

# Delivering the benefits of digital health care

*Research report*

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February 2016

Supported by



## About this report

Clinically led improvement, enabled by new technology, is transforming the delivery of health care and our management of population health. Yet strategic decisions about clinical transformation and the associated investment in information and digital technology can all too often be a footnote to NHS board discussions. This needs to change. This report sets out the possibilities to transform health care offered by digital technologies, with important insight about how to grasp those possibilities and benefits from those furthest on in their digital journey.

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## List of abbreviations

<b>BNF</b>	British National Formulary
<b>CDSS</b>	Clinical decision support system
<b>CDU</b>	Clinical decision unit
<b>CEO</b>	Chief executive officer
<b>CPOE</b>	Computerised physician (or provider) order entry
<b>CPRD</b>	Clinical Practice Research Datalink
<b>CRIS</b>	Clinical Record Interactive Search
<b>CT</b>	Computed tomography
<b>EHR</b>	Electronic health record
<b>GP</b>	General practitioner
<b>GPS</b>	Global Positioning System
<b>ICU</b>	Intensive care unit
<b>INR</b>	International normalised ratio
<b>IT</b>	Information technology
<b>MBI</b>	Modified Barthel Index
<b>MDM</b>	Mobile device management
<b>MHRA</b>	Medicines and Healthcare Products Regulatory Agency
<b>MMR</b>	Measles, mumps and rubella
<b>MSKCC</b>	Memorial Sloane Kettering Cancer Center
<b>NHS</b>	National Health Service
<b>NIB</b>	National Information Board
<b>NICE</b>	National Institute for Health and Care Excellence
<b>NOAR</b>	Norfolk Arthritis Register
<b>NPfIT</b>	National Programme for Information Technology
<b>PACS</b>	Primary and acute care system
<b>QOLS</b>	Quality of Life Scale
<b>RFID</b>	Radio-frequency identification
<b>RTLS</b>	Real-time location system
<b>UCSD</b>	University of California San Diego
<b>UCSF</b>	University of California San Francisco
<b>UK</b>	United Kingdom
<b>US</b>	United States

## Executive summary

Clinically led improvement, enabled by new technology, is transforming the delivery of health care and our management of population health. Yet strategic decisions about clinical transformation and the associated investment in information and digital technology can all too often be a footnote to NHS board discussions. This needs to change. These decisions need to move centre stage.

In this report we set out the possibilities to transform health care offered by digital technologies, with important insight about how to grasp those possibilities and benefits from those furthest along in their digital journey. The report draws on an extensive literature and evidence review, and on interviews with leaders of health care organisations who have been actively pursuing a digital strategy over many years.

Many reports about technology-enabled change tend to focus on the large number of exciting future opportunities but less on the pitfalls and how they are to be avoided. We aim to fill this important gap. We want the leaders of NHS organisations reading this report to deepen their understanding of the digital terrain and the possibilities it offers, particularly to meet the immense productivity challenge ahead, and also to gain practical insights that will help avoid expensive mistakes.

Around the world there is agreement that health care is at least a decade behind other industries in the use of information technology. It may be even further behind in realising the productivity and value improvements that have been seen elsewhere as the result of information technology. High-profile failures in the implementation of information technology have increased the burden on front-line staff and failed to deliver cost reductions.

The initial approach to extracting productivity improvements followed other industries and focused on improving transactions, removing duplication, increasing back-office efficiency and streamlining certain processes. These are important and there is still more to do but the most significant gains are to be found in more radical thinking and changes in clinical working practices. Information systems are one part of a much wider set of instruments for creating change.

We believe that the ingredients are now in place for technology to help deliver the ‘Triple Aim’ of health care and make significant gains in quality, efficiency and population health. Information technology can also provide the route to a model of care that generates new value for patients, professionals and organisations by meeting previously unmet needs.

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*“I think we’re about to come to the next era of medicine... as much as 30% of what we do today we will do differently... how we evaluate patients, how we follow up on patients, how we bring the expertise in between clinicians, how we manage patients in a hospital, how we think about even the role of the hospital.”*

*(Robert Pearl, Kaiser Permanente)*

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This means that becoming a digitally enabled health care provider is not about replacing analogue or paper processes with digital ones. It is about rethinking what work is done, re-engineering how it is done and capitalising on opportunities afforded by data to learn and adapt. Where technological interventions have failed, technology has simply been layered on top of existing structures and work patterns, creating additional workload for health care professionals.

There is a lot of interest in some of the leading edge of the technology boom – applications (‘apps’), big data, the ‘internet of things’<sup>1</sup> etc. However, our work suggests that there is still huge scope for major improvements in quality and productivity from the use of information systems that are available now and which are required if organisations are going to be able to benefit from the more futuristic ideas coming over the horizon. In conversation with some of the leading thinkers in health care, we have identified seven opportunities to drive improvements (see page 7).

Digital technologies will not deliver improvements in productivity on their own. Indeed, without careful implementation they can create inefficiencies and staff frustration and even threaten the quality of care. We have identified seven lessons that serve as conditions for success from those who have successfully implemented an effective digital strategy (see page 8).

1. The Internet of Things (IoT) refers to the transfer of data between objects, without any human interaction.



# Seven key areas of opportunity

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## 1. More systematic, high-quality care

Use clinical information decision support and knowledge management tools, integrated into standardised workflows, to deliver more systematic, high-quality care.

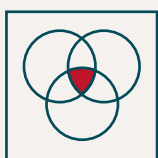
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## 2. More proactive and targeted care

Use real-time patient monitoring and powerful analytics to deliver more proactive and targeted care, reducing costs and improving outcomes.

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## 3. Better coordinated care

Attack the costs and harms that come from poor communication and fragmented care by developing information technology systems to integrate and coordinate care and support providers in collaborating more effectively.

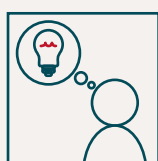
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## 4. Improved access to specialist expertise

Use telehealth to reduce costly referrals, avoid admissions and unnecessary appointments, and improve the ability of professionals to get things right first time by providing access to specialist expertise and advice easily and in real time.

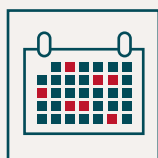
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## 5. Greater patient engagement

Reduce transaction costs and rewrite the relationship with patients and carers by providing tools for patient engagement and self-management that allow more meaningful participation in care and more opportunities for self-service.

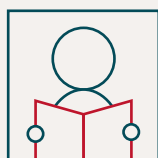
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## 6. Improved resource management

Bring to bear the tools used in other sectors for improved resource management to plan staff rosters and patient flow, match capacity to demand and improve scheduling.

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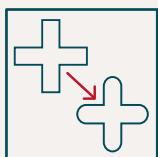


## 7. System improvement and learning

Use a combination of analytics, improvement science, a learning culture and organisational development to support system learning and improvement.

# Seven lessons for success

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## 1. Transformation first

Transformation comes from new ways of working, not the technology itself. A transformation programme supported by technology is needed, not the other way round. This is the fundamental lesson that underpins everything else.

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## 2. Culture change is crucial

The majority of the issues faced along the journey of transformation are people problems, not technology problems. This means that organisations need to invest at least as much into the programmes of organisational change and transformation as they do in the technology itself. Clinical and organisational leaders are required that have a deep knowledge of clinical and technological systems. They should be able to reimagine how work is done and know how technology could best support it.

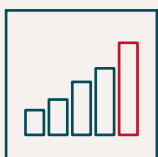
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## 3. User-centred design

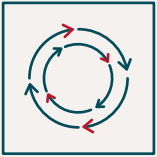
Insufficient attention has been given to the design of systems. Systems need to solve the problems and needs of the people who are going to use them, be they patients or professionals. This requires a deep understanding of the work as well as the needs of the user. There is a balance for organisations to consider between implementing an 'off the shelf' package solution (albeit customised for their organisation) and 'knitting together' existing clinical systems in their organisation. The combination of a core package solution with a small number of specialist clinical systems is emerging as the norm in top-performing digital hospitals.

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## 4. Invest in analytics

Improving productivity requires extensive redesign of work processes, the use of predictive models to reduce variation, allocate resources, anticipate demand and intervene earlier, and the ability to learn and adapt. None of this is achievable without analytical tools available to clinicians in real time and sophisticated support for planning, management and improvement.



## 5. Multiple iterations and continuous learning

Implementing technology is an ongoing programme of transformational change. Even with careful design there may need to be a number of iterations in the design of systems. This is a continuous process and there may be several cycles – some quite painful – before systems reach a tipping point where all of this investment starts to pay off.

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## 6. Support interoperability

The inability to share and combine data between different systems is a major rate-limiting step to realising the full benefit of technology in health care. Typically, high-performing digital hospitals are integrating all their systems, to as low a number as possible, across their organisation. Where possible, systems should be interoperable across different organisations to improve patient and citizen journeys and outcomes. In general it will be important to procure and use systems that comply with national data and interoperability standards.

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## 7. Strong information governance

Data sharing requires strong data governance and security, particularly in the face of a growing threat from cyber-attacks. Action is required at national and local levels to help organisations hold and share data safely, and also to enable citizens to own and share information if they choose to.

## The future of health care: digital heaven or hell?

Some will look at the years ahead and see a glorious nirvana in which the messy and inefficient services of today are transformed into predictive, coordinated and personalised care. Others will see a dystopia of doctors becoming slaves to algorithms and patients drowning in a sea of data and additional expectations. Both are possible, but a look at what leading providers have already achieved – described in this report – should be cause for optimism.

We conclude with our own vision of how health care is likely to change in the next 10 years:

- **Patient outcomes will be improved** because technology intelligently supports long-term health management and short-term episodes of illness or injury.
- Clinical professionals and their organisations will be **spending their time on their core competency** – treating patients – rather than wasting time managing processes. They will have access in real time to all the information they need.
- **Computing will be much more ubiquitous, but much less visible.**
- A lot **less time will be spent by staff on administrative tasks** and routine communication, as automation, voice recognition and natural language processing become more commonplace.
- **New roles and competencies will be added** to the managerial cadre in health care – most importantly that of analytics.
- Professionals will develop a **wider range of consulting and coaching skills**, to account for the increased ways in which they can interact with and empower their patients.
- Organisational and professional **boundaries will be far less visible**, as integrated information and communication systems dissolve many of the current divides between primary, secondary and tertiary care.

## 1

## Introduction

This report looks at the impact of digital technologies in health care, in particular their impact on the workforce and productivity. The digital technologies that are explored include:

- electronic health records
- telehealth
- monitoring equipment, including wearable devices
- electronic communications (e-communications)
- the use of web- and cloud-based tools
- data analytics – ‘big data’.

The report does not address the impact of medical technologies including diagnostics, genomics or robotics, which are also beginning to offer opportunities to improve productivity in ways we have not seen before.

In this report we set out the possibilities and benefits offered to health care by digital technologies, with important insight about how to grasp those possibilities and benefits from those furthest on in their digital journey. The report draws on:

- an extensive literature and evidence review, including recent literature on the impact of all of the digital technologies covered in this report
- 40 interviews with leaders of health care organisations who have been actively pursuing a digital strategy over many years, as well as leading technology suppliers, which took place in 2015 (see Appendix 1 for a list of the interviewees)
- a small survey of a panel of NHS leaders in primary, community and secondary care, which was carried out in 2015 – the panellists consisted of eight leaders of primary and community health providers and 10 chief executive officers (CEOs) of acute trusts (see Appendix 1).

An important point to note is the paucity of evidence available, particularly from the United Kingdom (UK), on the potential return on investment from the deployment of information technologies in health care. This reflects the fact that health care is currently in the foothills of a journey towards realising the full benefits from technology. Where we could find evidence, we have included it.

This report explores the following:

- the new digital health care landscape and how it may evolve
- why it has been so difficult to successfully deploy information technology in health care in the past, with seven lessons for the future
- seven opportunities for technology to improve productivity and quality.

Many reports about technology tend to focus on the large number of exciting future opportunities but less on the pitfalls and how they are to be avoided. We aim to fill this important gap. We want those reading this report to not only deepen their understanding of the digital terrain and the possibilities it offers but also be given practical insights that will help them avoid expensive mistakes.

The good news is that technology and its application are in a constant state of evolution and adaptation. This is making it ever easier to use technology and exploit its full potential. Important developments include:

- Natural language processing to allow free text to be structured and analysed
- the growth of artificial intelligence, decision support and cognitive computing, offering opportunities for automation and improved decision-making
- the increasing intelligence and reach of devices supported by the ‘internet of things’ and sensor technology, which will open up new possibilities for better resource management, patient self-care, improved prevention and remote monitoring
- further down the track, distributed ledger technology (DLT) may revolutionise the way in which we manage and share data. DLT uses ‘block chain’ technology which provides a means of creating a secure digital identity and allowing multiple users to work from a shared central database, potentially alleviating problems with interoperability (Government Office for Science, 2016; Swan, 2015).

Aside from these technological developments, the impact of digitising clinical information will be magnified further by medical advances in areas such as genomics and diagnostics. The UK is particularly well placed to take advantage of the genomic revolution. The 100,000 Genome Project aims to sequence 100,000 whole genomes from NHS patients by 2017 (Genomics England, 2015). The government wants the NHS to become the first major health service in the world to offer genomic medicine as part of routine care for NHS patients.

2

## The current digital health care landscape

There is a new and rapidly changing global health care landscape where digital technologies are changing the rules of the game. Alongside changes within the providers of health care, there is a growing consumer-based movement. The public are actively seeking out information on their health and demonstrating their enthusiasm to use digital technologies to manage their health and communicate with their health care provider (see infographic on the next page).

The NHS has experienced significant difficulties in realising the benefits of technology in the past. While the UK's National Programme for Information Technology (NPfIT) had some notable successes, including digital imaging, creating the capacity for online appointment booking ('Choose and Book'), GP to GP record transfers and secure email (among other things), it failed to digitise the hospital and community sectors, leading to its expiration in 2011 – nine years after it was initiated. NPfIT was originally budgeted at £6 billion but the total spend was estimated at closer to £10 billion (House of Commons Public Accounts Committee, 2013).

The failures of NPfIT are multiple, complex and overlapping. In essence, failure has been attributed to an attempt to force top-down change, with a lack of consideration to clinical leadership, local requirements, concerns or skills (Campion-Awwad and others, 2014). The government's digital strategy, *Personalised Health and Care 2020: Using data and technology to transform outcomes for patients and citizens: A framework for action*, which was developed by the National Information Board and published under the Coalition Government (NIB, 2014), has learnt lessons from NPfIT, with the core of its present strategy focused on national enablers for change. It is worth noting that the core aim of strategy was a good one. Other countries, such as Canada and the Scandinavian countries, are now implementing consistent instances of EPRs regionally.

The English health system is now reaching a digital tipping point. After years of lagging behind primary care, where the majority of GP practices have used electronic health records (EHRs) for over 10 years, community- and hospital-based services are beginning to catch up. A majority of the NHS acute trust



CEOs who were surveyed for this report revealed that they had the technology to support mobile working, e-rostering, patient-flow software and EHRs. A minority, meanwhile, had systems for telehealth, remote monitoring and tracking. The survey also revealed that across all settings, the greatest productivity gains have been gained from EHRs and support for mobile working. In primary care, patient portals have been particularly successful. The technology that has been least successful is the use of e-rostering in hospitals.

There are also opportunities for NHS organisations to bid for national monies, such as the Nursing Technology Fund,<sup>2</sup> to support local schemes. The recent Spending Review (HM Treasury, 2015) signalled a £1 billion investment in information technology for the NHS over the next five years, and this has since been augmented to £4.2 billion. The government’s digital strategy contains a number of supporting strategies and initiatives to encourage innovation and the uptake of digital technologies, including funding and programmes to promote system interoperability and the sharing of data (NIB, 2014). Further details of this programme are presented in Appendix 2.

A major challenge for all organisations across the NHS will be to find the necessary resources to invest in new technology. The primary and community care leaders we surveyed reported a level of investment of 1 to 5% of total expenditure over the past three years, with a significant rise anticipated over the next three. Meanwhile, the acute trust CEOs reported that a typical spend on digital technologies over the past three years had been 0 to 3% of total expenditure. By way of comparison, in 2012, the average spend on information technology for providers of hospital care in the United States (US) was just under 3% of their operating costs.<sup>3</sup> The surveyed CEOs expressed their frustration at how current financial constraints were limiting expenditure on technology.

