth services provided by a system and resources to the patient's need and ability.
Accessibility	The relationship between the digital skills and literacy of a patient population and the support available to use them.
Accommodation	The relationship between requirements of digital platforms and the patient's ability to navigate them.
Affordability	The relationship between the costs of internet services and devices and the patient's ability to pay for them.
Acceptability	The relationship between the health care organization's telehealth tools and workflows and the patient's attitude towards and comfort with tools and workflows.

Source: Sieck et al., 2021.

digital health can be viewed through a health equity lens to ensure that vulnerable groups and patients are not excluded from the benefits afforded by digital health. Actions to improve uptake across the five dimensions can include:

- improving access to the internet and online services (e.g. physical access, cost and reliability of internet services)
- support for improving digital literacy, including household, family and community support
- multiple channels of access (e.g. telephone, mobile applications, websites, dedicated devices, local access points)
- diversity and appropriateness of information and communication (e.g. multimodal information channels, adaptation of language and content for different population groups).

Community organizations and community health workers may play a key role in providing training for older adults and other marginalized groups. Support from health workers, as well as training to improve digital health literacy, may also be needed to facilitate access to digital health solutions (Xie et al., 2020). Any single digital health tool is unlikely to be a one-size-fits-all solution, and successful use of digital health tools in practice requires attention to the needs of different groups, recognition that other tools may be more appropriate for some people or, in some cases, an acknowledgement of wider inequalities (such as in health, wider social determinants, or in relation to facilities such as access to broadband and relevant equipment). Digital health tools can help to deliver more personalized care, but only if they take into account the preferences, skills and capabilities of each patient, and are complemented by other options where these are more appropriate.

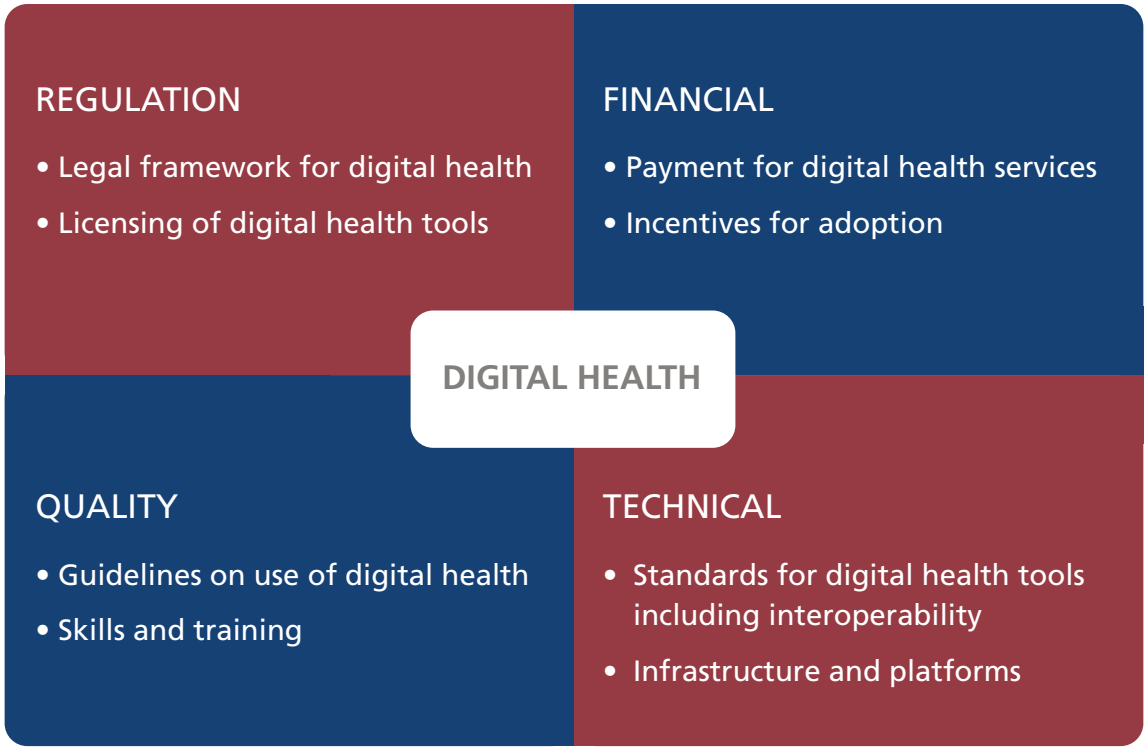
How do policy mechanisms support implementation of digital health?

Policy mechanisms to support implementation of digital health can be arranged around the four dimensions of regulation, financial, quality and technical mechanisms. We depict them in Figure 3, with examples of policy mechanisms in each of these dimensions.

Regulation

While in many ways digital health service provision has amounted to providing existing services through different means, digital health has nonetheless raised many distinctive regulatory challenges. For example, the greater potential for collecting and sharing information has raised privacy and data protection concerns; the introduction of remote care brings its own professional challenges around ensuring clinical quality and involves other actors such as those providing the technical services involved, raising new questions of liability. As the sector has evolved, there has been a trend from addressing these issues individually or in relation to particular applications towards more integrated legal and regulatory strategies.

Figure 3: Policy mechanisms supporting digital health



Source: Authors.

Regulatory frameworks need to adapt as technologies evolve

The progressive evolution of the sector from eHealth through mHealth and now to digital health has also involved constant regulatory challenges. For example, at the most basic level, software typically changes much more rapidly than hardware, including the underlying operating systems on which the software is running, the range of hardware platforms, and the need to keep up to date with features and to respond to user needs. One option is to take an approach which freezes software at a particular state in time, but this is likely to mean the software in question rapidly becoming out of date in comparison to others, which may result in users switching away from it. Another option is to adapt licensing processes to allow for this kind of regular updating, perhaps by focusing more on the processes being used by the developer to ensure that it continues to meet relevant standards of safety and efficacy. At a more challenging level, some software is based on machine learning and its value comes from being able to constantly learn and adapt; this again presents particular challenges for how to regulate and license rapidly evolving software devices. Thus, regulatory frameworks for digital health are obliged constantly to adapt as the technology itself develops.

Regulations for digital health have been developed to address privacy and data protection, cybersecurity, confidentiality and liability

Action at the European level has complemented national action. Legal frameworks have been emerging, addressing issues such as privacy and data protection, cybersecurity, confidentiality, liability of the different actors involved, and regulation of professional conduct in relation to digital health tools. Particularly relevant provisions of EU law include the regulation of personal data (Williams & Fahy, 2019) and the e-commerce directive[1], which establishes the principle that the country where an electronic service (for example, teleradiology) is based, is responsible for its oversight, including when it is provided across borders.

The World Health Organization has also highlighted the potential of eHealth to help achieve better health, adopting Resolution WHA58.28 on eHealth in 2005, which urged countries to draw up plans to develop and implement eHealth within their health systems. WHO has also explored the potential of standardization, mHealth and digital health more broadly, and developed a wide range of partnerships and collaborating centres[2].

Financial

A central aspect of implementing any change in health service organization and provision is financing. This includes the funding of initial research and development, as well as adaptation of funding mechanisms for the care provided in practice.

There has been less investment in organizational and system changes compared to technological development of digital health tools

There is extensive funding for technological development of digital health tools from both the public sector (Member States and the EU have provided substantial support, as well as elsewhere around the world) and the private sector. However, there has not been as much funding support for the organizational and system changes involved in introducing digital health tools. These dimensions are vital and, while they should be incorporated as part of the process of development of digital health tools, this has often been a weak point in the development of many potential technological solutions. Moreover, because these organizational and system dimensions for digital health tools depend on the specific settings in which they will be used, the process of engaging with those contexts and adapting the tools to fully realize their potential value necessitates their being adapted for each different situation, a process which in itself also requires financial support (van Limburg et al., 2011).

Determining reimbursement rates for digital consultations is complicated but vital for promoting uptake from health professionals

The ability of digital health tools to provide health care in different ways and at distance also raises questions about how such services should be reimbursed. There is as yet no consensus about how to value such services – should a consultation with a doctor provided remotely be reimbursed at the same rate as an in-person consultation, for example? On the one hand, there may be limits to the scope of the consultation provided, which should suggest a reduced rate; on the other hand, the patient or the doctor, or both, may value the accessibility of the remote consultation more highly and it may save ancillary costs for the system as a whole, which might suggest a similar or higher rate.