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*“We would like to spend significantly more as we are behind the curve. However, this is currently unaffordable given the current deficit position.” (Acute trust CEO)*

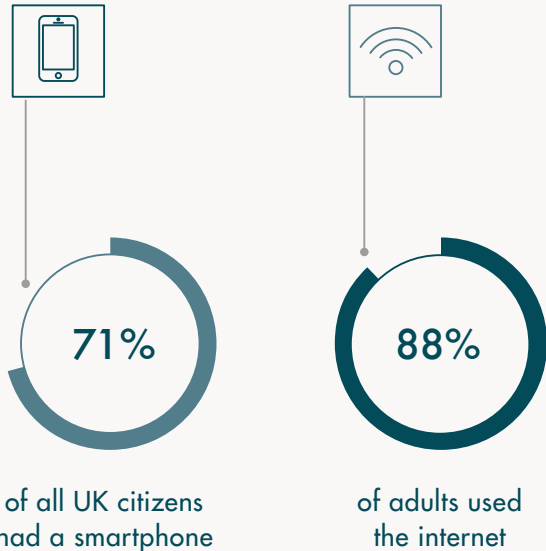
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2. [www.england.nhs.uk/digitaltechnology/info-revolution/nursing-technology-fund/](http://www.england.nhs.uk/digitaltechnology/info-revolution/nursing-technology-fund/)  
 3. <http://apps.himss.org/foundation/docs/2013HIMSSAnnualReportDorenfest.pdf>

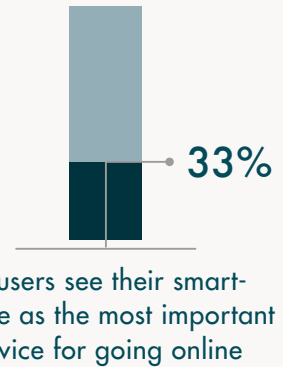
# The world of digital health in numbers

## Consumer IT

In 2015

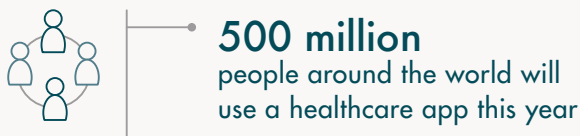
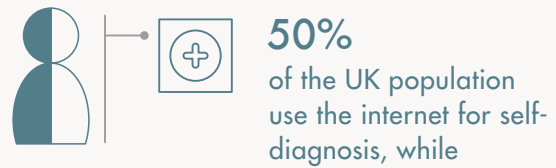


The average adult spends almost **2 hours** a day online on a smartphone

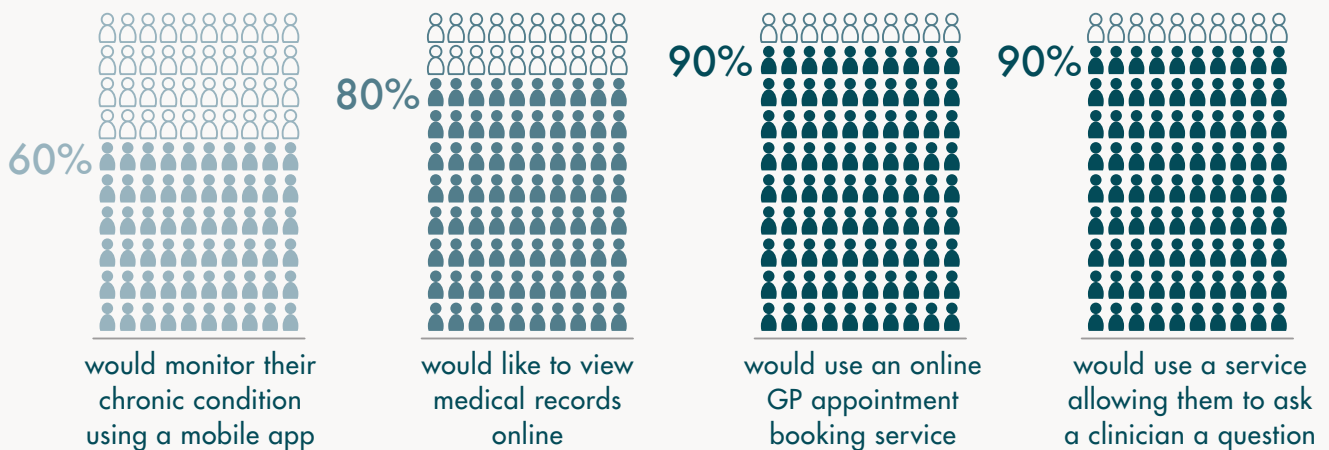


## But only 2%

of the population report any digitally enabled transaction with the NHS

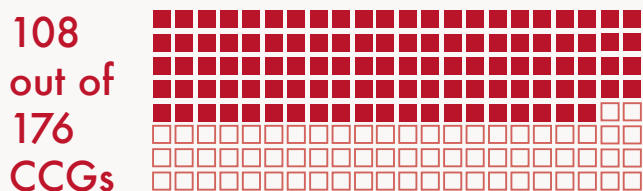


A 2012 survey of 7,000 patients found that

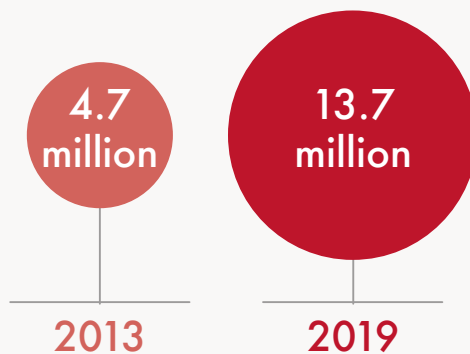


Sources for all of these data are available at the end of this report after the 'References' section.

## Telehealth



in the UK were commissioning telehealth services in 2013/14: a total spend of £15.2 million in that year.

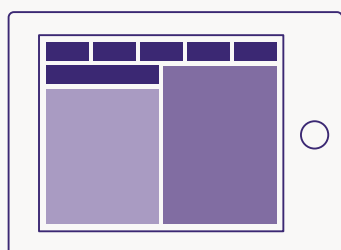


4.7 million people in Europe used a connected care system in 2013. This is projected to grow to 13.7 million by 2019.



**Just 14%** of over-65s in the UK have access to telecare services (e.g. fall alarms etc)

## Electronic health records



**Over 96%**

of GP practices have installed digital clinical record systems

**But under 4%**

offer patients online access to their records



Worldwide, **40%** of health care organisations reported a cyber-attack in 2013 – double that reported in 2009.

Between 2011 and 2014 the NHS suffered over

**7,000 breaches of data**



**that's 6**

data breaches every day

They believed that investment in this area would ultimately save money.

Figure 2.1 provides a high-level overview of the future digital health care landscape. The patient or service user is at its centre, surrounded by the patient-facing technologies that provide them with opportunities to manage their health and engage with health care providers. These include wearable devices, apps, online communities and patient portals. The EHR straddles the system as a whole, reflecting the pivotal role it plays in any digital strategy. It is the foundation on which many of the other apps are built. Next are the technologies that provide tools for health care professionals. These include decision support, the capacity to access other professionals' expertise, tools to prioritise and manage their clinical workload and tools to identify those patients at greatest risk. Finally are the technologies that support organisations, including tools for business process support, predictive analytics, flow management and e-rostering, which give new resource and clinical management capabilities to health care providers. Definitions of the technologies shown in Figure 2.1 can be found in Appendix 3.

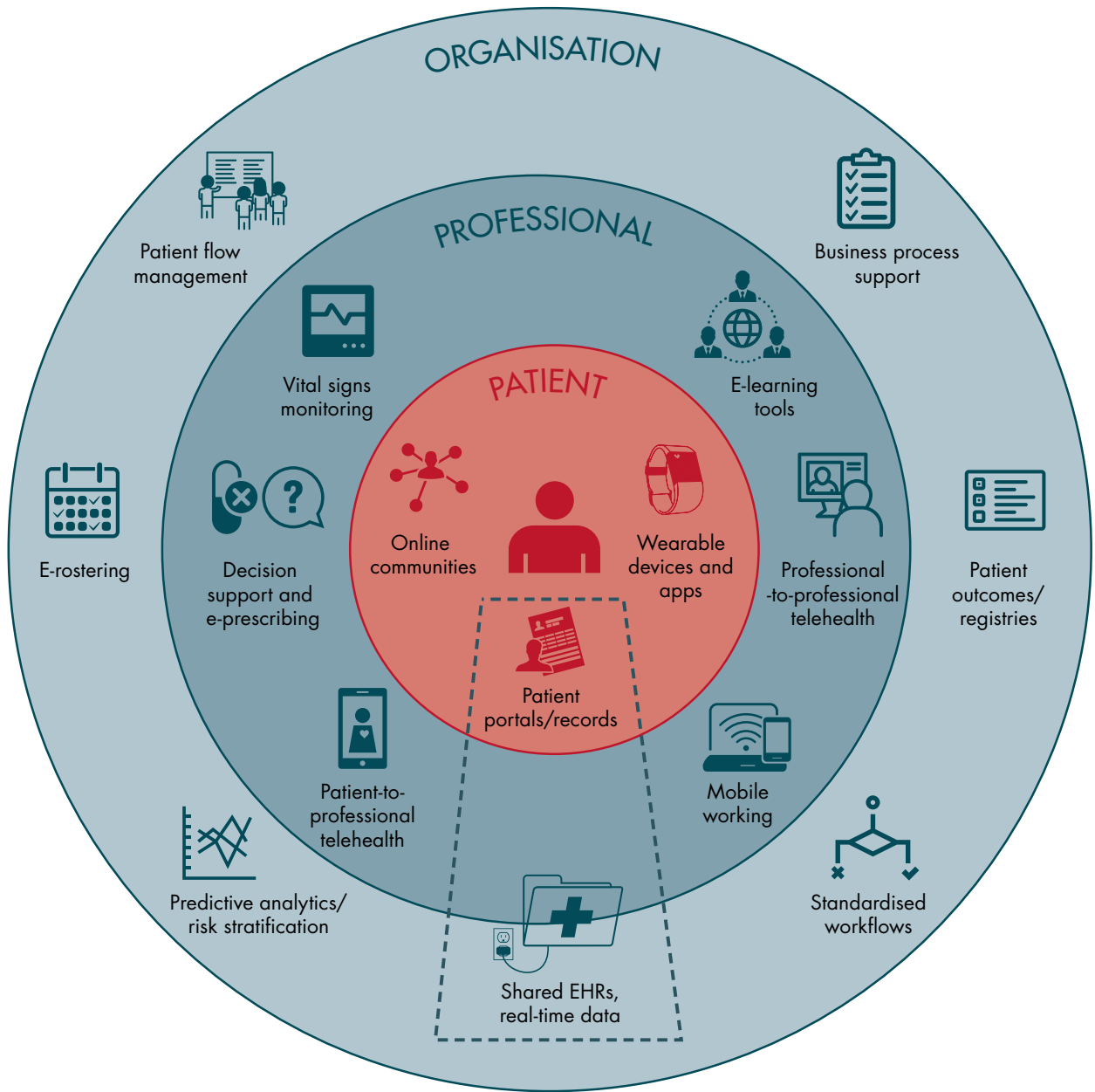
The speed with which benefits either have been or are likely to be achieved varies considerably. It is also clear that contextual and implementation factors play a big part in determining the ultimate impact. Striking examples of digital innovations that can deliver significant benefits relatively rapidly include:

- some of the apps that monitor vital signs and enable clinicians to identify and prioritise patients who require the most urgent attention
- the apps that support staff working peripatetically in the community.

The early evidence also suggests that these apps deliver a high return on investment.

The area that has created the greatest challenge is the implementation of the EHR. The reasons behind this are discussed further in the next chapter.

Figure 2.1: Overview of the future digital landscape



3

## Why has it been so difficult to deploy digital technology in health care? Seven lessons for the future

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“The history of technology as it enters industries is that people say ‘this is going to transform everything in two years’. And then you put it in and nothing happens and people say ‘why didn’t it work the way we expected it to?... And then lo and behold after a period of 10 years, it begins working.” (Robert Wachter, University of California San Francisco (UCSF))

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Becoming a digitally enabled health care provider is not about replacing analogue or paper processes with digital ones. Where technological interventions have failed, technology has simply been layered on top of existing structures and work patterns, creating additional workload for health care professionals. The technologies that have released the greatest immediate benefits have been carefully designed to make people’s jobs or the patient’s interaction easier, with considerable investment in the design process. Also, those we interviewed talked time and again about the importance of using technology to reimagine current work processes.

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*“I call it ‘The Safety Deposit Box Theory’ – you need two keys to unlock this... one of them is that the work needs to be reimaged... the second is the adaptation of technology.” (Robert Wachter, UCSF)*

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*“I don’t know of any instance of really major implementation of technology that has brought that [improvement of] productivity that hasn’t been associated with a major change in how the industry is organised. Health care is like a cottage industry from*

*the Middle Ages, it is like a guild system, so this isn't a question of IT [information technology] and how it is. It's really a question of structural reorganisation of health care, and that's why it is complicated to do." (Adam Darkins, Medtronic)*

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The EHR is the foundation to any digital strategy, yet this is the area where benefit has been hard to extract, partly because some early EHRs were adapted from billing systems and not designed for clinical use. There was no 'reimagining' of the work. So, some EHRs created new obstacles in clinical workflow and slowed processes up.

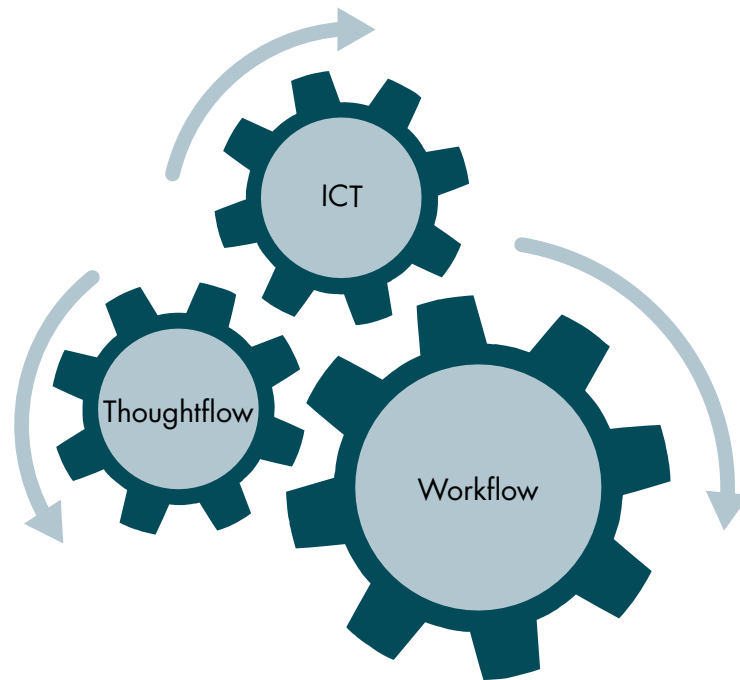
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*"In the early years, our statistics show that electronic health records actually caused negative productivity, you required 30% more effort." (Ash Shehata, KPMG)*

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Organisations at the digital frontier have spent decades building and refining their EHR. Wachter (2015), in his recent book *The Digital Doctor*, notes that poorly designed systems have led to significant increases in time spent on data entry and multiple unhelpful alerts – with some research showing that health care professionals spend over 40% of their time on computers compared with just 12% with patients (Block and others, 2013). There are also risks that staff focus so much on getting data into the system that they do not adequately interpret them. Deriving the full benefits from information technology in health care requires a sophisticated and complex interplay between the technology, the 'thoughtflow' (clinical decision-making) and the 'workflow' (the clinical pathway) (see Figure 3.1). Poorly designed information technology can disrupt thoughtflow and workflow; well-designed information technology can optimise them. Benefits will also be increased with systems that, as far as possible, automate data entry, for example with direct feeds from equipment that monitors vital signs.

Figure 3.1: Interplay between ICT, thoughtflow and workflow



From our analysis of the literature and the evidence provided by those we interviewed, we have identified seven lessons for the success of digital health care, which we now go on to describe. Throughout the report these are supplemented by specific lessons for particular technologies.



### Transformation first

**“It’s fundamentally not a technology project; it’s fundamentally a culture change and a business transformation project.” (Robert Wachter, UCSF)**

Transformation comes from new ways of working, not the technology itself – what is needed is a transformation programme supported by new technology, not the other way round. This is the fundamental lesson that underpins everything else.





## Culture change is crucial

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**“Bringing computers into your organisation is not simply a technical act, it’s a huge adaptive act.”**  
 (Robert Wachter, UCSF)

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Many of the issues faced along the journey of transformation are people problems, not technology problems. This means that organisations need to invest at least as much (and ideally significantly more) into the programmes of organisational change and transformation as they do in the technology itself. It requires clinical and organisational leaders who have a deep knowledge of both clinical and technological systems, who are able to reimagine how work is done and who know how technology could best support it. Leaders need to build a culture that is receptive to change and a strong change management process. Using clinical champions and supporting active staff engagement can help with this (Boonstra and others, 2014; Broderick and Lindeman, 2013). It is also essential to equip staff with the necessary tools and expertise to use new technology (Lovett and others, 2014; MacNeill, 2014; Sharma and Clarke, 2014; Veslemøy and others, 2014). This includes providing training before the technology is introduced, as well as real-time support once it is in place (Black and others, 2011; Boonstra and others, 2014). The increasing use of tablet computers (‘tablets’) with intuitive front-end applications should reduce the training requirement over time.

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*“We need to have IT systems that can be used without spending millions of pounds and hours and hours on training because that defeats the purpose of why we have the systems in the first place.”*  
 (Dr Harpreet Sood, NHS England)

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## User-centred design

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“We had a team of about 20 to 25 physicians who would spend a good chunk of time with our team actually building up the system and getting the system designed as they needed it to do their workflows, and without that we would have not delivered a product that people could have used.” (Eric Alper, Lifespan)

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Insufficient attention has been given to the design of systems. Systems need to solve the problems and needs of the people who are going to use them, be they patients or professionals. Staff are too often seen as ‘passive recipients’ of new technology and not involved in the development of systems’ architecture or user interfaces (Cresswell and others, 2013). Designing systems requires a deep understanding of the work as well as the needs of the worker. When systems meet clinical needs they are much more likely to succeed (Cresswell and others, 2013). Systems should support both the overall clinical ‘workflow’ and the clinician’s ‘thoughtflow’/decision-making. Bespoke user interfaces and information presentation, which the growing number of ‘front-end’ apps provide, can aid this. There is a balance for organisations to consider between implementing an ‘off the shelf’ package solution (albeit customised for their organisation) and ‘knitting together’ existing clinical systems in their organisation. The combination of a core package solution with a small number of specialist clinical systems is emerging as the norm in top-performing digital hospitals.

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*“Thoughtflow impacts the decision-making process, that is, it either enhances or makes it worse through the way we display digital information on a computer monitor or on a mobile device, so the concept of presenting the right information, to the right person, at the right time, is very important.” (Richard Bakalar, KPMG)*

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## Invest in analytics

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**“It’s what you do with the data that creates the value.”**  
 (David Blumenthal, The Commonwealth Fund)

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Successful providers have made significant investment in developing their own analytical and software development capacity. This enables them to generate the learning and insight from the data collected within both clinical and non-clinical systems. Appropriate data mining supported by sophisticated search tools and hyper-indexing, which can be used across all data systems simultaneously, are likely to help with this.

Data analytics can drive improvement in many areas, including operational and clinical processes as well as population management and the optimisation of treatment.

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*“They said our analytics were the best that they had seen in the world. The reason for that: when you track clinical data and load it into a longitudinal patient registry, it supplies a foundation for truly excellent analytic.”* (Brent James, Intermountain Healthcare)

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Intermountain Healthcare is a not-for-profit health system based in Salt Lake City in Utah in the US, which comprises 22 hospitals and is staffed by approximately 1,400 primary and secondary care physicians. It has invested in a significant ‘in-house’ analytic capacity. It has 17 statisticians with a Masters-level or higher qualification and their job is to support the analytics of the registry functions. The majority of their work involves producing routine reports on care delivery performance, to make performance transparent to the clinical teams at an individual patient level and at a process level. Intermountain Healthcare decided to develop in-house capacity as its experience of technological business intelligence systems was that the structure of reports had to be pre-defined and yet so many of the questions that cropped up in the clinical teams did not fit the pre-defined structures.



## Multiple iterations and continuous learning

“The whole journey started in the 1990s. We had two major failures – one a system that we designed ourselves and one a system that IBM designed with us... We probably spent five years building our own system; five years with Epic [a health care software company in the US] building the initial system; five years implementing our own system; five, six, seven years maximising what we have.” (Robert Pearl, Kaiser Permanente)

Implementing technology is an ongoing programme of transformational change.

Even with careful design there may need to be a number of iterations in the design of a system. This is a continuous process and there may be several cycles – some quite painful – before the system reaches a tipping point where all of this investment starts to pay off.

Ensuring that there are people on site with a deep understanding of the technological and clinical system will be essential in adapting the technology as the system improves and evolves. Clinical leadership and champions are particularly important. It is now routine for large health care organisations in the US to have chief medical and chief nursing information officers at board level.

*“As the CMIO [chief medical information officer] and lead physician... for the electronic medical record... I have a role... in the organisational strategy for deploying new technology... but also in taking feedback and input from the physicians in terms of what they need from the systems we have.” (Brian Clay, UCSD)*



## Support interoperability

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“One of the other things that we need to do worldwide is agree to certain minimum datasets or standards for interoperability, so that sharable and comparable data can flow with the patient, from provider to provider, and study to study.” (Amy Garcia, Cerner)

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Data sharing across multiple settings is essential to supporting coordinated care and realising the full benefits of technology in health care that are set out in this report. However, up until now there has generally been an inability to share and combine data between different systems.

Whole health economy benefits will be realised if providers agree to share the same instance of a clinical information system (rather than each implementing their own customised version). The National Information Board and other national bodies are taking significant steps to support this. Greater use of the NHS number should facilitate this too.

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*“The opportunity we have with the NHS number as a unique patient identifier to promote the interoperability is vast.”*  
(Dr Harpreet Sood, NHS England)

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However, there are also a number of things organisations can do to aid interoperability. It is important to note that while customising your EHR or wider health information system is likely to be important to productivity, over-customisation is likely to inhibit data sharing even when the same system is in use across multiple providers. Secondly, while there is no consensus on whether a single system is better than multiple systems linked through middleware, it will be important to ensure you have weighed up the benefits of both. Kaiser Permanente found that a single horizontal system which allowed for bespoke vertical systems for different specialisms within it was most effective. Thirdly, it is important to ensure common data and interoperability standards are used across systems.

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*"Our observation is that integration is important within organisations, and interoperability is important across multiple organisations."*

*(Rebecca George, Deloitte)*

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In general, it will be very important to procure and use systems that comply with national data and interoperability standards.



## Strong information governance

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*"One of the classic risks in health care is privacy of health information. Pre-EHR somebody's individual written patient record may not have been absolutely safe from unauthorised access when stored in primary care, in medical records or travelling between places of care. Once health care records are stored electronically, the size and scope of the problem changes. Electronic access across data networks makes it possible to access tens, hundreds, thousands, potentially millions of people's records. In addition, the ability to search data elements makes unauthorised honing down on particular elements, particular people, or a given population subset, possible."*

*(Adam Darkins, Medtronic)*

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Data sharing requires strong data governance and security, particularly in the face of a growing threat from cyber-attacks. A KPMG survey of 223 health care payers and providers in 2015 found that 81% had been compromised by cyber-attacks in the previous two years – and only half felt that they were adequately prepared to prevent attacks. The survey found that external attackers are the greatest threat to data security and that the top information security concern is malware infecting systems (Bell and Ebert, 2015).

Robust information governance mechanisms will be needed to give patients the confidence to share their data across care settings, and to assure health care professionals as they move away from paper-based systems.

The UK legislative landscape in this area is complex as a result of multiple Acts of Parliament and policy commitments (NIB, 2015a). At present, there is a tension between the Health and Social Care Act 2012, which encourages data transparency, and the Data Protection Act 1998, which seeks to guard and inhibit access to patient data. To date, organisations have attempted to overcome these challenges through formal information sharing agreements. However, the National Information Board is currently working to simplify information governance in England. Furthermore, an information governance toolkit is available to aid organisations in ensuring that sound information governance mechanisms are in place (HSCIC, 2015). This includes protecting data systems against malicious cyber-attacks, and reporting any breaches to the Department of Health and the Health and Social Care Information Centre.

4

## Seven opportunities to drive improvements

There are seven opportunities to drive improvements in productivity and quality of care. In this chapter, we frame each of them in terms of their broader impact. In addition, building on the ‘I statements’ created by National Voices (2013), we describe what they mean for those who use services.

- More systematic, high-quality care – My care is consistently delivered to a high standard
- More proactive and targeted care – The system finds me and intervenes at an early stage to avoid a crisis
- Better-coordinated care – The professionals involved with my care communicate with each other, working as a team and bringing together services to support me
- Improved access to specialist expertise – I, and those that support me, can access the specialist advice I need, wherever and whenever I need it
- Greater patient engagement – I have the information, and support to use it, that I need to manage my condition and make choices about my care
- Improved resource management – Whenever I use a service there are no unnecessary delays or wasted visits
- System improvement and learning – I know that the services that support me are always trying to find ways to improve my experience and the outcomes that are important to me

Below, we explore each of these opportunities in turn. We provide examples of how technology is enabling these benefits to be realised, the potential scale of benefit and, importantly, some of the key implementation lessons when deploying the technology.





## More systematic, high-quality care

SHARED EHRs, REAL-TIME DATA · DECISION SUPPORT & E-PRESCRIBING ·  
STANDARDISED WORKFLOWS

### *My care is consistently delivered to a high standard*

“When you talk about consistency of care, most... physicians think... you’re taking it down to the level of the lowest common denominator – a level that is acceptable to 100 physicians. I’m talking about the opposite – I’m saying let’s build the system around the three physicians that get the best results, and get the other 97 to increase their performance... we know how to do that.” (Robert Pearl, Kaiser Permanente)

A major problem in all health systems is that care often falls short of evidence-based good practice. For example, only 60% of adult diabetic patients receive all recommended care processes in the NHS (National Audit Office, 2015). Diagnostic and prescribing errors are also common. Experts estimate that diagnostic error exists in 10 to 15% of cases (Berner and Graber, 2008). Also, a study of errors in prescribing practice found 52 errors per 100 admissions (Lewis and others, 2009).

Technologies that aid clinical decision-making and help clinicians to manage the exponential growth in medical knowledge and evidence offer substantial opportunities to reduce variation and improve the quality care.

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*“... why on earth should we be expected to store all this knowledge in our head, be completely up to date with the thousands of journal articles that come out each year but not actually be comforted by the fact that decision support is there as our right-hand supporter.”*  
(Dr Simon Wallace, Total Mobile)

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In the future this support will come not only from access to clinical guidance or prompts to follow that guidance but also the automated interpretation of significant amounts of clinical data, including genomics.

### Decision support tools, including physician order entry systems

Clinical decision support systems (CDSSs) range from very passive electronic aids, such as hyperlinks to guidelines, to extremely proactive one-click flow mechanisms. There is strong evidence that they can improve the quality of clinical decision-making (Garg and others, 2005; Jaspers and others, 2011; Kawamoto and others, 2005) and there is some evidence that they can lower cost (Fillmore and others, 2013).

CDSSs are often combined with computerised physician (or provider) order entry (CPOE) systems. CPOE systems are information technology systems used to order medications, tests or procedures. When combined with CDSSs, they can integrate best-practice guidelines and prompt the user with varying levels of proactivity. The most passive may simply provide the user with recent test results (e.g. international normalised ratios – INRs – when prescribing warfarin). More active systems may alert the user to possible drug interactions, block an abdominal computed tomography (CT) scan request until pregnancy status is confirmed or even suggest certain prescriptions or investigations based on diagnosis or previous test results.

Such integrated CDSS and CPOE systems can lead to the following benefits::

- reduced likelihood of medication error – by 48% (Radley and others, 2013)
- reduced provider resource use (Chaudhry and others, 2006)
- reduced laboratory, pharmacy and radiology turnaround times (Steele and DeBrow, 2008)
- reduced need for ancillary staff (Stone and others, 2009).

In England, electronic prescribing has been commissioned in just 12% of hospitals, despite compelling evidence that it saves lives (Jee, 2015).

Box 4.1 gives some information on specific decision support tools that clinicians can use.

### Box 4.1: Decision support tools for clinicians

Technology and apps can facilitate easy access to guidelines, drug information and diagnostic aids, helping clinicians make informed, evidence-based decisions. There is a wide range of examples, including the following:

- Differential diagnosis generators.\* These help clinicians avoid errors and cognitive biases by combining symptoms, findings and other factors to suggest a list of possible diagnoses. An example is 'Isabel',<sup>4</sup> which uses a statistical natural language processing (SNLP) engine applied to a database of disease presentations rather than a rules-based model.
- NICE BNF app.<sup>4</sup> This app is available to NHS staff. It contains the British National Formulary (drug and dosing information) in searchable and downloadable format. It facilitates rapid and constant access to an important resource, which regularly updates.
- NICE Guidelines app.<sup>5</sup> This app contains searchable and downloadable summaries and full versions of clinical guidelines from the National Institute for Health and Care Excellence (NICE).
- VisualDX.<sup>6\*</sup> This is a visual clinical decision support tool that aids the diagnosis of dermatological conditions. Clinicians can search by symptoms and appearance of a patient's skin complaint to find disease information and medical images, tailored to the patient's skin phototype. This can assist in diagnosis and management. The tool can be used on both mobile devices and desktops during consultations with patients. The software has been described as intuitive and widely used following implementation (Barbieri and others, 2015; Skhal and Koffel, 2007).
- Epocrates.<sup>7\*</sup> This is a prescribing app that provides dosing and prescribing information. It includes a drug interaction checker, evidence-based guidelines and Pill ID – a tool that allows identification of medications by the appearance of their pills.

\* Note: Due to the NHS app library being updated, there is currently a lack of clarity as to the regulatory status of these apps (an issue discussed in further detail in the discussion on 'Wearables and apps').

4. [www.bnf.org/products/apps/](http://www.bnf.org/products/apps/)

5. [www.imedicalapps.com/2012/04/official-android-nice-guidance-android-app-helps-doctors-management-guidelines/#](http://www.imedicalapps.com/2012/04/official-android-nice-guidance-android-app-helps-doctors-management-guidelines/#)

6. [www.visualdx.com/](http://www.visualdx.com/)

7. [www.epocrates.com/](http://www.epocrates.com/)

Decision support is not just for doctors: it can also be a powerful resource for other staff such as nurses – particularly in settings where they may not have easy access to other clinical staff – and patients. More active, sophisticated, tools may have an even greater impact in remote locations.

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*“Imagine if you provided those same tools to a nurse practitioner in a remote community... they can then get advice based not only on their experience but now get the wisdom that these other doctors have trained the system to do and provide them a much more sophisticated understanding of leading practices... I think things like cognitive computing such as Watson [described in Box 4.21] need to be trained in very sophisticated places, but need to be implemented in less sophisticated places where they can have the most impact.”*  
*(Richard Bakalar, KPMG)*

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### Standardised workflows and ‘one-click flows’

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*“In the future we will be looking to standardise certain care processes, not just in this organisation but with other organisations who may share the same record, and they can be around elective care, acute care or long-term conditions.”* (Dr Gareth Thomas, Salford Royal NHS Foundation Trust)

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CDSSs can be developed to build protocols into customised workflows, hence standardising an entire care pathway. The approach to standardising workflow adopted by Intermountain Healthcare provides a good example of this process (see Box 4.2). An important feature of its approach is that staff are encouraged to deviate from the standardised protocol, subject to clear justification for doing so, with a view to it being refined over time.

## Box 4.2: Intermountain Healthcare’s approach to standardising clinical workflows

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*Hold on to variation across patients and limit variation across clinicians.*

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### Step 1

Choose a high-priority clinical process and lay out an evidence-based, best-practice guideline for that process. *It does not have to be perfect at this stage.*

### Step 2

Integrate it into clinical workflows via the EHR, laying out the clinical pathway for a condition once a clear diagnosis has been made. This is done by the data capture prompted by the system following the clinical pathway – thus prompting the use of the pathway itself.

### Step 3

Capture data on:

- where clinicians vary from protocol
- short- and long-term clinical outcomes
- cost
- patient satisfaction.

Intermountain Healthcare put a lot of resources into analysing these data and learning from them (explored further in Box 4.18).

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*“When you build workflow data capture... you need to know any time the clinician varies from protocol... this turned out to be far and away the most efficient way we found to measure variation in clinical practice.”*  
*(Brent James, Intermountain Healthcare)*

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### Step 4

Tell clinicians that no protocol perfectly fits each patient, so they need to ensure that they adjust the protocol based on patient need. The idea is to hold on to variation across patients (to meet the needs of individual patients) and to limit variation across clinicians (which is driven by individual clinician preferences or differences in knowledge and experience).

### Step 5

Build in a feedback loop to constantly improve the processes involved.

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*“When you [limit variation] you can use it to do research, so you can start to investigate and say ‘What’s the next big breakthrough or how do we improve this process?’ and you can start to use it as a tool to systematically improve the... knowledge base of the profession.”*  
*(Brent James, Intermountain Healthcare)*

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Standardised workflows can be taken a step further through ‘one-click flows’ or ‘one-click ordering’. Information is pushed through a ‘workflow engine’ to initiate the process, which triggers the tasks and processes for the workflow. An example is the approach taken at Kaiser Permanente for stroke patients.

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*“You come in with a stroke, the admitting physician with one click of the computer now creates the entire workflow, from everything from the [real logic] to the laboratory, to the diet, to the physical therapy, to the medication.”* *(Robert Pearl, Kaiser Permanente)*

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## Key lessons

### Overcome clinical resistance

Clinical decision support systems (CDSSs) (or indeed any information technology systems) may be met with suspicion by clinical staff who fear erosion of their autonomy. As Wachter (2015) writes in his book, *The Digital Doctor*:

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*“F]or the next few years, the emphasis is likely to be on... decision support for bite-sized problems, treatment advice for defined clinical scenarios... this bite-sized approach may ultimately prove to be the best path to the more ambitious goal of the fully digital doctor.”*

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### Avoid alert fatigue

Some hospitals average 20,000 physician alerts per month. Where there is a large number of alerts, they may be over-ridden and ignored by clinicians (Roshanov and others, 2013). One study found that to prevent one adverse drug event, professionals dealt with over 123 unnecessary alerts (Genco and others, 2015). There are a number of ways to address this problem:

- Reduce the number of alerts. One of Intermountain Healthcare’s design principles is to only use alerts in very special circumstances.
- Make essential alerts stand out. This could be through a colour, sound signal or both.
- Target alerts. Think about clinician work processes to ensure that alerts are targeted based on the task, context and the clinician they are alerting – e.g. prescription advice should appear exactly as the clinician is prescribing, rather than earlier in the process.
- Ask clinicians to respond to alerts. This prevents them from ignoring alerts when they arise (Roshanov and others, 2013).

### Do not rush into a technological solution

‘One-click flows’ can be very difficult to implement. When Intermountain Healthcare considers standardising a clinical workflow, it works on paper first. This gives the organisation the chance to see how it works in practice and consider improvements – before integrating it into the technology. It also means that professional and patient need drives the change, rather than the technology.

### Use protocols as a tool for learning

No protocol will ever be right for every patient. Clinicians will need to use their own judgement and adapt the protocol according to patient need. One unexpected hazard of using protocols might be over-compliance: Intermountain Healthcare experienced problems where clinicians were too ready to adopt the default prescribing choice, leading to inappropriate care in some cases.



## More proactive and targeted care

VITAL SIGNS MONITORING · PREDICTIVE ANALYTICS/RISK STRATIFICATION · SHARED EHRs, REAL-TIME DATA

### *The system finds me and intervenes at an early stage to avoid a crisis*

“[Productivity] doesn’t just come from putting an electronic medical record in, it comes from... [using] the data across the continuum to predict and prompt, and it’s a whole different ballgame.” (Matthew Swindells, Cerner)

Failure to spot warning signs in patients in community and hospital settings results in significant numbers of avoidable admissions and deaths. For example, a national audit of sepsis care found that the use of the Early Warning Score in general practice was 0% and in secondary care only 27%. Yet the systematic use of the score is known to significantly improve outcomes (Kmietowicz, 2015; NCEPOD, 2015).

There is significant potential to reduce cost by early intervention through more proactive and targeted care, supported by powerful analytics. Patient data can be used to predict clinical risk, enabling providers to target resources where they are needed most and spot problems that would benefit from early intervention.

The move to population health management will bring risk stratification of populations, identifying (for example) high flyers and targeting personalised interventions across health and social care settings to manage them proactively.

This is an area where the deployment of technology can rapidly deliver significant improvements in outcomes and savings. It should be a high priority for investment – particularly in a hospital setting. And as genomic information begins to become routinely captured as part of clinical examinations, the importance of analysis of this kind will only become greater.



## Predictive analytics

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*“We want them to be using predictive analytics to make doctors smarter and I think that this is going to have a major, major improvement in quality but also... the ability to lower costs.”*

*(Robert Pearl, Kaiser Permanente)*

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Computer-based algorithms, drawing on patients’ clinical and demographic data, can generate risk scores, highlighting those at high risk of readmission and allowing for preventative measures to be put in place. Northern Arizona Healthcare in the US has found that by sending scores to the nurses managing discharge, it has reduced emergency readmissions by 45% (Matthew Swindells, Cerner, personal communication).

Use of analytics can extend beyond simple readmission prevention, however. It may also have a role in predicting those in the community who are likely to use health care services in the near future. So-called ‘case finding’ tools are well established but have been held back in the past by having to rely on limited, out-of-date and poor-quality data. Systems of the future will draw on not just electronic clinical data (which is much cheaper to harvest) but also data from home monitoring equipment and even – in some systems – personal data held by retailers and telecoms companies.

## Monitoring of vital signs and early identification of those at risk

The early use of remote monitoring technology in the NHS is showing promising results. Systems have been developed that can:

- electronically record vital signs data
- calculate early warning scores
- automatically escalate to appropriate clinicians
- combine these data with laboratory tests to alert staff to risks of sepsis, acute kidney injury or diarrhoeal illness.

In addition, data available on mobile devices can be used to check a patient’s status from remote locations within the hospital, as well as facilitating handover between staff and task prioritisation using electronic lists.

Two examples of systems for the monitoring of vital signs are VitalPAC and Nerve Centre (see Box 4.3). A lot of work has been carried out on these systems to ensure that they are easy and intuitive to use.

### Box 4.3: Vital signs monitoring in practice

Vital signs monitoring software includes features that facilitate:

- remote monitoring
- early detection of deteriorating patients
- ward acuity data and handover
- task prioritisation.