The way in which they are reimbursed is likely to affect how much these services are provided in practice. The ability to provide services remotely may also bring into question volume or geographical limits on supply intended to limit costs or avoid cherry-picking; but, again, they may also enable access that is not otherwise available and provide a valuable signal of inadequacy of local services. The lack of consensus about how to evaluate the costs and benefits of digital health tools (Bergmo, 2015) and the variety of approaches taken by different European health systems as regards their financing suggest the need for further research into these issues.

Quality

The quality dimension includes provision of information, guidelines and standards, as well as efforts to improve the skills and knowledge of those involved in using digital health tools. A common theme emerging from the literature to support quality improvement is the need to ensure sufficient training for health workers and peer supporters in using technology and effectively communicating over video in order to enhance uptake and use (Ben-Pazi, Beni-Adani &

[1] Directive 2000/31/EC, OJ L 178, 17.7.2000, pp. 1–16 (https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:178:0001:0016:EN:PDF).
[2] See: https://www.who.int/health-topics/digital-health#tab=tab_1.

Lamdan, 2020; Torous et al., 2020). However, although there is a wide variety of guidelines and materials promoting the use of digital health tools to provide better health care, there is surprisingly little clear evidence of contributions from digital health tools to improving quality and safety, and similarly a lack of clear best-practice guidelines in how to optimize use of these technologies in practice. This suggests that the lack of evidence on the quality and added value of digital health tools may be hindering the effectiveness of policy mechanisms to promote the use of these tools in practice (see Box 1).

Box 1: Evidence on quality benefits of eHealth tools is scarce and paints a mixed picture

A systematic overview of the impact of eHealth on the quality and safety of health care found relatively little evidence of improvements in quality and safety from eHealth, nor indeed of cost–benefit improvements. Where there were positive examples, these were relatively isolated, with a lack of evidence regarding large-scale implementation (Black et al., 2011).

Similarly, a systematic review on the effectiveness of smartphone health applications (apps) (Scott et al., 2020) found a mixed picture. There was evidence of consistent clinical benefits for the self-management of glycosylated haemoglobin levels (HbA1c) for diabetes patients, some marginal clinical evidence of benefits for asthma, low back pain, alcohol addiction, heart failure, ischaemic heart disease and cancer, but no benefit for chronic obstructive pulmonary disease (COPD), cognitive impairment or chronic kidney disease. The review also reported that designs which increase the desire of patients to use the app (e.g. easy navigation, reminders, gamification, real-time feedback, easy data entry etc.) were most important for enhancing effectiveness.

Technical

The principal technical mechanism for facilitating digital health is interoperability. This sounds simple in theory – ensuring the ability of different digital health solutions to connect to each other and exchange data – but is actually difficult to achieve in practice.

For digital health to be effective, multiple levels of interoperability are required, from the purely technical through to ensuring shared understandings, right up to the organizational and system levels, as set out in Table 3.

Ensuring different technologies and processes can work together across systems is central to the stewardship and effectiveness of digital health

While individual developers or organizations are able to ensure the operability of their own specific technologies and processes, enabling them to work together is a challenge for the system as a whole. This is a key dimension of stewardship of the digital health system and one that depends on the active involvement of stakeholders from across the health system and beyond, which can be a challenge in itself. As with the other policy challenges, ensuring interoperability in digital health is not a one-time achievement, but is a constantly moving target as technologies evolve.

The EU has been working to address interoperability of eHealth and now digital health

The larger the scale, the greater the challenge of interoperability, and the European Union is engaged in one of the largest-scale efforts to address interoperability in the world. The EU's work to support the development and application of eHealth goes back to 1988 (Olsson, Lymberis & Whitehouse, 2004). This was initially focused on research and technological development of eHealth solutions, as well as collaboration between different actors at the European level. As strategic issues emerged, this approach has become increasingly focused on ensuring interoperability at the inter-system level. This ranges from principles for exchanging information, such as through a European electronic health record exchange format, to the technical infrastructure for connecting systems through the Connecting Europe Facility (Innovation and Networks Executive Agency, 2019).

More recently, and reflecting the wider evolution in the field discussed above, the European Commission has shifted its focus to digital health, centred around ensuring access of citizens to their health data and enabling it to be shared

Table 3: Levels of eHealth interoperability

INTEROPERABILITY LEVELS	ISSUES
Legal and regulatory	The relationship between existing telehealth services provided by a system and resources to the patient's need and ability.
Policy and organization	The relationship between the digital skills and literacy of a patient population and the support available to use them.
Care processes	The relationship between requirements of digital platforms and the patient's ability to navigate them.
Information	The relationship between the costs of internet services and devices and the patient's ability to pay for them.
Applications	The relationship between the health care organization's telehealth tools and workflows and the patient's attitude towards and comfort with tools and workflows.
Infrastructure	The underpinning communication and network infrastructure and how they are connected.

Source: Adapted from eHealth network (2015).

effectively where appropriate; making better use of data for health research and provision, in particular through personalized medicine; and using digital health tools to support citizen empowerment and person-centred care (European Commission, 2018). The next phase of these ambitions involves a proposed European health data space by the end of 2021, which aims to: enable the safe and effective sharing of health data for patient care; support research and regulation; enable digital health services; and clarify the safety and liability of artificial intelligence (AI) in health. While this has the potential to open up a new era of collaboration and learning between EU health systems, given the difficulties in achieving this kind of data-sharing within many national systems, the challenges involved in realizing this European vision should not be underestimated.

How has digital health been used during the COVID-19 pandemic?

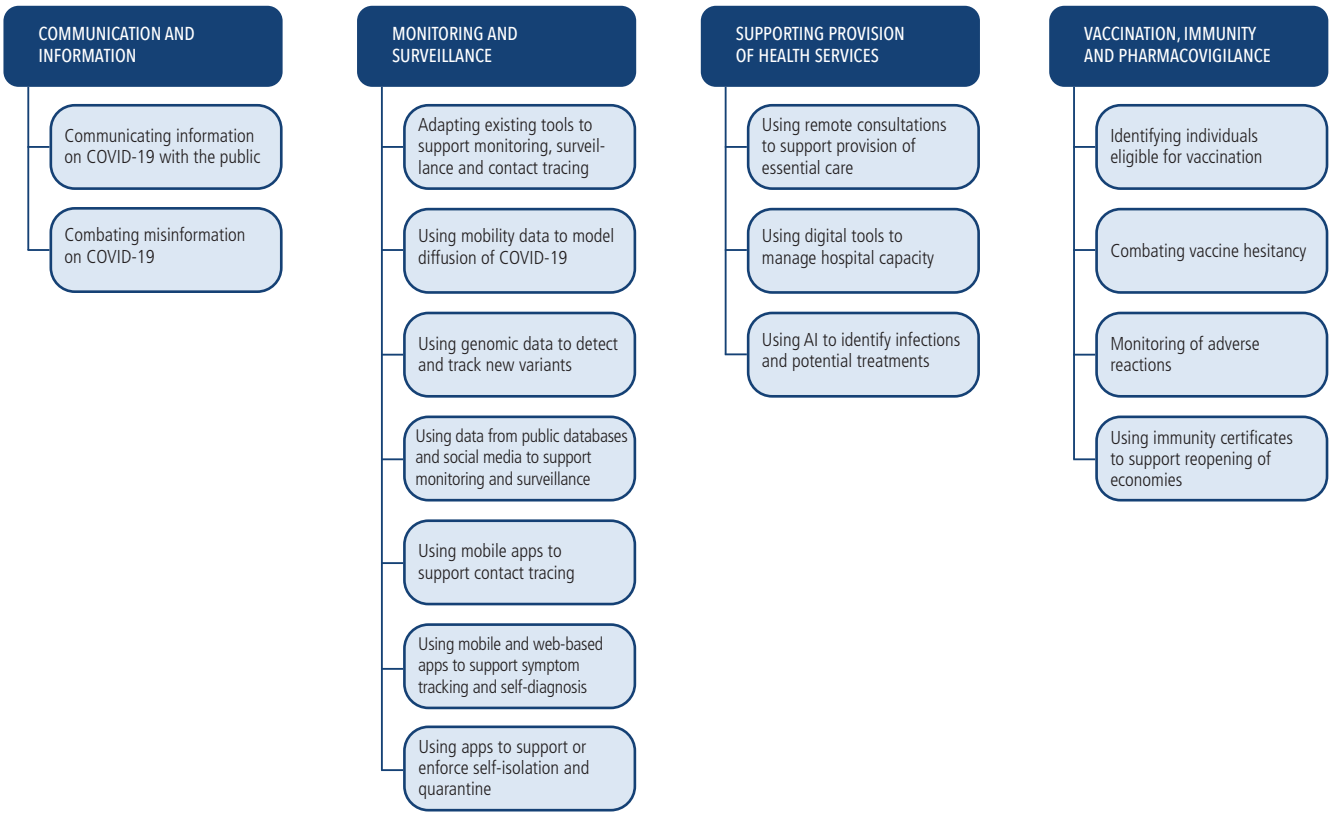
Digital health has seen very rapid development and uptake during the pandemic