Two proprietary examples are VitalPAC<sup>8</sup> and Nervecentre<sup>9</sup>

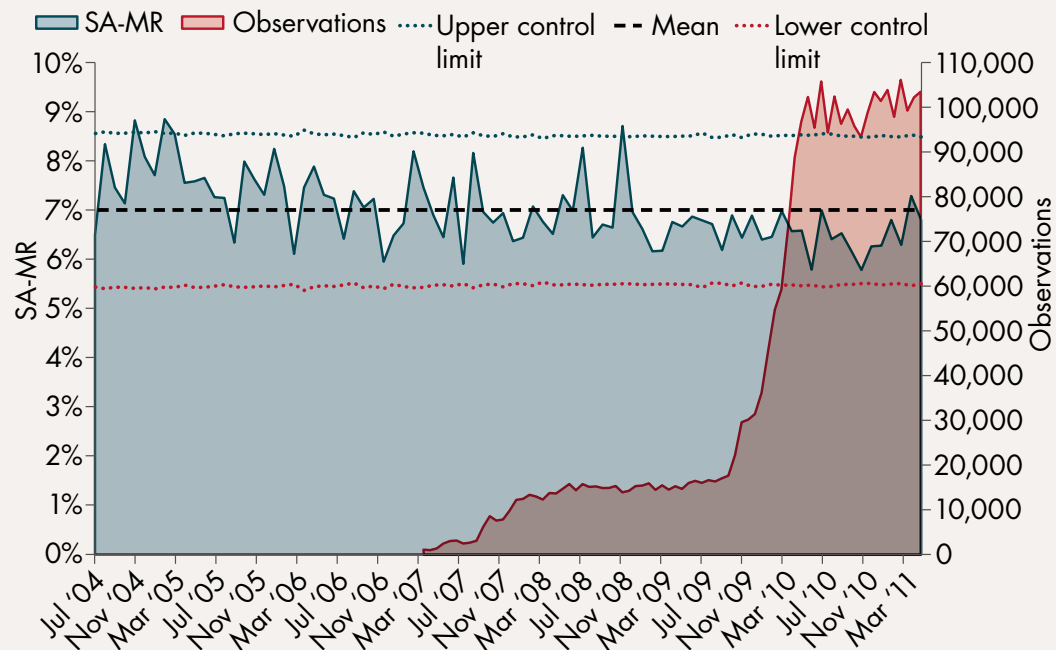
#### Impact

##### VitalPAC

VitalPAC is deployed across 50 NHS hospitals. Two peer-reviewed papers in BMJ Quality and Safety have evaluated some of VitalPAC’s features. Following the introduction of their software, they reported:

- an associated reduction in mortality (see Figure 4.1) – equated to an estimated 769 deaths avoided in 2010 across two hospitals (Schmidt and others, 2015)
- an associated reduction in norovirus outbreaks – by >90% (Mitchell and others, 2015).

Figure 4.1: Chart displaying the association between electronic observations and seasonal adjusted mortality rate



Source: Schmidt and others (2015)

8. <http://thelearningclinic.co.uk/vitalpac/>

9. <http://nervecentresoftware.com/>

*Nervecentre*

Nervecentre has been widely adopted in Nottingham University Hospitals NHS Trust. Mandie Sunderland, Chief Nurse at the trust, describes the benefit it brings:

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*“Ultimately, it is the patient who reaps the benefit of this innovative technology. Patients can be reassured that the combination of care delivered by highly skilled professionals and the use of mobile technology ensures that any change to their health status can be promptly identified and rapid clinical intervention guaranteed. All without the nurse leaving the patient’s bedside.”*

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Other examples include Birmingham Children’s Hospital NHS Foundation Trust, which worked with the McLaren Formula 1 team, to adapt technology used for the continuous remote monitoring of Formula 1 cars so that it could be used for the continuous monitoring of children’s vital signs in the paediatric intensive care unit. Its early warning system was able to predict oxygen saturation trends up to two minutes in advance, potentially saving £3 million per year through reductions in length of stay (The Health Foundation, 2011). In the US, a similar approach has been taken by Cerner – a health information technology supplier. It has developed a system to identify the early symptoms of sepsis. This continuously monitors key clinical indicators (including blood tests and vital signs) and attempts to recognise a potentially septic pattern. Cerner estimates that this could reduce in-hospital patient mortality by 24% and reduce length of stay by 21%, saving US\$5,882 per treated patient.<sup>10</sup>

### Monitoring in the community

Telehealth and other self-monitoring solutions are also providing a means to identify patients whose condition is deteriorating and where early intervention could mean that a hospital admission is avoided. For example, the US Department of Veterans Affairs’ telehealth programme has reduced resource utilisation as a result of its proactive approach to condition monitoring at home, ranging from 20% to over 55% for some chronic conditions (Cruickshank, 2012). Another good example is Aseptika (see Box 4.4).

10. Cerner St. John Sepsis Agent: [www.cerner.com/Solutions/Hospitals\\_and\\_Health\\_Systems/Acute\\_Care\\_EMR/St\\_John\\_Sepsis\\_Agent/](http://www.cerner.com/Solutions/Hospitals_and_Health_Systems/Acute_Care_EMR/St_John_Sepsis_Agent/)

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*“Since there is a large category of people who deteriorate over two or three days, with a deterioration pattern you can pick up... behaviours that are exacerbating the problem or symptoms. If you collect those in a systematic way, the algorithm... prioritise[s]... [the] likelihood of those elements causing hospital admission and then you monitor people... Then you can intervene. So the person with heart failure... you intervene by adjusting their diuretics... [or] by seeing them in the clinic urgently.” (Adam Darkins, Medtronic)*

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#### Box 4.4: Home-based early warning

The SENSOR project for patients with chronic respiratory disease is a collaboration between Portsmouth Hospitals NHS Trust, the University of Portsmouth and the UK-based Aseptika Ltd. It is aiming to develop and evaluate early warning systems for community-based patients.

A suite of medical devices, along with an iPad, measure a person’s lung function, physical activity, oxygen levels and weight. In addition, they send sputum samples to be tested using a novel testing kit, which can predict an increase in the virulence of bacteria in the lungs.

#### Impact

The hope is that the information gathered will spot early deterioration, allowing targeted intervention. Aseptika has predicted a reduced frequency of unscheduled admissions and reduced readmissions within 28 days – by 50 to 80%. The SENSOR project is currently undergoing clinical trials in Portsmouth.

Source: SBRI Healthcare, 2014; [www.activ8rlives.com/sensor/](http://www.activ8rlives.com/sensor/)

## Key lessons

### Implement vital signs monitoring solutions at scale

A number of hospitals have tried to implement vital signs solutions in one or two wards rather than across the hospital as a whole. They found that this led to duplication of work and an increased administrative burden in trying to marry separate paper and electronic systems. This suggests that to maximise the benefits of vital signs monitoring, it should be implemented across the whole hospital.

### Make the most of unstructured data

The vast majority of health care data is unstructured (such as doctors’ and nurses’ notes) and it is essential to find ways to make the best use of these data. This may mean finding technological solutions to convert them into structured data, or simply using better ways of finding and interpreting relevant information, such as natural language processing, sophisticated text mining or search tools.

### Predictive analytical systems are only as good as the data they are based on

Predictive analytical systems using statistical modelling are thought to be the best available technique for implementing proactive, more targeted care. However, they are only as good as the data that they use (Purdy, 2010). Drawing on a higher number of detailed datasets improves accuracy (Billings and others, 2013). Existing tools in the UK are often limited by out-of-date data and may generate false-positive results. Systems of the future, which draw on all available and current data – such as the complete clinical record, up-to-date investigation results, recent inpatient vital signs and results from home monitoring equipment – have the potential to more accurately flag those patients who are deteriorating, allowing for targeted early intervention and rescue.



### Better-coordinated care

MOBILE WORKING · PROF-TO-PROF TELEHEALTH · SHARED EHRs, REAL-TIME DATA

***The professionals involved with my care communicate with each other, working as a team and bringing together services to support me***

“Another huge opportunity with complex patients with the multiple morbidities patients have today, then when they go from primary care to secondary care and social care systems, we can coordinate care and make sure information is exchanged seamlessly without repeating constant tests, without constantly writing history notes but also understanding what has happened with previous conditions to a sufficient level to make a decision.” (Dr Harpreet Sood, NHS England)

The growing population of people with multiple conditions, many of whom are old and frail, makes effective care coordination a central challenge for any health and social care system. A typical patient can be in contact with a multiplicity of different caregivers and agencies, with no clearly defined person leading care. Without effective coordination, the experience of care will be poor and there is a significant risk of duplication or neglect.

In addition, health information about individual patients is frequently stored in a number of different and inaccessible silos across primary care, community and hospital systems. Even within a single provider, data can sit in different departmental systems.

Mental health services, where service users often have numerous interactions with multiple different professionals across a variety of locations, is a field where shared electronic records can be particularly beneficial. Digital technologies attack the costs and harms that come from poor communication and fragmented care by developing systems to coordinate care and support providers in collaborating more effectively.

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*“[A] lot of patients are on multiple care pathways and yet they are not really receiving a personalised care pathway that’s being delivered by a consistent care team, it’s pockets of care.” (Neil Williams, Total Mobile)*

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Box 4.5 gives an example of technology being used to support more integrated care.

### Box 4.5: Supporting integrated care for patients with diabetes

The **Western Diabetes Institute** is an 'integrated practice unit' in California, which co-locates multiple services and specialties required by patients with diabetes. It has partnered with ClickMedix, which offers a range of services, including:

- patient engagement tools and self-assessments
- teleconsultation with a network of specialists (including real-time data and care plan sharing across sectors)
- real-time outcome monitoring
- chronic disease management for a spectrum of diseases.

#### Impact

ClickMedix reports that:

- in one case study there were significant improvements in glycaemic control (by 1.66 over three months)<sup>11</sup>
- its system *could* lead to **physicians consulting with four to 10 times more patients and a 50 to 90% reduction in hospital visits** for patients with multiple chronic diseases.<sup>12</sup>

If all health care professionals have access to all patient information in real time, there is significant potential to reduce waste in the system, such as the duplication of tests. It can help make sure things are done at the right time, at the right place and not overdone. At Kaiser Permanente, a large not-for-profit health provider in the US, patients have already begun to experience the advantages of joined-up care:

11. <http://clickmedix.com/portfolio-items/whats-your-score-western-diabetes-institute-partners-with-clickmedix-to-transform-traditional-diabetes-care/>

12. <http://clickmedix.com/solutions/>

*“When you go to see an ophthalmologist and you haven’t had your colon cancer screening or your breast cancer screening, they can arrange it.” (Robert Pearl, Kaiser Permanente)*

Box 4.6 gives examples and ways of sharing data and information within and across providers.

### Box 4.6: Sharing data and information within and across providers

#### Integrating data within hospitals

The Mayo Clinic has designed its own app – **Synthesis**<sup>13</sup> – which works to combine data from numerous clinical systems within its organisation. This allows clinicians to go to one place in order to find blood test results, images, medications and other patient data. It also includes a messaging system for within the hospital and has patient-facing videos and material to facilitate doctor–patient communication.

#### Integrating data across providers and sectors

A number of health care organisations are sharing their data to facilitate coordinated care.

One example is **South Somerset Symphony**, a primary and acute care system (PACS) and joint venture between Yeovil District Hospital NHS Foundation Trust and South Somerset Healthcare Federation. It is using a shared electronic system to enable a single view of clinical activity between the hub and practices – allowing all providers to view a single patient record. Preliminary outcomes of integrated working show a reduction in:

- the number of admissions
- the number of Accident & Emergency (A&E) attendances
- length of stay (Castle-Clarke and others, 2015).

Proprietary systems, such as those offered by **Mirth**<sup>14</sup> and **Lumira**,<sup>15</sup> offer interoperability solutions for:

- areas wishing to integrate data from multiple different sources across health care settings
- facilitating access to a complete dataset for multiple users in different contexts.

13. [www.apple.com/iphone/business/profiles/mayo-clinic/](http://www.apple.com/iphone/business/profiles/mayo-clinic/)

14. [www.mirth.com/](http://www.mirth.com/)

15. [www.lumira.com/](http://www.lumira.com/)



### Integrating data via the patient

Systems have been developed in the US to allow the patient to bring together all their clinical information from multiple providers (e.g. laboratory results, medications, allergies and clinical notes). They also allow the patient to add their own data from apps or home monitoring equipment. At subsequent appointments, any health care professional authorised by the patient can view the complete record. In addition, self-help material or telemedicine applications may be integrated within the system. Examples include:

- Patients Know Best<sup>16</sup>
- Microsoft HealthVault<sup>17</sup>
- Get Real Health<sup>18</sup>
- Epic's 'Lucy' system.<sup>19</sup>

Nervecentre (described in Box 4.3) allows inpatient teams to seek specialist advice from other specialties by sending an instant message to the relevant specialist. This specialist then receives the referral details along with all of the patient's details, their up-to-date observations and results and location within the hospital.

Mobile access to data in real time as and when it is needed is of huge benefit to those working in the community:

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*"[T]here are many examples where a health care professional might be talking to someone in the community or in a remote clinic and they have to follow it up by chasing a report or a result and then get back to the patient. It's an inefficient use of time, effort and energy and doesn't really give confidence to the patient and the carers, particularly as often happens, a change in treatment is required. If that basic information had been available on a mobile device at the time of the consultation, then a more real-time, efficient and improved quality consultation would have resulted for all concerned."*

*(Dr Simon Wallace, Total Mobile)*

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16. [www.patientsknowbest.com/](http://www.patientsknowbest.com/)

17. [www.healthvault.com/gb/en-GB](http://www.healthvault.com/gb/en-GB)

18. [www.getrealhealth.com/](http://www.getrealhealth.com/)

19. [www.epic.com/software-phr.php](http://www.epic.com/software-phr.php)

One way of ensuring that all relevant professionals have immediate access to clinical data is by putting all relevant information – the patient’s entire record – in the hands of the patient. This means that wherever the patient is, their notes are. This approach has been adopted by ‘patient portals’ (see Box 4.10), allowing patients to own, store and control access to their clinical notes. For more information on patient resources, see the section ‘Greater patient engagement’ later in this chapter.

### Key lessons

The lessons for success, set out in Section 3, are particularly pertinent here. Investment in system design is needed to ensure ease of use by multiple users. Support for interoperability and sound information government mechanisms are also central to sharing data seamlessly and safely.

#### Create opportunities for informal exchanges between clinicians

Systems to share results or opinions digitally can remove the opportunity for the informal exchange of views and advice across teams, which often enrich and improve clinical decision-making. Clinical teams therefore need to provide alternative opportunities for face-to-face or other direct communication.



### Improved access to specialist expertise

SHARED EHRs, REAL-TIME DATA · PROF-TO-PROF TELEHEALTH · TELEHEALTH/TELECARE

***I, and those that support me, can access the specialist advice I need, wherever and whenever I need it***

“I do think... the one under-emphasised area where we see an opportunity for a very, very large productivity gain, not just in health care but in any kind of dealing with public services, is the movement of... conversations to video consultation.” (David Furniss, BT Global Services)

Telehealth and electronic communication remove geographical barriers between patients and health care professionals, improving quality and access

and delivering care to patients where they need it. This may be particularly beneficial for those receiving end-of-life care – a benefit realised by Airedale NHS Foundation Trust (see Box 4.7) – as well as those living in care homes.

Telehealth can also reduce A&E attendances and hospital admissions (see Box 4.7), leading to cost savings. A study of a heart failure telemonitoring service in Hull found an return on investment of 48% based on an assumed saving of £2000 per averted admission (Cruickshank and Paxman, 2013).

The specialist’s workload can also be reduced with the use of telehealth, through:

- using an initial email consultation to order tests
- more appropriate referrals
- reductions in the number of face-to-face consultations (Caffery and Smith, 2010).

#### Box 4.7: Airedale NHS Foundation Trust – care anywhere

Airedale NHS Foundation Trust’s telemedicine programme provides remote video consultations between health care professionals and patients in patients’ homes, care homes and prisons. It also supports professional-to-professional telemedicine, from hospitals to GPs and hospitals to prisons.

##### Impact

- The introduction of telemedicine solutions in care homes resulted in a **14% reduction in A&E attendances and emergency hospital admissions decreased by an additional 6%** compared with a control group without telemedicine (Hex, 2015).
- The incremental difference in costs between the telemedicine intervention and control groups was almost £1.2 million, with a **return on investment of £6.74 per £1 spent** by the clinical commissioning group (Hex, 2015).
- Additionally, **many more people have been supported to die in their home.** Previously most people died in hospital, but now 55% die at home.

Patients can now connect to clinicians via telephone, videoconference, email or web platforms. Kaiser Permanente found that engaging with patients over email improved performance on HbA1c screening and control, retinopathy screening and nephropathy screening (Zhou and others, 2010) (see Box 4.8 for further details of its telemedicine programme). Telehealth apps can be particularly helpful in large, sparsely populated geographical areas. They enable

a small number of clinicians to cover a large geographical area and even act internationally. However, this presents additional barriers, including regulation and accountability issues across international boundaries.

#### Box 4.8: Telemedicine at Kaiser Permanente

Kaiser Permanente has developed a number of different telehealth systems for remote consultations, including:

- integrated video visits – scheduled video appointments from a PC or smartphone to a Kaiser Permanente physician
- CDU-to-CDU telemedicine, where clinicians at a clinical decision unit (CDU) at one hospital can conduct remote consultations with patients at another, busier, CDU and ease the pressure there
- telestroke, which provides the ability to rapidly assess individuals with suspected stroke for possible thrombolysis, using a two-way video teleconferencing system.

#### Impact

*“Video truly will replace a visit... with less time [and]... in a way that the person doesn’t miss work...” (Robert Pearl, Kaiser Permanente)*

- In 2012, nearly **50% of contacts** between patients and primary care providers **took place over the telephone or through secure email** (Kaiser Permanente, 2015).
- Since the introduction of telestroke, the number of patients given tPA (thrombolysis) increased from 14 to 84 (over a 13-month period), with the **proportion given tPA in 60 minutes rising from 15.9% to 52.3%** ( $p < 0.05$ ) (American Telemedicine Association, 2015).

Clinicians can also use telehealth and other communications technologies to connect with each other (see Box 4.9). Videoconferencing, sharing of the patient record or using pre-defined, bookable appointments for professional-to-professional consultations might improve the interaction further. Such approaches have the potential to reduce referrals, improve care and educate and develop GPs.

20. [www.gpcare.org.uk/site/consultant\\_link/](http://www.gpcare.org.uk/site/consultant_link/)

### Box 4.9: Connecting professionals

Some centres have introduced ‘hotlines’ or email addresses for GPs to seek specialist advice. These have the potential to be developed further and become more widespread.

For example, in **Imperial College Healthcare NHS Trust’s paediatric services** (The King’s Fund, 2014), GPs have access to specialist advice via a 24-hour email hotline and a telephone hotline (12pm to 2pm weekdays), both run by consultants at St Mary’s Hospital.

Another example is **Consultant Link**, a service run by GP Care, which is a UK primary care federation. This has been used in at least eight GP practices. The service uses ‘hunt group’ telephone technology, whereby a call to a single number can be directed to multiple numbers. The GP’s unique hotline is linked to the first available local consultant’s mobile phone. Following the call, an audio file is attached to the patient’s notes. GP Care reports that since 2012, **63% of calls have resulted in avoidance of a referral.**<sup>20</sup>

New online services are also being developed that could disrupt traditional services. For example, in the US, HealthTap<sup>21</sup> is an online organisation that draws on a network of doctors to provide health advice. It enables patients to have a consultation via telephone, video or text messaging, 24 hours a day, wherever they are. Patients can share test results and get immediate answers, treatment and referrals.

Systems including Dr Now<sup>22</sup> and Babylon<sup>23</sup> offer a similar service in the UK, including teleconsultations and medication delivery. These are currently offered via subscription or one-off payments per consultation, although some GP practices are using proprietary systems to connect with their NHS patients.

21. [www.healthtap.com/](http://www.healthtap.com/)

22. [www.drnow.com/](http://www.drnow.com/)

23. [www.babylonhealth.com/](http://www.babylonhealth.com/)

## E-ICU

E-ICUs or tele-ICUs are intensive care units that receive support from a remote critical care team through patient surveillance and monitoring as well as remote consultations. Tele-ICUs can be associated with a number of benefits, including:

- reduced mortality and ICU length of stay rates, which some have linked to increased revenue and decreased ICU and hospital costs (see Goran, 2010; Kumar and others, 2013; Lilly and others, 2011)
- improved staff outcomes, for example:
  - prevention of intensivist and nurse burnouts and onset of post-traumatic stress, due to additional support provided by the remote team (Kumar and others, 2013)
  - a decrease in the turnover of registered nurses – in one centre it decreased by 56% 33 months after implementation, saving US\$1,090,909 per year (Goran, 2010)
  - greater collaboration between tele-intensivists and bedside physicians (Young and others, 2011).

## Key lessons

### Patient-to-professional telehealth can cost more than it saves

There is mixed evidence on the cost-effectiveness of patient-to-professional telehealth (Ekeland and others, 2010; Mistry and others, 2012; de la Torre-Díez and others, 2014). There are a number of factors that need to be taken into account:

- Staff engagement. Telehealth can have a significant impact on staff roles. Investment in organisational development and staff training will be required to ensure that it achieves its full potential.
- Patient selection. Ensure that telehealth is used with patients who will reap the greatest benefits. A systematic review found that, in some cases, the lack of in-person care hinders a thorough clinical assessment and appropriate treatment decisions (Guise and others, 2014). Sound referral processes and staff training can help with selecting appropriate patients (Hendy and others, 2012; Taylor and others, 2014). If a virtual system is simply run alongside a physical system, this is likely to double costs.

Patient engagement. This can be achieved through:

- raising patient awareness about the technology
- educating patients about how the technology should be used (particularly in the case of remote monitoring)
- assuring patients of robust information governance mechanisms
- tailoring the technology to patients' needs and environments.

There is also evidence that patients become more engaged in their own care through recording data (Vassilev and others, 2015).

### Be aware of increases in demand

Remote consultations can increase demand. Leaders at Kaiser Permanente found that virtual visits via telephone and email increased from under five million in 2008 to over 10 million in 2013, while face-to-face visits remained largely the same (Pearl, 2014). Health care providers must be aware of this possibility when developing business plans for telehealth solutions, rather than assuming that telehealth will reduce demand on face-to-face appointments.

### Identify appropriate cases for professional-to-professional telehealth

One study found that 'failed teleconsults', whereby a face-to-face consultation is required despite the teleconsultation, could increase costs by US\$709 million across the US (Cusack and others, 2007). This means that it is important for generalists to try to identify cases for professional-to-professional telehealth that will not require specialist follow-up – although this might not always be possible. Moreover, the same study found that when email consults and real-time interactions were used together, the cost of the additional visits was offset by early specialist involvement in patient care (Cusack and others, 2007).

### Engage staff when implementing e-ICU

Staff reluctance to engage with the e-ICU is likely to have a significant impact on both clinical effectiveness and cost-effectiveness. Health care professionals may be reluctant to engage because they do not understand how the system works, and find the remote team threatening (Kumar and others, 2013). In other cases, clinicians may not feel they need additional clinical input, and therefore do not use the e-ICU (Kumar and others, 2013).

When there is a difference of opinion on patient care between the bedside and remote teams, quality may be compromised.

Young and others (2011) suggest the following:

- Inform ICU nurses of the scope of the tele-ICU consultants’ authority.
- Encourage nurses to identify conflicting treatment directives and provide clear instructions for resolving those conflicts.
- Arrange periodic face-to-face meetings or site visits for bedside and consulting clinicians.



## Greater patient engagement

SHARED EHRs, REAL-TIME DATA · WEARABLE APPS · TELEHEALTH/TELECARE · PATIENT PORTALS/RECORDS · ONLINE COMMUNITIES

***I have the information, and support to use it, that I need to manage my condition and make choices about my care***

“Engage patients at a very early stage of their lives when they are very well or if they’re just at risk and we can start helping them get into patterns of behaviour and behavioural changes that are going to put them on a course or trajectory to minimise chronic conditions in the future. That’s where the huge savings are going to be in the long term. That’s where the huge productivity improvements will be as well.”  
(Richard Bakalar, KPMG)

Technology is rewriting the relationship between patients, professionals and care providers. Patients are taking more control over their health: 69% of doctors globally report that patients often look up conditions prior to consultation, and 62% of doctors say that patients often arrive self-diagnosed (Cello Health Insight, 2014). Tools for patient empowerment and self-management provide opportunities for patients’ active participation in their care, with the potential to reduce waste and improve service quality and outcomes.



However, there is one note of caution: some people could be disadvantaged in a world that relies on high levels of general and computer literacy. Over half of patients have limited literacy and numeracy skills (Rowlands and others, 2014). Data from the Office for National Statistics (2014) show that while technology use by those over the age of 65 has grown significantly since 2006, and we can expect it to grow further, it still lags behind that of younger age groups.

## Patient portals and access to the clinical record

Many health care providers, particularly in the US, have created patient portals. These give patients access to their medical information, such as discharge summaries, medications, immunisations and laboratory results. More advanced portals now enable patients to:

- develop and track their personal care plans
- request prescription renewals
- schedule non-urgent appointments
- exchange secure messages with their provider
- access their health education library.

The OpenNotes programme in the US has actively encouraged health care providers to give patients electronic access to their clinical notes. It reports:

- better self-management among patients
- improved medication compliance
- greater feelings of control over their health
- greater understanding of their health.

After a 12-month pilot programme, 99% of patients wanted to continue to have access to their notes online and none of the doctors decided to stop the practice (Walker and others, 2015).

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*“Patient co-production of data into a hospital EHR will redefine the interaction with care services. For example, pre-clinic questionnaires, data re: long-term conditions (blood pressure, weight, peak flow), will allow patients to triage themselves into the appropriate part of*

*the service. This will be transformational I believe.” (NHS trust CEO, from survey panel)*

Patient portals and online tools can also allow efficient resource management in the community, directing patients to the most appropriate source of advice and enabling GPs and other clinicians to focus on those with greatest need (see Box 4.10). A proprietary example in the US is iTriage,<sup>24</sup> which allows patients to access online health advice, find out where the nearest health facility is and manage their medical record. It has been downloaded over 14 million times.

#### Box 4.10: Using patient portals to make more effective use of staff time

**Hurley Group**, a London-based GP organisation, has developed a platform called **WebGP**.<sup>25</sup> This is designed as a ‘first port of call’ for patients seeking primary care advice. On entering the site, the patient has the option to:

- seek self-help material
- obtain admin support
- access pharmacy advice
- contact out-of-hours services
- have an e-consult with their GP.

An e-consult consists of the patient filling in a form explaining the problem they have, which is then sent to the GP to action. Hurley Group reports that e-consults take 2.9 minutes on average to respond to.

An analysis of a pilot study of WebGP over six months found that:

- of the e-consults, 40% led to a prescription, 40% led to a GP appointment and 20% led to a telephone consultation
- 18% of patients self-managed an issue for which they had planned to see a GP
- for every WebGP user requiring a GP response via an e-consult, five users required online self-help only (WebGP, 2014).

**Modality**, a primary care provider based in Birmingham, uses a hub-based approach for telephone consultations. Patients can contact the hub, which is staffed by former 111 receptionists and call-centre operatives (111 being the NHS urgent advice hotline number). The receptionist either signposts the patient

24. <https://about.itriagehealth.com/>

25. <http://webgp.com/>

to online self-care resources or takes the patient's details and organises a contact from either a nurse practitioner or a GP within the hour. The hub can be reached either by telephone, by using an online app, or through the Modality website.

Modality has reported the following:

- Efficiency savings. Each day, 700 calls are handled by the remote hub, with up to 1300 being processed on peak days like Mondays. On average, these calls are answered within 40 seconds – compared with a previous average wait time of six-and-a-half minutes (please note: these data were gathered shortly after the launch of the service).<sup>26</sup>
- Effective triage. The hub is able to send patients to the most appropriate practice.

## Improving the patient experience

New apps (see Box 4.11) give patients much more information and control over their care, with consequent improvements in their experience of services.

### Box 4.11: Improving the patient experience

#### Improving the inpatient experience

- Epic's 'Bedside'<sup>27</sup> app for patients includes a number of features, such as providing up-to-date information about scheduled events, a visual summary of the care team and a patient-friendly summary of laboratory results.
- The GetWellNetwork<sup>28</sup> has a number of different systems, which are tailored towards paediatric patients, adults, older people or federal patients. They focus on patient engagement and education and also offer features for communicating with family and friends, surfing the internet and accessing entertainment.
- The Mayo Clinic<sup>29</sup> has an app for its patients so that they have access to their clinical information and health data, as well as providing a number of administrative functions.

26. [www.digitalhealth.net/digital\\_patient/46624/health%ADit%ADand%ADvitality1/8](http://www.digitalhealth.net/digital_patient/46624/health%ADit%ADand%ADvitality1/8)

27. [www.epic.com/software-phr.php](http://www.epic.com/software-phr.php)

28. <http://getwellnetwork.com/solutions/inpatient>

29. [www.mayoclinic.org/apps/mayo-clinic](http://www.mayoclinic.org/apps/mayo-clinic)

### Improving the outpatient experience

- MyOps<sup>30</sup> is an app made by IBM, to be tested and launched in Burton Hospitals NHS Foundation Trust. It aims to improve the outpatient offer with:
  - a planned roadmap of essential features such as alerts, reminders and updates to appointments (including if there is a delay)
  - useful information about the hospital, including maps and parking information
  - the option to receive all clinic letters through the app.
- Similar benefits may be built into existing EHRs. Cerner provides an option for patients to change the date of their clinics online.<sup>31</sup>
- The Mayo Clinic app allows appointments to be requested or changed.

### Support for self-help and care planning

New electronic tools and apps can support patients at all stages of their journey – from those managed in the community, to those who are currently inpatients and those who are undergoing rehabilitation post-discharge. Apps and software can facilitate goal setting, target attainment and easy communication with the health care team. A systematic review has shown that tele-rehabilitation can be successful across a variety of specialties (Hailey, 2011).

Box 4.12 gives two examples of organisations that are engaging patients in online care planning.

#### Box 4.12: Support for self-care and care planning

VitruCare<sup>32</sup> is one example of a tailored online care management tool used in the UK. Patients can remotely log in to VitruCare, enter data related to their health goals (which are also available to their GP), send secure messages to their care team and connect with other patients using a social media tool.

- A study of VitruCare one year after implementation showed reduced clinical practice contacts in outpatients departments and A&E and reduced acute admissions (Ali and others, 2011).
- A second analysis found that contacts declined by 53% after implementation, with 71% fewer A&E attendances and 83% fewer acute admissions. The study also found that total costs were reduced – from £97,534 to £42,752 (Ali and others, 2011).

30. [www.youtube.com/watch?v=s-3SARau0js&app=desktop](http://www.youtube.com/watch?v=s-3SARau0js&app=desktop)

31. [www.cerner.com/solutions/Physician\\_Practice/Patient\\_Portal/](http://www.cerner.com/solutions/Physician_Practice/Patient_Portal/)

32. [www.dynamichealthsystems.co.uk/vitru-care-supported-selfcare](http://www.dynamichealthsystems.co.uk/vitru-care-supported-selfcare)

**Wellframe**<sup>33</sup> is a similar system, which has been used in adolescent psychiatry services and cardiovascular rehabilitation in the US. Its apps and web-based software allow service users to easily access and review their care plan as well as receive prompts to aid medication compliance. It also allows patients to check to-do lists, log exercises and contact their clinicians.

- A pilot study evaluating a Wellframe app to promote physical wellbeing in mental health patients found a high level of engagement (mean a daily usage rate 94%) and a response rate of 73% across all prompts, including those that encouraged physical exercise (Macias and others, 2015)

## Patient networks

An increasingly important source of advice and information for patients are online networks that signpost other resources but also leverage the insight and experience of patients themselves (see Box 4.13).

### Box 4.13: Peer-to-peer resources for patients

A number of proprietary services exist that allow patients to access advice provided by others with similar diagnoses. This can be in the form of articles or blogs or via extensive fora, the latter allowing for networking and personalised answers.

A well-known example is **PatientsLikeMe**,<sup>34</sup> which allows patients to search for advice and information about their condition provided by other patients. Users can also log and track symptoms, which they can present to their health care team. PatientsLikeMe has over 350,000 members, covering **2,500 conditions**, with **28 million data points about disease**. It uses its data to contribute to scientific research and generates revenue by selling the data to interested parties – such as pharmaceutical companies.

## Videos as a consultation record

Evidence from a range of specialties suggests that patients who are given a video recording of their consultation find it helpful and it has improved their recall of the advice and information given during the consultation (Meeusen and Porter, 2015; Tsulukidze and others, 2014). In mental health, and child mental health services in particular, recording of consultations is already widespread (see Box 4.14).

33. [www.wellframe.com/](http://www.wellframe.com/)

34. [www.patientslikeme.com/](http://www.patientslikeme.com/)

#### Box 4.14: Videoing consultations in child mental health

Recording of consultations is becoming increasingly widespread in child mental health services. While careful negotiation and explanation must take place before any recording, benefits include:

- the ability to monitor therapeutic change over time
- enabling children to observe and reflect on their behaviours
- training parents in how to handle certain behaviours
- facilitating the involvement of the wider multidisciplinary team
- aiding in teaching, training and research.

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*“Quite a lot of medical records are already video, especially in CAMHS [child and adolescent mental health services], and it is a tool for patient involvement.” (Stuart Bell, Oxford Health NHS Foundation Trust, via personal communication)*

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However, it is important that the issue of consent is carefully considered and that consent is obtained. Important consideration must also be paid to the storage and erasure of video material. The Royal College of Psychiatrists (2015) provides guidance on this issue.

As noted in Box 4.14, the recording of consultations raises important issues surrounding consent and information governance, as well as concerns about the effect it may have on the behaviour of both doctors and patients (Elwyn and Buckman, 2015).

### Wearables and apps

There has been a recent explosion in apps and wearable technology. However, it is far from clear what impact these will have on people’s health and their interactions with health care providers.

There are mixed feelings about them among professionals. In a global survey of doctors:

- 41% agreed with the statement that mobile apps could be a ‘game-changer’ for improving health

- only 36% stated that they would recommend a mobile health app in future to their patients (Cello Health Insight, 2014).

To date, there has been a real focus on apps and devices to improve wellness – such as step and calorie counters – as well as those focused on a single disease. There has been less of a focus on tools for complex costly patients. One interviewee said that developers shy away from apps for complex patients because:

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*“They’re too complicated, they’re too unappealing, the ROI [return on investment] is too unclear, the time to pay off is too long [and] they need to know too much about these patients in order to develop these applications.” (David Blumenthal, The Commonwealth Fund)*

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A systematic review into smartphone apps for the prevention, detection and management of cancer found that, while there are a ‘considerable number’ of apps available, the evidence for them is ‘lacking’ (Bender and others, 2013).

Devices such as Fitbit and smartphones collect a huge amount of data. Patient portals such as Patients Know Best<sup>35</sup> allow patients to integrate these with their EHR, while EMIS Health<sup>36</sup> is able to access data stored in Apple's Health app once the end user has consented to share it.<sup>37</sup> However, generally speaking there are issues around uploading app data to EHRs and even more so in meaningfully interpreting the results.

Several interviewees had mixed views on the potential of wearables and apps.

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*“There is an overemphasis on the device that people are using to capture the information and not on what am I going to do with the information now I have captured it?” (David Furniss, BT Global Services)*

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35. [www.patientsknowbest.com/](http://www.patientsknowbest.com/)

36. [www.emishealth.com/about-us/](http://www.emishealth.com/about-us/)

37. [www.apple.com/uk/ios/health/](http://www.apple.com/uk/ios/health/)

There also remain security concerns around the use of mobile technology, particularly in unregulated markets. In 2015, the UK NHS Health Apps Library carried out a systematic assessment of 79 apps certified as clinically safe and trustworthy. It found that 89% transmitted information to online services and that 66% of apps sending identifying information over the internet did not use encryption (Huckvale, 2015).

## Key lessons

### Ensure that patient-facing technology is easy to use

When designing patient portals or other patient tools, it is essential to ensure they are both easy to use and appealing to patients. Failure to do this may mean that there is low patient uptake of the resources. When developing WebGP (see Box 4.10 above), Hurley Group worked closely with designers and patients to ensure that it was both intuitive and engaging. Guidelines have been produced for developers working on apps for older people, which include avoiding animations and scroll bars and highlighting important information (Díaz-Bossini and Moreno, 2014).

### Patient portals can increase as well as manage demand

A Kaiser Permanente study found that patients with access to their records online (as well as e-mail access to physicians) had a higher number of office visits and telephone encounters, compared with the number prior to implementation of the patient online access system (Palen and others, 2012). This will not always be the case and the findings from this study were unexpected. However, when developing the business case for a patient portal, it is important to be aware of this risk.