The uptake of digital health in Europe before the COVID-19 pandemic was patchy. Nevertheless, the work done in previous years laid the ground for many different existing technologies to be applied to meet COVID-related challenges, as well as for adaptations at all levels within health systems aiming to support digital health (albeit to varying degrees). The pandemic also abruptly changed the relative importance of making use of digital health; in many instances, using digital health tools went from being viewed as an interesting potential opportunity to an immediate necessity. Thus, the pandemic has seen very rapid development and uptake of digital health tools in practice.

As noted, various countries were positioned quite differently at the start of the pandemic. Countries such as Estonia, Sweden and Finland were relatively well set, with digital health already integrated into their health systems. Other countries were developed in some ways but not in others, such as maybe having a quite well-developed technical infrastructure but relatively restrictive regulations, while others had not yet integrated digital health tools into their wider health systems at all. This has meant that, while there were shared ambitions for the use of digital health, countries were starting from quite different points along that process when the pandemic struck.

Overall, there are four principal areas where digital health tools are being used in response to COVID-19: first, communication and information; second, monitoring and surveillance; third, supporting provision of health services; and fourth, vaccination, immunity and pharmacovigilance (Figure 4).

Figure 4: Digital health tools have been used to support four main areas during the COVID-19 pandemic



Source: Authors' compilation based on data supplied to Health System Reponse Monitor.[3]

[3] The Health System Response Monitor can be found here: https://eurohealthobservatory.who.int/monitors/hsrm.

Communication and information

Digital health tools have been used to communicate information on COVID-19 with the public

Many countries have used digital tools to collect and share information about COVID-19, either through existing tools or those developed specifically for COVID-19. This has included straightforward web pages and dashboards displaying key data, such as numbers of cases, deaths and vaccination rates. Apps have been developed to communicate with the public, providing information about the virus and supporting the recognition of symptoms, their reporting and testing, and to connect with health services, such as in Croatia, Estonia, Finland, the UK, Italy and Canada. Some countries have also started to provide information specifically aimed at tourists. For example, in Spain, the Ministry of Health has set up a web portal and a mobile app (in multiple languages) targeting tourists travelling to Spain, named 'Spain Travel Health' (SpTH: https://www.spth.gob.es). This app provides information on the entry conditions, up-to-date information on the epidemic situation in Spain, and shows public health recommendations to follow upon arrival. An app for tourists and others entering the country, called FINENTRY, has also been launched in Finland, with the aim of smoothing travel when border restrictions are loosened; it can store a COVID test that has been done in the country of origin and book a COVID test in Finland if a test is required.

In some countries, more active tools, such as tracking mobile phone movements have been used to monitor the effectiveness of social distancing measures, identify people at risk, or enable reporting of symptoms (such as in Austria, Bulgaria, Israel, Italy and the UK). This links to current initiatives to develop apps to support contact tracing, which are discussed further below.

Digital health tools have proved pivotal in combatting misinformation on COVID-19

One issue during the pandemic has been responding to what WHO has called an 'infodemic' of misinformation concerning COVID-19. The flood of information about the pandemic, far from all of which has been accurate or well-informed, has presented a challenge to the health literacy of individuals as well as to the systems and platforms providing information. WHO has established a chatbot on Facebook to help address misinformation. In contrast to their approach on other health issues, social media platforms have also begun actively to address misinformation relating to the pandemic, although this remains an ongoing concern. A number of initiatives to combat misinformation have also been launched at the national and EU levels (see Box 2). Combatting misinformation and keeping solutions up to date remains a critical issue as information continues to evolve, new evidence and restrictions emerge and addressing vaccine hesitancy becomes a key challenge.

Box 2: A variety of national and EU-level initiatives have been launched to combat misinformation

National initiatives

At the national level, countries have developed a variety of strategies to combat misinformation. In Spain, all governmental social media accounts have been used to counteract inaccurate, misdirected or malicious information and to monitor their trends in collaboration with the main social media platforms (i.e. Twitter, Facebook, YouTube, Instagram, etc.). This effort has included setting up dedicated information channels in Telegram (https://t.me/sanidadgob) and WhatsApp, aimed at delivering public health recommendations directly to the citizens. In Finland, a similar approach has been taken with a wide range of websites and social media used as platforms to communicate with the public and disseminate information, along with the use of chatbots to answer queries. Health authorities have held webinars on modelling the epidemic, on vaccinations, and on other issues that have been widely discussed in the media, and have also been active in press conferences available via YouTube or broadcast by Yle (national public radio). During the emergency phase of the first wave, Estonia launched an interactive automated chatbot ('Suve') to fight misinformation and ensure that anyone living in or visiting the country could get questions answered from official sources. The chatbot was available in Estonian, Russian and English on the websites of the Ministry of Social Affairs, the Health Board and the special COVID-19 emergency website: kriis.ee.

Initiatives at the EU level

At the EU level, the EU had already put in place a Code of Practice on Disinformation in 2018 before the pandemic, to which online platforms Facebook, Google, Twitter, Microsoft and TikTok are signatories. In response to the pandemic, a specific monitoring programme was established to gather information on the actions of these signatories in relation to the pandemic (European Commission & High Representative of the Union for Foreign Affairs and Security Policy, 2020), the results of which suggest that online platforms have been taking greater measures to address disinformation during the pandemic than has ever previously been the case. It remains to be seen whether this will be a one-off response for the pandemic or part of a broader change in the role of online platforms regarding disinformation.

Monitoring and surveillance

Existing monitoring and surveillance tools have been adapted and used in response to COVID-19 in most countries

Most countries in Europe were already using some digital health tools to support infectious disease monitoring and surveillance prior to the pandemic. These systems have been adapted and enhanced in response to COVID-19. For example, in Estonia, information flow to the Health Board, the body responsible for monitoring and surveillance of infectious diseases, was deemed too slow at the beginning of the pandemic, resulting in the automation of reporting of COVID-19 related information to the Health Information System. In many countries, a number of global digital health tools developed prior to the pandemic have been used to support surveillance, monitoring and contact tracing (see Box 3).

Box 3: Digital health tools developed to respond to previous outbreaks have been adapted for COVID-19

Many countries are making use of surveillance, monitoring and contact-tracing tools developed for previous challenges. In Norway and more than 40 countries globally, District Health Information Software 2 (DHIS2) software had been in use for disease surveillance before the pandemic and was adapted to support case detection, situation reporting and active surveillance for COVID-19. The software was designed by a global collaboration between WHO and a wide range of partners led by the University of Oslo. In Switzerland and several public health offices in Germany, the Surveillance, Outbreak Response Management and Analysis System (SORMAS), a mobile eHealth app, is being used for surveillance, monitoring and contract tracing. This system was originally developed in 2014 in response to the Ebola outbreak in West Africa. A number of countries (e.g. Malta) have also made use of Go.Data, a data outbreak investigation tool for data collection and visualization developed by the WHO and partners. Go.Data was also developed to help respond to Ebola outbreaks, and facilitates rapid data collection through mobile applications, and to help responders make best use of data and information collected during the emergency. Go.data is designed particularly to support case investigation and contact follow-up, and to help visualize chains of transmission.