### Action is needed to ensure that data from apps and wearables are used appropriately

The potential to transfer data from patient devices to EHRs raises concerns about how large amounts of data will be stored and meaningfully interpreted by health care professionals – particularly those in primary care. Additionally, strategies to prevent over-reaction to physiological variants and false positives, while at the same time ensuring safe responses to abnormal results, are required. Investment in analytical capability is likely to be needed, particularly that which identifies



trends and anomalies. It may be necessary to target resources to those most likely to benefit from ongoing monitoring.

### Use medical apps with caution and apply professional judgement

Medical apps are apps that:

- diagnose
- support diagnosis or clinical decisions
- make calculations to determine diagnosis or treatment or
- are used for any medical purpose.

All medical apps, including web apps, should have a CE mark, showing conformity with European Regulations. This ensures that they are clinically safe. However, the CE mark is not assurance that they meet best practice or that they have been tested for clinical accuracy or patient benefit. Therefore, it is essential to apply professional judgement when using medical apps. One option is for GPs to only recommend the use of wearable apps/devices that they trust at the prescribing stage. The Royal College of Physicians (2015) recommends that if someone is using an app that does not have a CE mark, they should urgently seek the app developer to obtain one. All medical devices should meet the requirements of the Medical Devices Directives and Regulations and any issues with medical apps should be reported to the Medicines and Healthcare Products Regulatory Agency (MHRA) (Royal College of Physicians, 2015).



### Improved resource management

MOBILE WORKING · BUSINESS PROCESS SUPPORT · PATIENT FLOW MANAGEMENT · E-ROSTERING · SHARED EHRs, REAL-TIME DATA

***Whenever I use a service there are no unnecessary delays or wasted visits***

“We should be tracking all materials... tracking the time of our procedures and automating our scheduling... The more analysis we have on that... the more clinicians can make efficient decisions, which will then improve their productivity.” (Joel Haspel, GE Healthcare Finnamore)

There are significant opportunities to improve productivity by bringing to bear the tools widely used in other sectors for improved resource management. These include tools to plan staff rosters, manage patient flow and improve scheduling. This will enable business processes to be much more efficient.

## E-rostering and mobile working

Tracking and management of staff time through e-rostering solutions can be used to ensure that the workforce is employed where it is needed most, enabling quality and efficiency improvements. *Well-implemented* systems can:

- significantly reduce time taken to develop the staff roster
- avoid both overstaffing and understaffing and reduce reliance on agency staff
- provide more flexible and less stressful working patterns for staff
- support automatic collation and transmission of workforce activity data
- incorporate task management and allocate clinical tasks to staff in real time, when linked to clinical record systems.

While the majority of NHS trusts now have some sort of e-rostering software, there are few independent evaluations of e-rostering solutions in the literature. Anecdotally, the experience of implementing these systems has been mixed. The trusts we surveyed generally found the results from implementing e-rostering systems to be disappointing. However, some trusts report efficiencies in the entire health care workforce management process. Black Country Partnership NHS Foundation Trust has identified financial savings in excess of £750,000 through the use of e-rostering solutions.<sup>38</sup> A number of those we interviewed were very positive about the opportunities presented by e-rostering as part of a wider digital strategy (see also Box 4.15). The systems are also becoming increasingly more sophisticated – not only creating rosters but also then allocating and tracking tasks.

38. [www.allocatesoftware.com/wp-content/uploads/sites/1/2015/03/ALLOCATE-HEALTHROSTER.pdf](http://www.allocatesoftware.com/wp-content/uploads/sites/1/2015/03/ALLOCATE-HEALTHROSTER.pdf)

*“[With the] ability to use technology to be predictively allocating your most experienced nurses and the appropriate skills mix to where the patients need them, you get a big cost saving, but you also get the quality improvement from being able to do that.”*

*(Matthew Swindells, Cerner)*

### Box 4.15: E-rostering

E-rostering systems can bring new levels of flexibility and oversight to the workforce, providing users with insight into their staffing needs and enabling rapid deployment and changes to rota patterns.

**The RotaGeek<sup>39</sup> mobile app is an example of a proprietary system used by some NHS providers<sup>40</sup>** to facilitate e-rostering. It enables online rota design based on work terms and conditions, employee preferences and leave requirements. Staff can use the app to submit requests to swap shifts or leave and to receive updates and changes to their rota.

**Another approach is to link e-rostering to the EHR, as done by Bromley Healthcare in London – a community provider with 800 staff working across 17 locations. Using Allocate Software,<sup>41</sup>** managers are able to see which tasks have been completed, how long they have taken, where they have taken place and by which member of staff. They can then reallocate the workforce in real time, based on workload and demand. Change has not been easy and staff have often resisted the new ways of working. However, basing decisions on data and information has helped.

- Bromley Healthcare now has the **best 2015 Friends and Family score** in London (at 98%).
- It has seen **dramatic reductions in non-attenders** (from 13% to 4%).
- It has seen **improvements in Quality of Life Scale (QOLS) scores and Modified Barthel Index (MBI) scores** – the latter being a measure of activities of daily living.
- **Waiting times have fallen** and **district nursing appointments have increased** (from 100,000 to 140,000).

Source: Jonathan Lewis, Bromley Healthcare (personal communication)

39. [www.rotageek.com/index.html](http://www.rotageek.com/index.html)

40. Via personal correspondence.

41. [www.allocatesoftware.com/](http://www.allocatesoftware.com/)

## Support for mobile working

Active support for mobile working (see Box 4.16) can also reap significant productivity gains. A high proportion of those we surveyed across hospital, community and primary care settings confirmed this. For example, remote access to records, via tablets and other mobile devices, can transform the way that staff in the community deliver care. Instead of having to travel to a base twice a day to pick up and return heavy notes, a case list can be downloaded at home. Apps can include CDSSs and in-built protocols, facilitating efficient care that is compliant with best practice. They can also work in both online and offline mode to facilitate mobile working.

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*“You get efficiency gains not just from avoiding going backwards and forwards but also you get a better consultation and a better job experience... the technology allows them to do their job better.”*  
*(David Furniss, BT Global Services)*

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### Box 4.16: Remote access to clinical records

Examples of apps that support remote working include **MIA Maternity by Isosec**<sup>42</sup> – a tool for community midwives – and **TotalMobile**<sup>43</sup> – for community care. The apps work in offline and online mode. When online they automatically push and pull data from the central hospital server (sync), ensuring that all patient information is up to date and available to all members of the team.

MIA Maternity has been introduced at Imperial College Healthcare NHS Trust, where the following benefits have been reported:

- There has been a saving of five hours per midwife per week.
- This is equivalent to **£9,000 per midwife per year**, with an additional **£600 per year** of travel costs saved (Isosec and Imperial College Healthcare NHS Trust, 2015).

Total Mobile claims that its system, which has been used by UK community care providers, can save up to **two hours per clinician per day**.

42. [www.isosec.co.uk/](http://www.isosec.co.uk/)

43. [www.totalmobile.co.uk/](http://www.totalmobile.co.uk/)

## Managing patient flow

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*“I should be able to track all my people and all my moveable assets... and I should be able to manage... that from a command centre. So I could see that somebody is... finishing up a procedure and I’m going to need the bed within an ICU... and at the same time I can see what’s going on in A&E.” (Joel Haspel, GE Healthcare Finnermore)*

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Global Positioning System (GPS) technology allows companies to track, in real time, exactly where staff and resources are. The logistics industry has harnessed the potential of tracking to fundamentally change the way it works, driving improvements in efficiency, productivity and customer experience.

Patient-flow tracking systems can help to identify both patients waiting within the system and at-risk patients. This allows staff to act quickly and help manage problems. Tracking technology such as real-time location systems (RTLs) – which draw on radio-frequency identification (RFID), infrared and barcode technologies – can track room status, patient status, patient waiting times, staff status and mobile equipment location (see Box 4.17). This can be combined with patient tracking in order to gain a holistic view of a department or ward.

### Box 4.17: Using real-time location systems (RTLs) to improve processes and manage flow

Royal Wolverhampton NHS Trust is using RTLs as the enabling technology to automate all care delivery support processes. The system can accurately pinpoint the locations of tagged equipment, badged patients and staff. It tracks all patient–staff interactions, patient-to-patient contact and patient–equipment contact. The system is being used to help with flow and capacity management as well as to enhance infection and prevention control.

At Wolverhampton, the ‘Safe Hands’ programme is using the software to monitor hospital employees washing their hands upon entering and exiting a patient care area. The system allows infection prevention nurses to remotely observe and analyse the behaviours of ward staff. It gives real-time feedback to inform wards of their progress. It does this by colour coding scores on electronic screens to show good, average or poor hand-washing compliance to encourage behaviour change.

The following benefits to the use of RTLs at Wolverhampton have been found:

- Beds are becoming available to new patients in less than 40 minutes.
- Finding a tagged asset takes 25 seconds – allowing timely patient intervention.
- Nearly 75% of discharged patients leave wrist badges in a drop-box, which automatically triggers the cleaning of vacated beds.
- The number of observed hand-washing events increased by over 1000% per month after implementation. There were 1.2 million automated hand hygiene observations versus 600 manual ones over a one-month period after implementation.
- Staff can access their own data to self-govern performance and are extremely positive about the system.

Source: The Royal Wolverhampton Hospital NHS Trust (2014) and TeleTracking (2014)

In the US, there are other examples of patient tracking systems. A key component of some of these is not only the tracking system itself but also the co-location of all the people managing patient flow in a ‘command centre’ (Jensen, 2004). The patient-flow systems provide the command centre with key metrics from across the patient pathway.

## Business process support

Processes such as human resources (payroll and recruitment), estates and facilities, procurement and billing all represent areas where efficiencies could realistically be achieved using technology-assisted processes, including robotics. Maximal efficiencies may only be achieved, however, when individual processes are not just made quicker but are also combined into a single integrated solution. Some organisations are striving to achieve this by forming strategic partnerships with business process support specialists. These specialists manage and deliver a host of support services on behalf of the organisations, including information technology, human resources, estates and facilities, and finance services.

## Key lessons

### Use e-rostering as a tool for workforce redesign

E-rostering solutions are not electronic versions of paper rosters, but a tool to redesign workforce deployment. When implementing e-rostering technology, think about how the workforce is already working – particularly the ‘informal, process oriented information exchange and communication’ that take place across staff (Gurses and others, 2006). If the technology is adaptable it can support changes in how teams work over time. This will allow changes to workforce design to be made iteratively and increase the likelihood of acceptance by staff.

### Support staff engagement with ‘bring your own device’

A number of organisations have found that giving ward nurses a mobile device – such as a tablet or mobile phone – and allowing them to take it home, customise it and use it for personal tasks, have ensured higher uptake of the technology. Not only this, but they have found that nurses have been checking their rounds on their way to work and familiarising themselves with the handover notes.

The sense of ownership created through allowing employees to take responsibility for devices, has led to other benefits, including front-line staff identifying and downloading useful apps for their day-to-day work. In one case, an interviewee noted nurses were using a hosiery selector app to choose bandages for pressure sores for diabetics. The benefits of the app had been passed on by word of mouth across the nursing team.

Mobile device management (MDM) enables organisations to shut down mobile devices if they are lost or stolen, or to wipe clinical information systems once they are taken off clinical premises.

### Develop the capacity to work offline

In moving to mobile working, benefits can be gained from apps that can work offline. These enable mobile workers to carry out tasks where Wi-Fi is not available – and to upload their notes to the clinical system once a signal is restored.

### Consider data privacy issues

Patient tracking systems need to be sensitive to data privacy issues. Patient confidentiality can be protected through the use of identity numbers rather than names; and patients should be informed about the data on them that are being collected and how these data are being used (Yao and others, 2010).



## System improvement and learning

STANDARDISED WORKFLOWS · PATIENT OUTCOMES/REGISTERIES · SHARED EHRs, REAL-TIME DATA · PREDICTIVE ANALYTICS/RISK STRATIFICATION

***I know that the services that support me are always trying to find ways to improve my experience and the outcomes that are important to me***

“Electronic health records are dumb. They are not the major source of productivity or value enhancement. They are a mechanism for entering and storing data. It’s what you do with the data that creates the value.”  
(David Blumenthal, The Commonwealth Fund)

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*“We see a huge opportunity for analytics to be applied to that data such that the care pathways become learning pathways.”*  
(Neil Williams, Total Mobile)

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Feeding the learning from clinical and non-clinical data back into existing processes is essential to fully realising the benefits of digital technology. In this report we have already highlighted numerous examples of how this continuous cycle of improvement and learning can take place. One of the most advanced examples of a health care provider using technology to drive improvement is Intermountain Healthcare in the US (see Box 4.18).



### Box 4.18: Intermountain Healthcare

A core part of Intermountain Healthcare’s digital strategy is system improvement and learning from the data it collects. It captures three key types of data:

- intermediate and final clinical outcomes – short- and long-term clinical outcomes, including where clinicians have varied from protocol
- cost data – stored and used with the clinical data to manage quality improvements and cost reductions
- patient satisfaction and experience.

Intermountain Healthcare gains significant benefits from tracking detailed cost data as part of managing each clinical process, given the tight link between cost and quality. This approach is aligned with the Institute for Healthcare Improvement’s ‘Triple Aim’ concept:

- improving the patient’s experience of care
- improving the health of populations
- reducing the per-capita costs of health care for populations (see Berwick and others, 2008).

Intermountain Healthcare’s clinical registries are directly derived from its clinical workflows (see Box 4.2). It currently has 58 such condition-specific registries – tracking a complete set of intermediate and final clinical and cost outcomes by patient – some of which have been established for 20 years.

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*“Within our registries we track long-term patient outcomes, which physicians usually didn’t have before. They are extremely useful in changing and improving clinical practice. You then use that structure for doing clinical research.” (Brent James, Intermountain Healthcare)*

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Together, these registries account for about 80% of all inpatient and outpatient care delivered within the Intermountain Healthcare system.

Data analysts are fundamental to this process. Intermountain Healthcare’s Institute for Health Care Delivery Research employs 17 statisticians at Masters level or higher to analyse registry data and produce routine reports on care delivery performance. The intention is to make performance transparent to the clinical teams at an individual patient level and at a process level. According to Brent James, Executive Director at Intermountain Healthcare, Intermountain Healthcare has carried out three formal evaluations to understand whether these data analysts could be replaced by a business intelligence system. However, it has always found that analysts are the preferable option given that they offer considerably

more flexibility than a technological solution. Intermountain Healthcare embeds its analysts in clinical teams and leaders believe that they represent very good value for money, often costing less than a nurse but offering insight that could save their salary many times over.

- Intermountain Healthcare has already taken out 10% of its costs in the last three years. It believes that these systems will enable it to reduce the cost of care by 50% – through both reductions in waste and non-value-adding activity and improvements in clinical outcomes.

Source: Interview with Brent James, Intermountain Healthcare

The use of large clinical databases and disease registries with vast numbers of data points, allow for powerful analyses and provide health care organisations with new understanding and levers for quality improvement (see Box 4.19).

#### Box 4.19: Disease registries

Analysis of large sets of patient-level data can provide new insights into disease patterns, aetiological associations and treatment trends. Examples include the following:

- The **Norfolk Arthritis Register (NOAR)**<sup>44</sup> is a long-running epidemiological study using data collected from patients living in Norfolk with a diagnosis of inflammatory arthritis. Clinical information – such as symptoms, signs, blood tests and other data – is collected from consensual patients and stored on a central database. NOAR has managed to collect and centralise data on over 3,500 incident cases, resulting in over 80 scientific research publications.
- The **Clinical Record Interactive Search (CRIS)** system<sup>45</sup> allows authorised researchers to access anonymised information extracted from the electronic clinical records system of South London and Maudsley NHS Foundation Trust (a mental health trust). Investigators can use the data to identify patterns and trends of disease and study treatment use and efficacy. CRIS data led to 15 research publications in 2015 alone.
- The **Clinical Practice Research Datalink (CPRD)**<sup>46</sup> contains anonymised primary care records and is made available for authorised researcher projects. Use of the CPRD has resulted in over 1,500 publications since 1987, including confirming the safety of the measles, mumps and rubella (MMR) vaccine.

44. [www.inflammation-repair.manchester.ac.uk/musculoskeletal/research/CfE/noar/noarinfo/](http://www.inflammation-repair.manchester.ac.uk/musculoskeletal/research/CfE/noar/noarinfo/)

45. <http://brc.slam.nhs.uk/about/core-facilities/cris>

46. [www.cprd.com/intro.asp](http://www.cprd.com/intro.asp)

The use of data can also help to drive improved care pathways and ensure that patients receive optimal care, as in the example of Advocate Healthcare (see Box 4.20).

#### Box 4.20: Optimising care based on algorithms and learning

Advocate Healthcare, a hospital chain in Chicago, has an algorithm that uses data to predict where patients ought to be discharged to, for example a nursing home, their own home with nursing support or a hospice. When the algorithm was used to look at past trends, Advocate Healthcare found that approximately 30% of its patients were being discharged to a sub-optimal venue. It recommends that 19% of the time, patients should go to a lower level of care than that recommended by physicians or patients themselves, while 11% of the time they should go to a higher level of care.

- Advocate Healthcare estimates that the algorithm has saved US\$200 million a year in the total cost of care, just from sending patients to the right place (Cerner Corp, 2015). (Note: this is an estimated saving to the wider health care economy, not just Advocate Healthcare.)

We are also starting to see significant investment in artificial intelligence, with the best-known example being Watson (see Box 4.21). This is some distance from mainstream adoption but signals a promising direction of travel.

#### Box 4.21: IBM Watson

Watson is a supercomputer built by IBM. It is able to extract meaning from free text, enabling it to store data from any written source. Following data upload and 'coaching' by experts, Watson is able to respond to questions about highly complex situations and provide recommendations backed by evidence. It has a wide range of applications across multiple industries, including health care.

Watson is currently being 'coached' by oncology experts at Memorial Sloane Kettering Cancer Center (MSKCC) in the US so that it might be able to inform decision-making in cancer care. The idea is that Watson will be able to analyse a patient's medical record to identify key characteristics that might influence outcomes. It will then identify potential evidence-based treatment options using data from clinical expertise and research. Following this, it will rank treatment options and present these to the user with supporting evidence from a wide range of sources. This will allow clinicians to match individual patient characteristics to the vast and complex research and knowledge base and provide tailored and evidence-based treatments.

Watson is still in its development stage, undergoing ‘coaching’ at MSKCC. Therefore, widespread real-world outcomes are yet to be realised. However, so far it has been shown that:

- Watson is able to choose the preferred treatment option for oncology patients with 89 to 100% precision, depending on cancer type (Epstein and others, 2014)
- all of Watson’s returned recommendations for lung cancer treatment were within guidelines and over 80% were in line with that selected by MSKCC clinicians (Kris and others, 2015).

Watson is also being used in a number of other contexts:

- Manipal Hospitals in India has decided to roll out Watson to aid with decision-making for its cancer patients (IBM, 2015a).
- Watson is being used to train medical students at the Cleveland Clinic in Ohio to take an evidence-based, analytical approach to their work (IBM, 2012).
- IBM is partnering with Johnson & Johnson to develop an app that will use its analytics to provide treatment plans and health advice (IBM, 2015b).
- Watson will be used in Boston Children’s Hospital in Massachusetts to aid in management decisions in rare paediatric diseases (IBM, 2015c).

## Education and training

Finally, technology can be used to assist with medical education and professional development, ensuring consistent and high-quality training across geographically disparate organisations. WebEx,<sup>47</sup> by Cisco, is a videoconferencing technology with a suite of interoperable products to meet a range of needs. Particularly helpful for remote learning is the ability to host ‘webinars’ (seminars or other presentations that take place on the internet), utilising screen sharing and the display of PowerPoint slides and images. Medical schools – such as Oxford University Medical School – deliver some lectures and tutorials using this technology, allowing students at remote hospital placements to access centrally delivered university teaching. It may also be of use to professional organisations delivering training across multiple sites and has been used in this way by AT Medics – a large primary care provider in London (see Box 4.22).

47. [www.webex.co.uk/](http://www.webex.co.uk/)

### Box 4.22: Videoconferencing for training and education

Videoconferencing can be successfully deployed across geographically disparate organisations in order to deliver consistent and high-quality training.

For example, **AT Medics**<sup>48</sup> uses WebEx technology to deliver training sessions to its staff, including fortnightly teaching given by hospital consultants.

The videoconferencing software has enabled the organisation to efficiently deliver the same training sessions across multiple sites, engendering a feeling of connectedness between practices and fostering relationships with secondary care colleagues.

Simulation learning has also been shown to have positive effects – particularly for surgical trainees – in terms of decreasing operating time and improving operative performance (Nagendran and others, 2013).

### Key lessons

A number of the lessons for success that apply to other areas are particularly important to this area. Investment in analytical capacity is essential to ensure that the data in the system are being used to improve existing processes, as highlighted in the Intermountain Healthcare example (see Box 4.18). Building an organisational culture that questions the way things are done and continuously seeks improvement is also key. Integral to all of this is ensuring that the workforce is equipped to exploit the insight that data provide. This applies to all staff – not just managers or organisational leaders. As far as possible the technology itself should facilitate this.

### Gain patient consent for use of data beyond direct care

NHS England and the Health and Social Care Information Centre are developing a care.data programme.<sup>49</sup> This will bring health and social care information from different settings together to see what is working well in the NHS and what could be improved. The programme has highlighted the sensitivities around using patient data for reasons beyond direct care

48. <http://atmedics.com/>

49. [www.england.nhs.uk/ourwork/tsd/care-data/](http://www.england.nhs.uk/ourwork/tsd/care-data/)

without adequate patient engagement and consultation. This experience highlights the need for organisations to have good data governance, to be entirely transparent about how they will use patient data and to gain informed consent for data analysis.

### Accept that data collection is expensive

Brent James of Intermountain Healthcare conservatively estimates that it costs one US dollar for every data item they collect in their outcomes tracking system. Do not collect data because it may be useful in the future or to a limited number of people. If you are going to collect data routinely, you should be able to evidence its wider benefit.

Intermountain does this through small individual projects, before building data collection into existing processes.

5

## How to maximise the benefits from a digital technology strategy

Grasping the opportunities we have described in this report will require new skills and capabilities at all levels of the digitally enabled organisation. It will also require the board to think about the deployment and use of technology in an entirely different way.

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*“One of the big challenges now for myself and the leadership team is to... get that deep engagement and understanding of what an EHR can do and get it aligned with strategic priorities, rather than what has been described as the ‘hobbyist’ approach.”*

*(Dr Gareth Thomas, Salford Royal NHS Foundation Trust)*

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We have laid out the potential path to acquiring full maturity as a digitally enabled organisation in Figure 5.1. This is a path that reflects the expectations set by the National Information Board (NIB, 2015b) but frames it as a longer-term journey rather than a one-off assessment. It also puts more emphasis on the skills and capabilities across the organisation, particularly the organisation’s analytical and improvement capabilities.

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*“So how do you get from patient administration systems, into medical records, into the digitisation of medicine? Every board should have a view about how they’re going to get there and they should have a view about how they will be there in 5 years’ time not 20 years’ time because the future is coming towards you.”*

*(Matthew Swindells, Cerner)*

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Figure 5.1 sets out five stages of maturity for:

- leadership and improvement capacity
- board focus and attention
- technical infrastructure
- analytical capacity.

Stage 5 is the most advanced. It requires:

- engaged leaders who are deeply knowledgeable about the clinical and technological systems in place
- a commitment to maximising the benefits of technology from leaders at board level and below
- an advanced technological infrastructure
- dedication to using data for continuous improvement and learning.

The digital strategy will be an integral part of a broader transformation strategy as well as day-to-day operational management. The EHR and underlying data platform will be supplemented by a wide variety of front-end apps that:

- improve the patient and staff experience
- improve efficiency
- drive better clinical outcomes at organisational and population health levels.

The organisation will be an attractive place to work in and likely to see improved recruitment and retention of staff.



Figure 5.1 : Organisational and leadership capabilities

<b>Leadership and improvement capacity</b>	<b>1</b> <ul style="list-style-type: none"> <li>• Head of information technology (not at board level)</li> <li>• No improvement lead</li> </ul>	<b>5</b> <ul style="list-style-type: none"> <li>• CEO leadership with support from chief medical information officer, chief nursing information officer and leads within each clinical area for joint improvement and information technology strategy</li> </ul>
<b>Board focus and attention</b>	<ul style="list-style-type: none"> <li>• Firefighting technical problems</li> <li>• Information governance</li> </ul>	<ul style="list-style-type: none"> <li>• Maximising benefits from digital and improvement capabilities at all levels – patient, clinical team, organisation and system</li> </ul>
<b>Technical infrastructure</b>	<ul style="list-style-type: none"> <li>• Picture archiving and communication system (PACS)</li> <li>• Some bespoke clinical and business systems</li> <li>• Robotic pharmacy</li> </ul>	<ul style="list-style-type: none"> <li>• EHRs integrated with a variety of systems and applications, including: clinical monitoring, RFID tracking and asset management, patient portals, CDSS and knowledge management</li> <li>• Interoperability across the system</li> </ul>
<b>Analytical capacity</b>	<ul style="list-style-type: none"> <li>• Focus on key performance metrics</li> <li>• No dedicated analytic capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Systems support continual improvement and learning at all levels and across the system</li> <li>• Informatics capability at all levels of the organisation</li> </ul>

*“So how do you get from patient administration systems into medical records into the digitisation of medicine? Every board should have a view about how they’re going to get there and they should have a view about how they will be there in 5 years’ time, not 20 years’ time, because the future is coming towards you.” (Matthew Swindells, Cerner)*

## What could the future look like?

So what does everything we have described add up to? What might technology mean for the workforce and the way we deliver services in 5, 10, 20 years' time?

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*“Over the next three to five years we will see a very significant change in the way in which people can access health and social care services, and so the commitments to access your shared electronic health record, which is the same place where you can book an appointment, you can see your prescriptions, you can access digital health services accredited by the NHS, you can have the information provided to you in a more targeted way about how you can look after your health better.” (Will Cavendish, Department of Health)*

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There are three main areas for change, with:

- progressively higher levels of risk
- potential disruption of the current operating and business models
- implications for the workforce.

### Operational improvement

First, although there is a lot of interest in new models of care, the most significant improvements in productivity over the next few years are likely to come from the combined impact of large numbers of small changes and extracting the full benefit from the technologies currently available. The areas where digital tools are most likely to help are:

- reducing duplication and rework
- removing unjustified variation from standard clinical processes and increasing reliability
- identifying deteriorating patients and those at risk of infection
- predicting the probability of an extended stay or readmission

- cutting out unnecessary steps from processes or staff and patient movement
- improving communication and hand-offs between professionals within single organisations and across multiple organisations
- removing administrative tasks from clinical staff
- scheduling and improving flow
- inventory and procurement management
- rostering, mobile working and staff deployment
- patient self-service for administrative tasks such as booking
- other automation, for example robotics in back office automation.

Some of these require fully functioning EHR systems or other methods for creating aggregated real-time patient data and a combination of the tools detailed in this report. Others can be achieved by less expensive tools and systems that may be implemented in more modular way.

### Redesign of the whole pathway

Doing the current work more efficiently, with fewer errors and in ways that are easier and more convenient for staff would get many organisations a long way. Additional opportunities come from the redesign of complete pathways both within organisations and beyond their traditional boundaries – the second main area for change. The following offer the potential for very substantial savings and improvements in the effectiveness of the workforce:

- reduced variation
- the ability to ensure that the most appropriate level of care is provided
- fitting staffing skill mix to demand more effectively.

There are also opportunities for patient involvement with some tasks being transferred to patients and there are benefits from improved self-care.

### Population health management

The third shift is a move from pathways to populations. This involves a change of focus from the effective management of the patient through the pathway to maintaining the health of populations over time. It requires a mindset shift in providers and a focus on:

- early intervention and targeting
- enabling patient self-management
- shared decision-making
- measuring outcomes and value rather than counting activities.

To do this, systems will need to become more adept at using digital tools to:

- link care episodes
- build better data and analytics, including using predictive models
- create ways of providing feedback, producing learning and generating improvement
- support patients with self-management
- support shared decision-making.

This is likely to be most disruptive, requiring significant shifts in models of care:

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*"If systems [are] based more on patients with information and able to express their preferences – [they are] likely to generate a very different pattern of flows." (Adam Darkins, Medtronic)*

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In the longer term, what we have written could be interpreted as describing a future in which health care will transform from the messy, inefficient world it is today, with much that is clinically uncertain and variable, to a glorious nirvana of streamlined efficiency, clinical certainty and consistency and patients who are so effective at managing their own health and care that they barely need to trouble the doctor. The sceptics may see a much bleaker world where clinicians are tied to computers, trying to interpret a sea of data, while patients are overburdened with self-management tasks and anxiety about health, generated by obsessional monitoring and difficult-to-interpret probabilistic predictions about their genetic risk factors. Information technology and the digitisation of health information are disrupting the health care landscape and the outcome of that disruption is inherently uncertain. Given that health warning, our best assessment of what the future may hold, is as follows.

First, information technology will be omnipresent but much less visible. No more carts with personal computers on the ward. Medical technology will become more and more intelligent. Data will be held remotely in the cloud, allowing professionals to use hand-held devices that give them access to everything they need. Some have described the smartphone as the new stethoscope, the difference being that the patient has one too.

Second, technology is driving a fundamentally different relationship between patient and professional. This requires new skills for both. Professionals will require new coaching skills in order to ‘activate’ and engage people in their care. They will also need skills that can adapt to the wide range of patient capabilities and new consulting styles. In some areas, technology and the ability of patients to self-manage will require a very different approach from how professionals work now.

Third, technology is also driving a very different relationship between professionals. It supports medicine as a team rather than individual pursuit. This too will require new ways of working. As the traditional barriers between primary, secondary, community, social and mental health care are broken down, so will some of the traditional roles and services. For example, the current hospital outpatient model looks increasingly anachronistic in a world where consultants can offer advice to professionals and patients remotely. Multi-skilled staff with a range of core therapeutic skills are likely to become an increasingly fundamental part of the workforce.

Fourth, the management of the potential sea of data presents health care and its workforce with their greatest opportunity and challenge. All staff will need to develop and extend their analytical skills. Meanwhile, new professional roles in the area of clinical and medical informatics are likely to emerge and become a core part of any clinical team. Many have talked about how the new access to clinical decision support tools will enable all staff to work to the top of their license. This may well be true, but it may also present opportunities to work beyond the scope set by current professional boundaries. We need to move from the sea of data and wealth of information, to a personalised, informed and intelligent environment.

Fifth, managerial staff will also require new analytical skills in order to maximise the benefits from the newfound intelligence about their organisation and how it is operating. They will also need sophisticated organisational development competences in order to take staff on the transformation journey that technology can facilitate.

6

## Conclusion

We started the work for this report with a question – what are the opportunities to use technology to improve the productivity of the health system and the workforce in particular? We found all the complexities that might be expected. We also found a huge scope for investment in this area to destroy value as well as create it.

In this report we have identified seven opportunities for information technology to support changes in services and ways of working that would drive improvements in quality, efficiency and population health – opportunities to:

- use clinical information decision support and knowledge management tools, integrated into standardised workflows, to deliver **more systematic, high-quality care**
- use real-time patient monitoring and powerful analytics to deliver **more proactive and targeted care**, reducing costs and improving outcomes
- attack the costs and harms that come from poor communication and fragmented care by developing information technology systems to integrate and **coordinate care** and support providers in collaborating more effectively
- use telehealth to reduce costly referrals, avoid admissions and unnecessary appointments, and improve the ability of professionals to get things right first time by **providing access to specialist expertise and advice** easily and in real time
- reduce transaction costs and rewrite the relationship with patients and carers by **providing tools for patient engagement and self-management** that allow more meaningful participation in care and more opportunities for self-service
- bring to bear the tools used in other sectors for **improved resource management** to plan staff rosters and patient flow, match capacity to demand and improve scheduling
- use a combination of analytics, improvement science, a learning culture and organisational development to support **system learning and improvement**.

Digital technologies will not deliver improvements in productivity on their own. Indeed, without careful implementation they can create inefficiencies and staff

frustration and even threaten the quality of care. As well as seven opportunities, there are seven important lessons for successful implementation.

- **Transformation first.** Transformation comes from new ways of working, not the technology itself. You need a transformation programme supported by technology, not the other way round. This is the fundamental lesson that underpins everything else.
- **Culture change is crucial.** The majority of the issues faced along the journey of transformation are people problems, not technology problems. This requires sophisticated leadership and change management capabilities. This means that organisations need to invest at least as much in the programmes of organisational change and transformation as they do in the technology itself. Clinical and organisational leaders are required who have a deep knowledge of both clinical and technological systems, who are able to reimagine how work is done and who know how technology could best support it.
- **User-centred design.** Insufficient attention has been given to the design of systems. Systems need to solve the problems and needs of the people who are going to use them, be they patients or professionals. This requires a deep understanding of the work as well as the needs of the worker. Organisations need to consider a balance between implementing an ‘off-the-shelf’ package solution (albeit customised for their organisation) and ‘knitting together’ existing clinical systems in their organisation. The combination of a core package solution with a small number of specialist clinical systems is emerging as the norm in top-performing digital hospitals.
- **Invest in analytics.** Improving productivity requires extensive redesign of work processes, the use of predictive models to reduce variation, allocate resources, anticipate demand and intervene earlier, and the ability to learn and adapt. None of this is achievable without analytical tools available to clinicians in real time and sophisticated support for planning, management and improvement.
- **Multiple iterations and continuous learning.** Implementing technology is an ongoing programme of transformational change. Even with careful design there may need to be a number of iterations in the design of systems. This is a continuous process and there may be several cycles – some quite painful – before systems reach a tipping point where all of this investment starts to pay off.



- **Support interoperability.** The inability to share and combine data between different systems is a major rate-limiting step to realising the full benefit of technology in health care. Typically, high-performing digital hospitals are integrating all their systems, to as low a number as possible, across their organisation. Where possible, systems should be interoperable across different organisations to improve patient journeys and outcomes. In general, it will be important to procure and use systems that comply with national data and interoperability standards.
- **Strong information governance.** Data sharing requires strong data governance and security, particularly in the face of a growing threat from cyber-attacks. Action is required at national and local levels to help organisations hold and share data safely. Patients should also be enabled to own and share information if they choose to.

## Messages for government

There is a welcome recognition by the government of the central role that information technology needs to play in the delivery of health care (NHS England, 2014; NIB, 2014). As emphasised by Lord Carter (Carter, 2015), it is likely to be fundamental to any strategy to deliver long-term improvements in productivity. However, as this report has shown, gains can be hard to realise and require up-front investment in technology and, most importantly, people. Active steps need to be taken to support this investment. Mindful of the lessons from the NPfIT, a significant proportion of that support needs to be for the necessary clinical as well as managerial leadership and organisational development. The government's digital strategy (NIB, 2014) also recognises the central importance of interoperability and information governance. However, progress has been slow, particularly with respect to bridging the gap between health and social care. The pace needs to quicken.

## Messages for regulators

This report has concentrated on the impact of digital technologies on health care provision. But there are important implications for the regulators of NHS providers. NHS Improvement needs to develop its own capability in this area in order to give the appropriate support and guidance to NHS boards. For the Care Quality Commission, digital technologies open up new possibilities in

terms of how it regulates providers. In the future, it could use real-time data to spot problems not only as they are happening but also, with sophisticated risk prediction tools, before they happen. It too needs to develop new capabilities in this area.

## Messages for NHS boards

Technology is transforming the landscape of health care, and offering a route to significantly improve productivity and quality. All NHS boards need to deepen their understanding of the new capabilities that technology gives them and, most importantly, align their technology and transformation programmes. We hope that this report will help boards in doing this. It will require significant strategic investment not only in technology but also in the workforce as a whole. A critical issue for all boards will be to develop clinical leaders to support the integrated programmes of technology and transformation. We have much to learn from the US. The majority of large health care providers have chief medical and chief nursing information officers. There are also opportunities to use non-executive appointments to strengthen capability in this area, especially as this is largely new terrain for the NHS. Finally, boards may want to consider leasing rather than buying technology as a more cost-effective and affordable route to acquisition.

Early strategic priorities should be the areas where technology is able to facilitate some relatively easy and significant wins. Most notable are the systematic and comprehensive use of vital signs monitoring and support for mobile working. In the short to medium term, the use of EHRs, telehealth, patient portals and staff rostering apps can also generate savings and improve quality. However, these require sophisticated leadership with support for organisational development and change management to ensure that the full benefits are realised. In the longer term, the really big benefits will come from the transition to a system and ways of working premised on continual learning and self-improvement.