Mobility data has been used to help model the diffusion of COVID-19

Data from transport and mapping information has been widely used to track movement patterns and to help monitor the spread of the virus. The EU has promoted taking a common approach for using mass mobility data to help model the diffusion of COVID-19 and the effectiveness of response measures, and developed a set of principles for doing so (eHealth Network, 2020). This addresses the overall principles for making use of such data (such as using aggregated, anonymized data and safeguards that protect personal information) as well as technical standards and platforms for data exchange. This data combined with data about the virus have enabled detailed study of the close links between the movement of people within and between countries, the spread of COVID-19, and the effectiveness of mobility restrictions on reducing spread (Iacus et al., 2020).

New ways of using digital health tools to support monitoring and surveillance have emerged

Genomic surveillance has also emerged as a vital part of surveillance during the pandemic. This has enabled new genetic variants of SARS-CoV-2 and their severity and transmissibility, as well as susceptibility to vaccines, to be detected and tracked (Cyranoski, 2021). Systematic genomic surveillance remains limited, however, and is undertaken by only a few countries (such as Australia, Denmark and the UK).

Research suggests there may be other novel methods for digital health tools to support monitoring and surveillance. In a 'digital epidemiology' study, Higgins and colleagues (2020) demonstrated that internet search trends of COVID-19 symptom key words (e.g. shortness of breath, anosmia, headache, etc.), were correlated with new daily confirmed cases and deaths from COVID-19 in case study countries and US states. Another study analysed changes in language on Twitter for mental health and COVID-19 symptoms. The authors found that language used in tweets could provide insights into worsening mental health in local communities and also identified mentions of several COVID-19 symptoms before they were updated in official Centers for Disease Control and Prevention (CDC) guidance (Guntuku et al., 2020). This suggests that analysing data from public databases or social media may assist in the surveillance of infectious disease outbreaks and early identification of symptoms.

Mobile apps to support contact tracing have been developed in a number of countries, but their effectiveness is unknown

Some models suggest that the speed of contact tracing is particularly important with COVID-19, and that using digital contact-tracing tools might help speed up and involve citizens in the process (Hernandez-Quevedo et al., 2020). In a few countries (e.g. England and Estonia), contact tracing had initially been undertaken using Excel files, creating issues over the number of contacts and the speed at which they could be contacted. An example can be seen in England, where an estimated 16,000 cases went unreported in September 2020 due to limitations in the amount of data that could be handled in an old version of the software. While Estonia also used Excel for contact tracing early in the pandemic, this system was replaced by a new database called 'ODOO', which contains information on positive cases and their contacts.

Many countries have developed and launched contact-tracing apps (e.g. Austria, Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Georgia, Germany, Iceland, Ireland, Italy, Malta, Russian Federation, Spain, Ukraine and the UK) (Hernandez-Quevedo et al., 2020). These are usually mobile phone apps that work on Bluetooth technology, but in some cases they use geolocation services (e.g. monitoring bracelets in Russian Federation).

One of the first apps to be developed was the Austrian Red Cross app 'Stopp Corona'. One specificity of this Austrian example of a Corona-tracing app is that it was not commissioned or developed by a public authority; it was developed independently and then presented to the public authorities for possible endorsement. The app is voluntary but its use is recommended. By the end of July 2020, the app had been installed by around 870,000 users (roughly 10% of the Austrian population). It is therefore considerably less widespread than the German Corona app, which had been downloaded by 17 million users (roughly 20% of the German population) by mid-August 2020.

The question of the role of citizen mobile devices in the management of the pandemic had caught the attention of European public health authorities (as well as the public) as early as March 2020. It soon became clear that the approach within EU Member States would be different from East Asian countries, where official Corona apps were made obligatory and used to control access and movement as well as to enforce quarantine. The consensus in the European discussion was to dismiss location tracking and instead focus on voluntary and anonymized proximity tracing using the

opportunities offered by the Bluetooth functionality of mobile devices. Subsequent discussions on whether contact data should be stored and analysed centrally or decentrally resulted in decentralized approaches becoming the de facto standard – especially since the tools provided by Apple and Google (i.e. their joint application programming interfaces (APIs), which allow applications to 'talk' to each other) only support decentralized approaches in order to protect individual privacy.

As regards the pandemic response, two key questions were whether digital health tools would add value in practice and whether the public would accept them. Not all members of the public have smartphones that can support such apps due to incompatible software (e.g. Portugal, the UK), for example, and not everyone who has one would necessarily be willing to participate in such an initiative. Some research suggests that an app can be effective, but on the basis that 80% of people with smartphones use that app, or 56% of the population overall (University of Oxford, 2020). However, despite initial surveys suggesting that around three-quarters of the population in countries such as the UK, France, Italy and Germany were willing to do so, in practice the rates of uptake of contact-tracing apps so far have been much lower than this (Milsom et al., 2020). Moreover, there are concerns that the contact tracing that is provided by these apps is unreliable (Leith & Farrell, 2020). As such, apps are not a panacea for contact tracing and should be utilized in combination with manual test, trace and isolation activities conducted by local public health teams (Rajan, Cylus & McKee, 2020).

Mobile and web-based applications have been launched to support symptom tracking and self-diagnosis

Many countries have launched mobile or web-based applications for people and health professionals to remotely track symptoms, with some apps having the functionality to give advice on whether the person needs to see a health professional (see Box 4). In some countries, these apps have also been used to track the spread of infection.

Box 4: Initiatives have been launched to remotely track symptoms

The Federal Ministry of Health in Germany financed the creation of a COVID-19 quarantine app 'Symptom Diary' to support the local public health office with quarantine measures. The diary is based on a secure and user-friendly internet platform for clinical data collection and digital patient diaries, where all important data can be viewed in one place and transmitted to the relevant authorities. Doctors can follow the course of the disease in real time, and the offices and institutions involved save considerable capacity thanks to automation.

In Spain, patients in a number of regions were able to use a symptom-checker app (mobile or web application); this information was then monitored by the regional health authorities to deliver at-home care or recommend transfer to a hospital, if further care was needed. In the UK, a COVID Symptom Study app was launched in March through a collaboration with a health science company and King's College London (Drew et al., 2020). The app combines self-reported data on symptoms with software algorithms that allow analysts to predict who has the virus and to track infections in the UK and other countries. More than 4 million people have contributed to the study worldwide, with over 300,000 in the UK, making it the largest community-based monitoring of COVID globally. The app is also being used to track long-COVID symptoms (Rajan et al., 2021).

In Finland, a national medical device 'Omaolo' has been developed (and CE-marked) for COVID-19 symptom self-assessment. A person using the symptom checker receives an assessment of whether they might have a coronavirus infection and whether they should be tested. It also gives advice on whether the person needs to see a doctor or a nurse, plus information on how to stop the virus from spreading. The app has helped prevent people visiting health centres when symptomatic and has also been used to track developments around the country.

Digital technologies have also been used to support or enforce self-isolation and quarantine

Countries are also using digital technologies to support or enforce self-isolation and quarantine. In Romania, the 'Coronaforms' application was launched, which collects data on tested individuals and allows district public health authorities to send isolation orders to patients who test positive and also to their family physicians. Other applications in Europe and Asia have been created to enforce self-isolation; however, on a policy level, these approaches raise substantial concerns about privacy, the role of the state and the acceptability of different forms and degrees of monitoring. In the Ukraine for example, selfies are being used to enforce self-isolation (see Box 5).

Box 5: Using 'selfies' to enforce self-isolation in Ukraine

During the COVID-19 crisis, certain travellers arriving in Ukraine from abroad have been subjected to mandatory self-isolation (quarantine) for two weeks. The Ministry for Digital Transformation of Ukraine developed an app ('Diy Vdoma' – 'Act at Home') early in the pandemic in order to give people the option of isolating at home rather than undergoing a 14-day observation in a government-selected quarantine facility. To use the app, travellers must have a Ukrainian SIM card and have downloaded the app before passport control. At the border, guards send a code to the traveller's phone to activate the app and link that individual to the phone number on the SIM card. The user then has 24 hours to reach their end destination and upon arrival there must enter their full name and address to confirm this as their place of self-isolation for the next 14 days.

Every day, at random, users' phones receive around 10 notifications asking for a selfie, over 14 consecutive days; no notifications are sent at night. The selfie image is compared to the photograph taken at the border using facial recognition software, and the location where the selfie was taken is used to ensure that the user is still in quarantine. The app itself does not constantly track the user's location as this would breach privacy laws in Ukraine. The user has a 15-minute window to respond before the app states that they have broken quarantine rules.

The speed with which this app was developed and rolled out meant that problems had to be fixed while people were still in quarantine. Technical issues have included problems with the facial recognition system not matching up to photos, the app resetting the quarantine timer and the system not uploading the photographs.

On a technical level, this app demonstrates the ability to repurpose existing technology to support COVID-related policies. However, on a policy level, this approach to quarantine enforcement raises substantial privacy concerns.

As of mid-August 2021, most arrivals in Ukraine no longer have to rely on the Diy Vdoma app as they are able to avoid quarantine as long as they take a PCR COVID-19 test and it shows negative, but quarantine is still required for arrivals from some countries.

Supporting provision of health services

The use of remote consultations has proved critical to support the continuation of essential health care

Remote consultations between health professionals or between health professionals and patients have long been recognized as a promising tool to improve quality and access to care. Their use in practice in many countries had, however, remained limited due to 'technological challenges, professional scepticism and ethical, financial, administrative and legal barriers' (Richardson et al., 2020). The suspension of non-urgent face-to-face care during the pandemic in most countries has nevertheless seen the use of remote consultations accelerate (see Box 6). While remote consultations have primarily been used in primary care (e.g. Croatia, France, Malta, Poland, Sweden, the UK), they have also been used in secondary care (e.g. Armenia, Estonia), and more widely across different types of care (e.g. Austria, Belgium, Germany, Israel, Italy, Luxembourg, Malta, the UK).

Box 6: The use of remote consultations has increased dramatically in many countries

In Spain, remote medical consultations provided through the app 'MEDIQUO' increased by more than 150% in mid-March 2020 compared to the previous month, with many consultations related to COVID-19 (Richardson et al., 2020). The leading facilitators for this rapid scaling up of the use of remote consultations in the country have been identified as its pre-existing highly developed digital health capacity, the experience of its health professionals in the use of established digital tools (e.g. electronic health records, e-prescription, etc.) and the online interaction of citizens and patients with their health care service.

In England, general practitioner (GP) data show that telephone consultations increased from 856,631 to 2,022,798 per week between 2 March and 18 May 2020, while video consultations through Germany's largest doctor–patient portal ('jameda') increased by more than 1000% from February to March 2020 (Richardson et al., 2020). In France meanwhile, 5.5 million teleconsultations were provided by 36,000 physicians in March and up to 56,000 physicians in April 2020 (Richardson et al., 2020).

In some UK hospitals, virtual trauma clinics have also been established, allowing patients to receive a video or telephone consultation, following which they are triaged to theatre, further clinic or discharged. The service is run by doctors that cannot do face-to-face consultations, together with other professionals such as pharmacists (Westley et al., 2020).

Some specific initiatives to use digital health tools for remote management of COVID-19 patients with mild symptoms or recuperating at home after hospital care have also been used in, for example, France, Iceland, Italy, Luxembourg and the Netherlands. This has ranged from simple self-monitoring of systems to more active remote monitoring (such as through teleconsultations), the use of monitoring devices such as oximeters, or local clinical staff such as nurses actively monitoring patients at home.

This use of digital health tools has not, however, been without its challenges, such as whether a remote consultation is appropriate and sufficient. While remote consultations can help provide accessible, continuous care when this is not otherwise possible, they cannot and should not fully replace in-person consultations for many patients, especially those who have not had prior contact with the health systems (Ben-Pazi, Beni-Adani & Lamdan, 2020). Even in countries where these digital health services were, in principle, already available before the pandemic, the scale and character of use has created new challenges in terms of adaptation of quality or reimbursement rules, issues that are considered further in the following section.

Digital health tools have supported the management of hospital capacity

Digital tools have also been used in some countries to help health facilities manage patient capacity. The German Interdisciplinary Association for Intensive Care and Emergency Medicine, the Robert Koch-Institute and the German Hospital Federation have, for example, established the 'DIVI-Intensivregister', which provides information on free ventilation places, intensive care capacities and the COVID-19 cases treated in participating hospitals throughout Germany. Since early April 2020, hospitals have been required to report their intensive care capacity to the DIVI intensive care register on a daily basis. This enables regional shortages in intensive care to be identified, allowing for actions to be taken in real time, such as redirecting patients to hospitals with spare capacity. In Malta, the main hospital, Mater Dei, created a 'COVID-19 Emergency Operation Centre' to simulate predicted demand and supply, using real-time data on indicators such as current bed occupancy levels in different wards. Other countries have used digital health tools to match demand for health workers with supply, most often through web-based online portals (e.g. Canada, Estonia, Germany, the Netherlands).

Artificial intelligence is being used to provide rapid identification of COVID-19 infections and potential treatments

The European Commission has funded the development of artificial intelligence software to help speed up identification of COVID-19 infections through computerised tomography (CT) scans (European Commission, 2020). This is focused on patients presenting with symptoms such as chest pain, for whom the software can alert the radiologist to the potential presence of COVID-19 infection. Ten European hospitals across nine Member States[4] began piloting this tool in May 2020, with the results intended to inform the use of artificial intelligence tools for health more broadly.

The Commission has also supported the use of pan-European high-performance computing to help identify existing drugs that could be repurposed to help treat COVID-19. The EXSCALATE4COV consortium brings together 18 institutions across seven countries, including supercomputer infrastructure in Italy, Germany and Spain, and has identified a candidate drug, raloxifene, which is being evaluated through a clinical trial[5].

[4] Belgium, Estonia, France, Italy, the Netherlands, Portugal, Romania, Spain, Sweden.

[5] See: https://www.dompe.com/en/media/press-releases/exscalate4cov-italian-medicines-agency-aifa-authorizes-raloxifene-clinical-trial-for-paucisymptomatic-covid-19-patients-treated-at-home-and-in-medical-facilities.

Vaccination, immunity and pharmacovigilance

Digital health applications have been used in a number of countries to support the rapid rollout of mass vaccination programmes and to ensure accurate and rapid information about any adverse reactions to a vaccine. In some countries, digital health tools have also been used to track and certify the vaccination or immunity status of individuals, although the use of immunization certifications generally remains controversial.

Vaccination

Digital health tools have played a key role in the effective rollout of vaccination programmes

The logistics of the COVID-19 vaccination process are formidable and vaccination programmes are occurring at unprecedented scale and speed. Even where systems for large-scale vaccination exist, these have been challenged by the magnitude of the COVID-19 vaccination process. Digital health tools have proved critical in supporting different aspects of the rollout of vaccination programmes. Many countries have, for instance, made use of text messaging or online services to contact individuals eligible to receive a vaccination, or to enable people to book appointments. Other countries have made use of digital technologies to support logistical issues, such as distribution to health facilities and storage. In Israel, for example, Pfizer vaccine packages, which require cold storage, are under electronic surveillance from the time they leave US factories to when they are distributed to health facilities to ensure they are stored in appropriate conditions. Malta also uses continuous temperature mapping and alarm facilities to ensure cold chain storage procedures are followed.

Digital health tools have been used to identify individuals eligible for vaccinations and keep track of those vaccinated

The challenges of COVID-19 vaccination programmes are not simply logistical. The limited initial supply of vaccines or of sufficient health workers to administer immunizations meant countries had to develop prioritization categories for vaccines, requiring identification of particular population categories such as on the basis of age or chronic conditions. The capacity to be able to identify and track particular groups often depends on the capacity and availability of digital health systems that store this information. This is especially so if information has to link with systems outside the health system to obtain criteria for identifying priority groups (e.g. based on occupation) that may not be visible within from health information systems.

The ability to uniquely identify individuals and link them between systems has been a long-standing challenge for digital health systems, and remains a challenge in practice for many countries. Nevertheless, there are many successful examples of centralized or regional registers of patients being used to support vaccine rollout and tracking those who are fully vaccinated, have received one dose, been offered a vaccine but refused, or are not yet eligible to receive one. In the UK and other countries, for example, GP patient registers have been used to identify those eligible for a vaccine. In Romania, a special COVID-19 module has been created in the National Electronic Vaccination Registry to register those that are fully vaccinated or awaiting a second dose.

Alongside the 'infodemic' of misinformation regarding COVID-19, there has been a long-standing challenge of vaccine hesitancy in recent years. While there is overall a lack of clear evidence about how best to address vaccine hesitancy (Dubé, Gagnon & MacDonald, 2015; Jarrett et al., 2015), there is some evidence that drawing on tools from social marketing strategies may be beneficial (Nowak et al., 2015). There has already been increasing use of more sophisticated digital health tools such as chatbots to support information provision during the pandemic (see Box 2). These digital tools may be able to support wider strategies for addressing vaccine hesitancy regarding any vaccine for COVID-19.

The rapid development of COVID-19 vaccines has increased pressure to monitor and provide quick and reliable information on adverse reactions

As with the regulation of other medicinal products, the licensing of COVID-19 vaccines includes requirements to track adverse reactions, either through general adverse reaction reporting systems or through product-specific mechanisms, such as studies of side effects of a product that is already on the market (also called phase 4 trials). Monitoring adverse reactions from COVID-19 vaccines creates considerable technical and policy challenges, with the additional particular challenge of involving manufacturers of the vaccines themselves as additional actors.

Given the very rapid development timetable of COVID-19 vaccines and the use of emergency authorization, there has been enormous public and media pressure to provide rapid, reliable and transparent information about any adverse reactions. To support rapid monitoring, many countries have drawn on existing systems for monitoring adverse events of vaccines, medicines and medical devices. For instance, in the UK, the Yellow Card Scheme operated by the Medicines and Healthcare products Regulatory Agency (MHRA) allows health care professionals and patients to report side effects through an online portal; data are summarized and reported regularly on the gov.uk website. In Denmark and Norway, cross-border registry studies are being used to monitor effectiveness and safety of vaccines. In Germany, the Paul Ehrlich Institute is conducting an observational study on the tolerability of COVID-19 vaccines using a smartphone app, SafeVac App 2.0.

There are several other ways in which digital health tools could be used to improve the provision of information regarding any adverse reactions to a vaccine. One way is to make more active use of electronic health records, where these exist, and there have been projects to explore the potential of drawing on this source of information (Coloma et al., 2013), although these are likely to face both technical

and governance barriers. A further step would be to build on apps developed for self-reporting of symptoms during the pandemic, and follow the same approach to develop mechanisms for voluntary reporting of any symptoms following vaccination.

Immunity certification

Vaccination passports have been considered to support reopening of economies but raise a number of questions over fairness, equity and usefulness

The issuing of digital vaccine or immunity certificates to track immunity status has been considered by some countries to support the reopening of economies and schools.

Such immunity might be acquired through vaccination, or through having already had the virus. Immunity certificates may open up the possibility of tracking people who are immune to COVID-19 and allowing these people to act in ways that others would not, such as being able to provide certain types of services, visit vulnerable people or travel without restrictions applied to others. In Israel, for example, a 'green pass' has been issued which allows fully vaccinated individuals to access venues that unvaccinated individuals cannot and to travel without restrictions.

The use of vaccine certificates nevertheless raises a wide range of problems (Ada Lovelace Institute, 2020). First, evidence is still not clear on how long immunity lasts after infection and what this immunity means – does it prevent severe symptoms but still allow transmission to others, for example? If immunity can be relied upon, are tests accurate and accessible? Should immunity only be acquired through vaccination or other means? And what would happen if some vaccines are deemed more effective than others? Issues around equity and fairness arise if some individuals have access to services, international travel or can return to workplaces when others cannot. These issues are especially important for children, individuals that cannot have vaccines for health reasons, or groups that are not yet eligible for vaccines due to prioritization in rollout. And if there are significant benefits in being able to demonstrate such an 'immune' status, how do countries counter potential fraudulently acquired certificates? Thus, behind a seemingly simple-sounding digital certificate of immunity that could be checked on public transport or at work, for example, lies a linked set of scientific, practical and political challenges that will need careful consideration.

What policy mechanisms were used to support digital health use during the pandemic?

This section summarizes how countries have used policy tools to facilitate the use of digital health tools during the pandemic, either specifically in relation to COVID-19 or more generally. We use the policy mechanisms framework described in section 2, this time focusing on the specific mechanisms used during the pandemic. An overview of the policy tools that have emerged from the analysis in this policy brief are described in Table 4.

Table 4: Policy tools used to facilitate uptake of digital health during COVID-19

Regulatory mechanisms • Removing restrictions on number and/or length of remote consultations that can be given by a provider. • Removing restrictions on professionals that can give remote consultations. • Removing restrictions on the type of care for which remote consultations can be provided. • Removing restrictions on which types of patients can access remote consultations.
Financial mechanisms • Providing reimbursement for remote consultations. • Expanding which professions and types of care can receive reimbursement for remote consultations. • Investment to support providers to purchase IT equipment and implement broader infrastructure. • Investment to support development of digital health technologies.
Regulatory mechanisms • Provision of training on remote consultation to clinicians. • Development of professional guidelines on safe use of remote consultations and e-prescribing. • Implementation of adapted pathways for care such as triage.
Technical infrastructure • Development of apps to support contact tracing, monitoring and surveillance. • Adaptation of existing software to support monitoring and surveillance. • Use of devices to enable or enhance remote monitoring of patients. • Development of new tools for organizing the health system, such as managing supply and demand for personal protective equipment or intensive care facilities.

Regulatory mechanisms

Many countries relaxed regulations on the number of remote consultations that could be conducted as well as who could provide and access them

Many countries had regulatory restrictions regarding digital health tools in place before the pandemic, which they have since relaxed. For example, some countries had restrictions on how many remote consultations clinicians could provide, or for how long (e.g. Germany lifted volume/time restrictions on physicians). In Romania, the requirement to use the electronic national health insurance card in order to access telephone/online consultations was removed during the pandemic, and remote consultations were allowed for any physician (family physician or specialist), with a limit of eight consultations per hour. Another type of restriction had been to only allow teleconsultations for patients with whom a physician had already had an in-person consultation, which some countries previously had in place but then lifted (e.g. the Netherlands). In Poland, Article 10 of the 'Code of Medical Ethics' prior to the pandemic limited remote consultations to emergency situations only but a new decree was issued in March 2020 to allow specialists to conduct remote teleconsultations and to be reimbursed at the same rate as for a face-to-face consultation (Szmuda et al., 2020). Some countries kept certain restrictions in place though; for example, France continued to restrict teleconsultations to patients who had consulted the relevant physician in person during the 18 months before the pandemic.

Emergency legislation in some countries has been implemented to facilitate use of e-prescriptions and other tools

Many countries have also implemented emergency legislation to open up the use of digital health solutions such as enabling e-prescription (e.g. Austria, Belarus, Greece, Ireland, Italy, Malta), allowing remote certification of sickness absence from work, or increasing the scope of use of digital health in social care. Although Germany has historically had a relatively low level of digital health tool use, the timely adoption of the Digital Provision Act in 2019 laid the basis for greater adoption of digital health in 2020, including during the pandemic. This has been expanded by additional legislation during the pandemic, enabling greater use of digital health tools and processes within the health system (e.g. electronic referral letters).

Strong legal frameworks for data protection and privacy are important but not sufficient to promote uptake of digital health

Although data privacy concerns were prominent in discussions about digital health before the pandemic, they have had a relatively low profile as a policy issue during the pandemic, although some countries have specifically relaxed data protection rules during this period (e.g. the UK). The major area where data protection concerns have been discussed is in relation to contact-tracing apps, although ultimately countries have broadly opted for voluntary data sharing, respecting existing privacy rules, although there are some mandatory requirements for the use of app-based contact tracing (e.g. for those quarantined following contact with COVID-19 in Poland). Some countries have made formal regulatory changes to existing laws in order to enable digital health solutions to be used, such as in Finland, providing a limited duration legal basis for their national proximity-tracing app, while others have made changes on the basis of executive authority rather than through legislative change. Other countries have put in place specific requirements for apps, including Belgium where apps were required to use only anonymized data, be open source and be interoperable between different regions and with the federal eHealth platform.

Financial mechanisms

Reimbursement rates for remote consultations have been adjusted in many countries to compensate for income lost through reduced face-to-face consultations

The need to change regulations regarding reimbursement to ensure remote consultations are paid at the same rate as in-person consultations has been identified as a key facilitator to the uptake of telehealth (Ben-Pazi, Beni-Adani & Lamdan,2020; Kapoor et al., 2020). Many countries limited reimbursement for remote consultations in the past but have increased it during the pandemic. For some countries, this has meant adding specific reimbursements for COVID-19 related consultations (e.g. Belgium, Denmark, Ireland, Romania). In many countries though, reimbursement has also been increased for other conditions, or more broadly across the health system, with remote health services now reimbursed at the same or even a higher rate than face-to-face consultations (e.g. Denmark, Estonia (see Box 7), France, Italy).

These changes in general have still not taken the form of a general opening up of reimbursement to all forms of digital health or even remote consultations; rather, countries with reimbursement limits have more typically expanded the scope of which professions can now provide remote consultations (e.g. Belgium, for a limited set of professions/specialities), or the types of consultation that can be provided (e.g. Germany, with varying limits by type of consultation) or a combination of both (e.g. France, with simplified conditions plus increased scope and coverage). Other countries already reimbursed remote consultations in principle, but have clarified the scope of existing rules and their application during COVID-19 (e.g. Switzerland).

Box 7: Reimbursing remote consultations in Estonia

E-consultations with GPs and other specialized physicians were already everyday practice in Estonia before COVID-19. However, in May 2020, the use of e-consultations increased by 67% compared to the previous year. Within the first 6 months of the year, 14,497 patients used the e-consultation services 17,875 times in all and the total cost was EUR 575,000.

The Estonian Health Insurance Fund (EHIF) reacted almost instantly to the suspension of elective care by introducing a fee for distance

outpatient specialist consultations on 24 March to provide an alternative to the usual office visits. The EHIF defined the list of consultations that could be conducted remotely as well as minimum standards and monitoring requirements. The fees for remote services were the same as for regular consultations. Moreover, hospitals were eligible to apply for a one-time compensation of 1.5% of their annual outpatient care contract amount to scale up their capacity to deliver remote consultations. Providers could apply for this payment if at least 20% of visits (compared to the number of visits during the same time period in the previous year) were done remotely and at least 20% of remote visits were conducted as video consultations. During the emergency situation, about one-third of consultations were conducted remotely, including more than three-quarters of consultations in psychiatric care. The EHIF continues to finance remote consultations, although the service standards and criteria will be reviewed and tightened.

Greater investment is being made to promote the use of digital health tools both during the pandemic and longer term

A number of countries have pledged additional funding to support the use of digital health technologies both during the crisis and to develop broader infrastructure for the longer term. In Ireland, the 2021 budget committed EUR 58 million to develop eHealth and information and communications technology (ICT) infrastructure as key drivers of efficient flows of health data. Moreover, a share of EUR 15 million allocated to addressing mental health challenges created by the pandemic has been committed to e-mental health support. In Germany, the Ministry of Health has provided EUR 50 million to public health offices to support the upgrading of hardware and software for contact tracing and training employees in the use of these systems. An additional EUR 4.3 billion, with the Federal Government providing EUR 3 billion and the Länders (Federal States) another EUR 1.3 billion, has also been committed to enhance the digital infrastructure in hospitals to promote internal, intra-sectoral and cross-sectoral care, and to introduce or improve telemedicine, robotics and high-tech medicine.

Quality

Efforts to promote quality improvement in the use of digital health tools have focused on training health workers and developing their competencies

Although there has been a rapid proliferation of research into responses to COVID-19, there has been relatively little use of quality improvement mechanisms to improve the use of digital health tools during this period. Some exceptions in a small number of countries have targeted the provision of training on remote consultation to clinicians (Sweden, the UK), or the development of professional guidelines on safe use of remote consultations and e-prescribing (Malta). There have also been adapted pathways for care, such as enabling remote consultations between GPs and specialists in order to minimize referrals to hospitals (Croatia, the Netherlands, Russian Federation,).

In Italy, the National Institute of Health (ISS) has set up dedicated webinars and distance learning courses, which also earn health professionals continuing medical education credits. This has occurred alongside a more general shift to distance learning for health workforce training. In addition, slightly over half of the regions in Italy had put in place specific plans guiding the implementation of telemedicine by September 2020, including advice on when telemedicine services should not be used (Box 8).

Box 8: Regions in Italy have developed guidance on using telemedicine

Several Italian regions have put in place plans for telemedicine. Whereas some have defined general organizational plans, others have provided instructions for specific health problems, such as diabetes or autism (in Abruzzo), or targeted specific categories of the population, such as paediatric patients (in Lazio). Lombardy and Piedmont have established which precise services are deliverable at a distance and many have defined specific tariffs for telemedicine.

As part of further efforts to promote quality, the ISS has also provided guidance stating that (pending better evidence), it is not advisable to resort to telemedicine services with:

- unknown patients who manifest an altered state of consciousness, dyspnoea at rest or low values of systolic pressure;
- patients with acute pathologies or exacerbations of chronic pathologies, even if in isolation; or,
- frail or chronic patients for whom home stay would not constitute a safe choice in the presence of COVID-19 symptoms.

Evidence on effectiveness of digital health tools during the pandemic and acceptability to patients and professionals is lacking

There has been relatively little evidence either on how patients and professionals perceive the use of digital tools or how effective these tools have proved to be. Some emerging evidence suggests that patients are broadly positive about the increased use of digital health tools; for example, the preliminary results from a feedback survey in Estonia suggest that more than 80% of patients were satisfied with remote consultation and would use it again. In Germany, although the partial lifting of measures in May 2020 made it easier to return to face-to-face consultations, data on usage since then indicate a sustained interest in online consultations, and the attitude of patients towards remote consultations remains positive, with surveys suggesting that most patients are willing to try the option of a remote consultation and that, of those who do, the vast majority are content to do so again.

There is emerging evidence also around the use of digital health for specific conditions. A study on the potential use of telemedical consultations for urological patients found that 84.7% of study participants wanted a remote consultation during the pandemic; of the remainder not wanting a remote consultation, the majority cited technical limitations as the primary barrier (Boehm et al., 2020). Looking at the use of remote consultation for children with

cerebral palsy, Ben-Pazi, Beni-Adani & Lamdan (2020) found evidence that it could improve accessibility, delivery of multidisciplinary care and enhanced patient participation.

Technical infrastructure

While some technologies used during COVID-19 were new, most built on pre-existing solutions

Most countries have made expanded use of online platforms to disseminate information about COVID-19 and related activities. Some have also created additional platforms, such as platforms to monitor patients remotely (e.g. Belgium, enabling GPs to monitor COVID-19 patients). Some countries have accompanied online platforms with the use of additional devices to enable remote, or at least physically distant monitoring, including vital signs such as blood oxygen levels (e.g. Germany, Italy, the Netherlands, UK). This builds on a trend in digital health; for example, in diabetes care, where technologies, including smart socks, smart insoles, smart mats and smart thermography, have emerged in recent years to help remotely monitor diabetes complications such as diabetic foot syndrome and foot ulcers (Najafi, 2020). There has also been development of new tools for organizing the health system, such as an application in Belgium to manage supply and demand for personal protective equipment and for intensive care facilities in Germany.

The most high-profile area of new digital health infrastructure has, of course, been the development of specific applications for contact tracing in relation to COVID-19. This has required substantial investment within individual countries, as well as increasing coordination at the international level both in the public sector (in particular through WHO and the European Commission's e-health network) as well as the private sector through the initiative by Apple and Google to provide a specific type of common platform for such applications. The European Commission has also established the European Federated Gateway Service to ensure that national contact-tracing apps can be linked on the gateway and work across borders. By April 2021, apps from 16 EU Member States had been linked through the system. The gateway ensures that personal data are pseudonymized, encrypted, only used for necessary purposes, and stored for 14 days to protect individual privacy.

Discussion: How can policy-makers build on progress made with digital health during COVID-19?

In order to retain added value from greater use of digital health tools post COVID-19, active strategies are needed now to build on the current momentum for use

A great deal of work had been done over many years to facilitate and promote the use of digital health tools. Although the full potential of digital health had not been realized, this provided a basis upon which digital health tools could be rapidly developed and scaled up in response to the pandemic. While some of the digital health tools were novel (in particular contact-tracing apps), much of the underpinning technology that has been used during the pandemic already existed. Rather, the challenges brought by COVID-19 have created different needs and a new willingness to make use of these tools, as well as to make the necessary personal, organizational and system changes.

At system level, most actions to support the use of digital health tools during the pandemic have concerned the relaxation of limiting mechanisms, in particular the opening up of financing for these services where that was not already the case, such as for remote consultations in some systems and, more recently, increased direct investment in digital health tools and the infrastructure to support them. How far regulatory limits have been addressed is less straightforward, with relatively little formal adaptation of regulatory frameworks for digital health tools. In many countries the regulatory framework to enable the use of digital health tools was already in place, if relatively underused. In cases where there have been tensions between existing regulations and the imperatives of the pandemic, rather than permanent changes, the pandemic has more often been treated as an exception with temporary adaptations, such as to procurement processes. This raises the issue of what will happen in those cases where expanded use of digital health tools has depended in part on such temporary measures; will their use be once again restricted once the immediate emergency of the pandemic has passed?

Policy efforts have largely focused on removing barriers to uptake but more policies are required to create a supportive environment for digital health

It is important that policy-makers, local stakeholders and providers learn from the experiences of digital health implementation, use and development during the pandemic. So far, the primary focus of policy has been on removing limitations to the uptake of digital health tools, but it is equally important to identify policies and practices that can be put in place to create an enabling and supportive environment for the expanded use of digital health tools.

The first important lesson is that strong leadership from government and national health bodies is needed to support implementation. Looking to the future, the development of

national or regional policies or strategies on digital health, which move beyond a focus on eHealth and also target mHealth and big data and analytics, will become increasingly important as these applications advance. Gaps in existing regulation also need to be addressed in many countries. It is likely to become important for national authorities to regulate mHealth technologies for quality and safety as they do other medical devices. Legislation on liability and on reimbursement levels is also important to encourage uptake by health professionals.

However, even where particular uses of data may be allowed within a legal framework (such as the data protection rules of the European Union), this is not necessarily sufficient. Even with a strong legal framework, concerns may arise that require clear values, communication and engagement in order to address them. Development and application of digital health tools typically involves cooperation between the public and private sectors, in particular the companies providing the digital technologies themselves. This can raise further concerns, with different levels of trust and apprehension amongst the public towards different actors in the public and private sectors. The governance of these partnerships between the public and private sectors needs to be addressed as part of the overall strategy for effective development and use of digital health tools. Active strategies to build and maintain public trust in the institutions involved in digital health developments are important, beyond the establishment of legal frameworks.

Strategic investment and reforms to reimbursement can help to promote uptake and use

Emergency funding has proved critical to facilitating use of digital health tools during the pandemic. Greater **strategic investment** longer term can help to support developments in digital health. These investments are likely not only to be needed to support development of technical infrastructure across the health and long-term care sectors but also to support wider infrastructure development, such as implementation of high-speed internet. Continuing investment in research and development can also help to ensure that new technologies are developed and continue to evolve. After all, vaccines against COVID-19 were only available so rapidly as they built on many years of ongoing research.

Importantly, the financing strategy for the development of digital health tools is not only about the development of the technology, but must also encompass the individual, organizational and system changes involved in its use. This element has been relatively neglected so far in comparison to investment in the technological infrastructure but is required for the long-term durability of digital health innovations that have been established during this crisis period. One important element to promote organizational change is to put in place pragmatic reimbursement provisions for digital health tools. This may be facilitated by policy-makers bringing together stakeholders to reach agreement on reimbursement levels. Evaluations of the impact of any financing of digital health tools on their use in practice and the impact on the system as a whole will be important to help understand if they are able to reduce costs as well as their potential impact on the number or workload of staff, or redistribution of work among staff. An understanding of these implications can help to mitigate any resistance to funding models for digital health that may be encountered from individuals, health care providers or organizations.

Active strategies to support co-design and use of digital health tools at the local level are needed to ensure their acceptance

Some of the rapid uptake of digital health tools seen since the start of the pandemic has been accepted precisely because these have been exceptional circumstances. However, as health systems emerge from the pandemic period and a more 'normal' routine is re-established, we cannot assume that this acceptance will continue. Digital health tools can help to provide more efficient and patient-centred care, but this will depend on digital health tools not being seen as a 'second best' temporary solution by either patients or professionals. Active strategies to support continued co-design and use of digital health tools at the local level will be crucial, combined with system-level support, in particular around financing and evaluation.

Policies should be underpinned by a better understanding of patient preferences, digital inequalities and appropriate use of digital health tools

Limited research from the pandemic indicates that patients are likely to view some digital health developments, such as remote consultations, favourably. More evidence is nevertheless needed on acceptability and patient preferences across different groups to ensure that digital solutions can deliver more personalized and higher quality care in the future. An increased understanding of digital inequalities across population groups and how to address these is also needed. Investigating effective ways to enhance acceptability by patients and the public, such as through co-developing digital tools, will be important to engender sustained changed in health care delivery.

Finally, while there has been a remarkable volume of academic publication looking at experiences of the use of different tools, there remains a need to strengthen guidance and support for the effective and appropriate use of digital health tools. Gaps in evidence remain on the impact, efficacy and cost-effectiveness of many tools utilized during the pandemic and their impact on patients and health professionals. The lack of evidence on the quality and added value of digital health tools may be hindering the effectiveness of policy mechanisms to promote the use of these tools in practice. A first step should therefore be to develop better evidence about the effectiveness and added value of the digital health tools and how best to use them, as a basis for better use of policy mechanisms promoting their use. Rapid reviews and evaluations of current digital health tool use, and their benefits and issues, are needed to provide an evidence base on what should continue and what adaptations are required. These reviews can help to

ensure that, when systems come to establish their new steady-state working for the medium term, this is based on learning from what has already happened during the pandemic.

Developing strategic independence for digital health in Europe presents a longer-term challenge

The pandemic has highlighted ways in which Europe has been reliant on third countries and parties for needs which turned out to be strategically essential during such a health crisis. This has also been the case for digital health tools and was highlighted by the dependence of European governments on a technological solution for contact tracing determined by Apple and Google.

This question of strategic independence has been a longer-term issue for digital health. Network effects have meant that hospitals or other organizations can become dependent on a particular system for their information technology infrastructure. As well as the issues of potential inefficiencies for those organizations, given that the majority of such suppliers are from outside Europe, this also raises issues of strategic independence for Europe as a whole.

This presents a longer-term policy challenge for Europe and requires renewed attention. Key issues related to this area that require consideration include whether certain minimum services for public health should be required of vendors within the EU, irrespective of their country of operation, and whether consideration be given to binding requirements for interoperability of systems to prevent dependence on particular vendors.

Conclusion

Digital health tools offer enormous potential for health systems and there have been many years of effort put in across European health systems, as well as at the international level, in order to facilitate and promote their use. This provided a context for making widespread use of digital health tools as part of the response to the COVID-19 pandemic, in particular for communications about and monitoring of COVID-19, in supporting the continued provision of health services during the pandemic, and by potentially playing a part in the process of exiting from pandemic-related restrictions. However, many of these initiatives have been created very rapidly and on an exceptional basis; there is now a need for consolidation, evaluation and learning to provide an evidence base for making best use of digital health tools in the medium term. The pandemic is also raising policy challenges associated with digital health, including some that may arise in the near future (such as in relation to immunity) and more strategically (in relation to strategic independence). This policy brief aims to provide a basis for policy-makers to take stock and put in place actions now that will help to maximize the potential of digital health as part of an effective response to the pandemic as well as for the long-term future of health systems.

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