If these opportunities are grasped, there are considerable grounds for optimism. Technology can support a clinical transformation agenda that will deliver benefits to patients, staff and the bottom line.

## Appendix 1: Methods

### Literature review

We reviewed academic and grey literature on the impact of digital technologies covered in this report. In collaboration with the Health Services Management Centre library at the University of Birmingham we conducted searches related to the following technologies:

- Health information technology generally
- Electronic health records
- Telehealth
- Decision support and CPOE
- Technology to manage patient flow
- Patient technology
- Point of care testing
- Robotics
- Training
- Big data

We did not limit our search by geography, although it was restricted to English language papers. Our initial searches returned over 500 results. We reviewed titles and abstracts to identify articles primarily focused on benefits to health care organisations (as opposed to patients), with a particular emphasis on productivity and efficiency, which we reviewed in full. We used ‘snowballing’ methods to supplement these searches, and carried out further searches on particular proprietary systems as we identified them.

### Interviews

We conducted 40 semi-structured interviews with leaders of health care organisations who have been actively pursuing a digital strategy over many years, as well as leading technology suppliers. Each interview lasted approximately one hour and was carried out between March and September 2015. The full list of interviewees is set out below.

## Survey

We carried out two small surveys. We sent one survey to 30 primary and community care leaders, which had a response rate of 27% (n=8). We sent a second survey to 32 leaders in secondary care, which had a response rate of 31.25% (n=10). We have aggregated and anonymised the results of both surveys.

## Notes

The literature in this area is vast and our review was not exhaustive. We found that much of the literature is limited. It is backward-looking, and for the most part documents the difficulties in benefitting from information technology, rather than the opportunities. There is also considerable uncertainty around costs and outcome data and many studies use proxy cost measures.

Given our focus on those at the digital frontier, many we interviewed were based outside of the UK. This gave us a good grasp of what the future holds, but limited our understanding of the current technology landscape in the UK.

Finally, our surveys had a very small response rate and are not representative of health care providers across the UK. We have not drawn on the survey extensively and anything which does rely on the surveys is clearly marked in the report.

Table A2.1 sets out the key stakeholders we interviewed as part of the project.

**Table A2.1: List of interviewees**

<b>Name</b>	<b>Title</b>	<b>Organisation</b>	<b>Country</b>
<b>Eric Alper</b>	Chief Medical Information Officer	Lifespan	US
<b>Richard Ashby</b>	Chief Executive Officer	Metro South Health	Australia
<b>Ladi Awosika</b>	Chief Executive Officer	Total Health Trust	Nigeria
<b>Richard Bakalar</b>	Advisory Managing Director	KPMG	US
<b>Ran Balicer</b>	Director	Clalit Research Institute	Israel
<b>Amanda Basset</b>	Director of Workforce Insight	Allocate Software	UK
<b>David Blumenthal</b>	President	The Commonwealth Fund	UK
<b>Will Cavendish</b>	Director General of Innovation, Growth and Technology	Department of Health	UK
<b>Brian Clay</b>	Chief Medical Information Officer	University of California San Diego (UCSD)	US
<b>Theresa Cullen</b>	Chief Medical Information Officer	Veterans Health Administration	US
<b>Adam Darkins</b>	Vice President for Medical Affairs and Enterprise Technology Development	Medtronic Inc.	US
<b>Bruce Darrow</b>	Chief Medical Information Officer	Mount Sinai Medical Centre	US
<b>John Deverill</b>	Managing Partner	GE Healthcare Finnamore	UK
<b>Jai P. Dwivedi</b>	Chief Information Officer	Rajiv Gandhi Cancer Institute	India
<b>David Furniss</b>	Vice President, Propositions and Frameworks, Global Government and Health	BT Global Services	UK
<b>Amy Garcia</b>	Chief Nursing Officer for Nursing Workforce Solutions	Cerner	US
<b>Joel Haspel</b>	Partner	GE Healthcare Finnamore	UK
<b>Owen Heckrath</b>	Technical Advisor	Health Information Systems Program	South Africa
<b>Brent James</b>	Executive Director	Intermountain Healthcare Institute for Health Care Delivery Research	US
<b>Alok Khare</b>	Vice President	JIL Information Technology Ltd	India
<b>Girish Kulkarni</b>	Chief Medical Informatics Officer	Cytecure Hospitals	India
<b>Jonathan Lewis</b>	Chief Executive Officer	Bromley Healthcare	UK

<b>Name</b>	<b>Title</b>	<b>Organisation</b>	<b>Country</b>
<b>Kelly Limonte</b>	Health Care Industry Manager	Microsoft UK	UK
<b>Kagiso Ndlovu</b>	Health Informatics Program Manager	Botswana-UPenn Partnership	Botswana
<b>Elaine O'Brien</b>	Clinical Strategist	Cerner	US
<b>Martyn Partridge</b>	Professor of Respiratory Medicine and Patient Centred Care	Imperial College, London	UK
<b>Robert Pearl</b>	Chief Executive Officer	The Permanente Medical Group	US
<b>Eric Poon</b>	Chief Medical Information Officer	Duke	US
<b>Efrat Shadmi</b>	Lecturer	University of Haifa	Israel
<b>Ash Shehata</b>	Partner	KPMG	US
<b>Harpreet Sood</b>	Senior Fellow to the Chair and Chief Executive's Office	NHS England	UK
<b>David Steyer</b>	Digital and Mobile Solutions Technical Lead	KPMG	US
<b>Mandie Sunderland</b>	Chief Nurse	Nottingham University Hospitals NHS Trust	UK
<b>Matthew Swindells</b>	Senior Vice President, Population Health and Global Strategy	Cerner	UK
<b>Gareth Thomas</b>	Clinical Director for Innovation	Salford Royal NHS Foundation Trust	UK
<b>Robert Wachter</b>	Professor and Interim Chair of the Department of Medicine	University of California San Francisco (UCSF)	US
<b>Simon Wallace</b>	Clinical Consultant	Total Mobile	UK
<b>Jonathan P. Weiner</b>	Professor of Health Policy and Management and Health Informatics	John Hopkins University	US
<b>Neil Williams</b>	Head of Connected Health	Medicom Innovation Partner	UK
<b>Anonymous interviewee</b>	Anonymous	A technology company	UK

## Appendix 2: National Information Board digital technology strategy

To support the government's vision for the future, the National Information Board has developed a number of approaches to encourage the uptake of digital technologies, set out in *Personalised Health and Care 2020: Using data and technology to transform outcomes for patients and citizens: A framework for action* (NIB, 2014). This document highlights seven key areas for data and technology to improve service delivery:

- Enable me to make the right health and care choices.
- Give care professionals and carers access to all the data, information and knowledge they need.
- Make the quality of care transparent.
- Build and sustain public trust.
- Bring forward life-saving treatments and support innovation and growth.
- Support care professionals to make the best use of data and technology.
- Assure best value for taxpayers.

The activities within each of these areas cover a broad terrain, although they can be separated into two groups: those concerned with patient or clinician-facing initiatives and those concerned with the logistics of digital transformation.

The former includes:

- giving patients read and write access to their full medical record
- approving apps
- transforming NHS Choices into a single, digital access point to signpost patients to services, provide advice and enable patients to book appointments online.

The latter includes the development of:

- an overarching interoperability strategy
- common data standards.

The most recent intervention has been the launch of a digital maturity self-assessment tool (NIB, 2015b). This aims to provide a baseline assessment for

the NHS in England of the current strengths and gaps in health care providers' provision of digital services at the point of care.

Another part of the NIB's strategy is to make England a leading digital health economy – maximising digital technology to support research into new medicines, including breakthroughs in genomic science (NIB, 2015c). This is running alongside another government initiative: the 100,000 Genomes Project. Genomics England, a company wholly owned and funded by the Department of Health, aims to sequence 100,000 whole genomes from NHS patients by 2017 (Genomics England, 2015).

Since the publication of the NIB's framework in November 2014 (NIB, 2014), and a series of roadmaps in 2015 (e.g. NIB 2015a; 2015c; 2015d), progress has been made in realising the vision (NIB, 2015e):

- More than 96% of people registered with a GP now have a summary care record and 85% of 111 services, 73% of ambulance services and 35% of A&E services also now have access to the record.
- In the first quarter of 2015, more than 3.7 million repeat prescriptions were ordered online.
- Through MyNHS,<sup>50</sup> patients are able to compare the outcomes and effectiveness of more than 37,600 health and care organisations.

50. [www.nhs.uk/Service-Search/performance/search](http://www.nhs.uk/Service-Search/performance/search)



## Appendix 3: Health care technology definitions

<b>Shared electronic health records (EHRs) and real-time data</b>	Clinical records that capture all patient information digitally, including clinical assessments, vital sign monitoring and diagnostics. They are frequently augmented by decision support tools and e-prescribing systems
<b>Patient portals/records</b>	Online portals that give patients access to their medical records, signposting to other services, information, advice and resources for self-management
<b>Wearable devices and apps</b>	Patient-facing technology that records data about an individual, such as heart rate, weight, activity level, blood sugar level or blood pressure
<b>Online communities</b>	Websites providing patients with opportunities to network with other patients and seek peer support and advice about their condition
<b>Decision support &amp; e-prescribing</b>	Clinical decision support systems provide clinicians with online knowledge to aid with diagnostic and treatment decisions. E-prescribing allows professionals to electronically prescribe medication or deliver other instructions
<b>Mobile working</b>	Technology that enables professionals to work outside of clinical settings (e.g. patients' homes). Examples include apps for mobile devices with access to clinical data systems
<b>Patient outcomes/ registries</b>	Large databases containing patient outcome data that can be analysed for scientific research, to improve clinical decision-making or for operational processes
<b>E-learning/webinars</b>	Technology to enable formal remote learning through seminars (e.g. WebEx) and informal knowledge sharing such as online communities of practice and social media
<b>Professional-to-professional telehealth</b>	Real-time phone, video or email (including pictures) conversations between professionals (e.g. a generalist and a specialist), allowing for provision of a diagnosis or advice
<b>Telehealth/telecare</b>	The remote exchange of information between a patient and health care professional. It can include telemonitoring (remote transmission of clinical signs), telemedicine (remote phone, video or email consultations) or telecoaching (to change behaviours)
<b>E-rostering</b>	Electronic systems that allow for smart rostering of staff. They may draw on live data such as bed occupancy and acuity in order to allow for real-time deployment of staff

<b>Patient-flow management</b>	Systems that map patient status and location, allowing for task prioritisation and bed management – for example, systems that highlight which tasks need completing before a patient can be discharged
<b>Business process support</b>	Back-end systems such as human resources, estates and facilities and procurement tools
<b>Vital signs monitoring</b>	Electronic entry of patient observations with additional processing to automatically calculate risk scores and act on those results
<b>Predictive analytics/risk stratification</b>	Use of statistical modelling to predict those at risk of re-admission following discharge or <i>de novo</i> deterioration in the community
<b>Standardised workflows</b>	Standardisation of an entire clinical pathway to provide clear and unambiguous processes, ensuring consistently high standards of care

## References

- Ali S, Coletta J and Pope R (2011) 'QIPP and care plans for long term conditions: revisited', *HSJ*, 19 May.
- American Telemedicine Association (2015) *Operationalizing Telemedicine in Managed Care: Lessons from Kaiser Permanente*. 2015 Annual Meeting. American Telemedicine Association. [www.americantelemed.org/docs/default-source/ata2015/operationalizing-telemedicine-in-managed-care-full-compressed1.pdf?sfvrsn=2](http://www.americantelemed.org/docs/default-source/ata2015/operationalizing-telemedicine-in-managed-care-full-compressed1.pdf?sfvrsn=2) . Accessed November 2015.
- Barbieri JS, French B and Umscheid CA (2015) 'Uptake and impact of a clinical diagnostic decision support tool at an academic medical centre', *Diagnosis* 2(2), 123–7.
- Bell G and Ebert M (2015) *Health Care and Cyber Security: Increasing threats require increased capabilities*. KPMG. <http://advisory.kpmg.us/content/dam/kpmg-advisory/PDFs/ManagementConsulting/2015/KPMG-2015-Cyber-Healthcare-Survey.pdf> . Accessed January 2016.
- Bender JL, Yue RYK, To MJ, Deacken L and Jadad AR (2013) 'A lot of action, but not in the right direction: systematic review and content analysis of smartphone applications for the prevention, detection, and management of cancer', *Journal of Medical Internet Research* 15(12), e287.
- Berner ES and Graber ML (2008) 'Overconfidence as a cause of diagnostic error in medicine', *American Journal of Medicine* 121(5 suppl), S2–23.
- Berwick DM, Nolan TW and Whittington J (2008) 'The Triple Aim: care, health, and cost', *Health Affairs* 27(3), 759–69.
- Billings J, Georghiou T, Blunt I and Bardsley M (2013) 'Choosing a model to predict hospital admission: an observational study of new variants of predictive models for case finding', *BMJ Open* 3(8), e003352.
- Black AD, Car J, Pagliari C, Anandan C, Cresswell K, Bokun T and others (2011) 'The impact of ehealth on the quality and safety of health care: a systematic overview', *PLoS Med.* 8(1), e1000387.
- Block L, Habicht R, Wu AW, Desai SV, Wang K, Silva KN, Niessen T, Oliver N and Feldman L (2013) 'In the wake of the 2003 and 2011 duty hours regulations, how do internal medicine residents spend their time?', *Journal of General Internal Medicine* 28, 1042–7.
- Boonstra A and Broekhuis M (2010) 'Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions', *BMC Health Services Research* 10, 231.
- Boonstra A, Versluis A and Vos J (2014) 'Implementing electronic health records in hospitals: a systematic literature review', *BMC Health Services Research* 14, 370.
- Broderick A and Lindeman D (2013) *Scaling Telehealth Programs: Lessons from early adopters*. The Commonwealth Fund.
- Caffery LJ and Smith AC (2010) 'A literature review of email-based telemedicine', *Studies in Health Technologies and Informatics* 161, 20–34.

- Campion-Awwad O, Hayton A, Smith L and Vuaran M (2014) *The National Programme for IT in the NHS: A case history*. University of Cambridge.
- Carter, Lord (2015) *Review of Operational Productivity in NHS Providers: Interim report: An independent report for the Department of Health by Lord Carter of Coles*. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/434202/carter-interim-report.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/434202/carter-interim-report.pdf). Accessed January 2015.
- Castle-Clarke S, Kumpunen S, Machaqueiro, Curry N and Imison C (2015) *The future of primary care: New models and digital requirements*. [www.nuffieldtrust.org.uk/documents/future-primary-care-new-models-and-digital-requirements](http://www.nuffieldtrust.org.uk/documents/future-primary-care-new-models-and-digital-requirements)
- Cello Health Insight (2014) *The Digital Health Debate*. Cello Health Insight [www.cellohealthinsight.com/wp-content/uploads/2015/05/The-Digital-Health-Debate-Report-2014.pdf](http://www.cellohealthinsight.com/wp-content/uploads/2015/05/The-Digital-Health-Debate-Report-2014.pdf) . Accessed December 2015.
- Cerner Corp (2015) *Edited Transcript: CERN –Cerner Corp investment community meeting*. Cerner Corp. <http://phx.corporate-ir.net/External.File?t=1&item=VHlwZT0yfFBhcmVudELEPTUxODg0NjR8Q2hpbGRJRjRD01NzcxNzg=>. Accessed November 2015.
- Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, Morton SC and Shekelle PG (2006) ‘Systematic review: impact of health information technology on quality, efficiency, and costs of medical care’, *Annals of Internal Medicine* 144(10), 742–52.
- Cresswell KM, Bates DW and Sheikh A (2013) ‘Ten key considerations for the successful implementation and adoption of large-scale health information technology’, *Journal of the American Medical Informatics Association* 20(e1), e9–e13.
- Cruickshank J (2012) *2020 Health Telehealth: What can the NHS learn from experience at the US Veterans Health Administration?* 2020health.org
- Cruickshank J and Paxman J (2013) *Yorkshire & the Humber Telehealth Hub: Project evaluation*. 2020health.org
- Cusack CM, Pan E, Hook JM, Vincent A, Kaelber DC, Bates DW and Middleton B (2007) *The Value of Provider-to-Provider Telehealth Technologies*. Center for Information Technology Leadership.
- De la Torre-Díez I, López-Coronado M, Vaca C, Aguado JS and de Castro C (2014) ‘Cost-utility and cost-effectiveness studies of telemedicine, electronic, and mobile health systems in the literature: a systematic review’, *Telemedicine Journal and E-Health* 21(2), 81–5.
- Díaz-Bossini J-M and Moreno L (2014) ‘Accessibility to mobile interfaces for older people’, *Procedia Computer Science* 27, 57–66.
- Ekeland AG, Bowes A and Flottorp S (2010) ‘Effectiveness of telemedicine: a systematic review of reviews’, *International Journal of Medical Informatics* 79(11), 736–71.
- Elwyn G and Buckman L (2015) ‘Should doctors encourage patients to record consultations?’, *British Medical Journal* 350, g7645.
- Epstein AS, Zauderer MG, Gucalp A, Seidman AD, Caroline A, Fu J, Keesing J, Hsiao F, Megerian M, Eggebraaten T, DeLima R, Setnes M, Bach P and Kris MG (2014) ‘Next

- steps for IBM Watson oncology: scalability to additional malignancies', *Journal of Clinical Oncology* 32, 5s.
- Fillmore CL, Braye CE and Kawamoto K (2013) 'Systematic review of clinical decision support interventions with potential for inpatient cost reduction', *BMC Medical Informatics Decision Making* 13, 135.
- Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, Sam J and Haynes RB (2005) 'Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review', *Journal of the American Medical Association* 293(10), 1223–38.
- Genco EK, Forster JE, Flaten H, Goss F, Heard KJ, Hoppe J and Monte AA (2015) 'Clinically inconsequential alerts: the characteristics of opioid drug alerts and their utility in preventing adverse drug events in the emergency department', *Annals of Emergency Medicine*, doi: <http://dx.doi.org/10.1016/j.annemergmed.2015.09.020>
- Genomics England (2015) *The 100,000 Genomes Project*. [www.genomicsengland.co.uk/the-100000-genomes-project/](http://www.genomicsengland.co.uk/the-100000-genomes-project/) . Accessed November 2015.
- Goran SF (2010) 'A second set of eyes: an introduction to tele-ICU', *Critical Care Nurse* 30(4), 46–55.
- Government Office for Science (2016) *Distributed Ledger Technology: beyond block chain*. Government Office for Science.
- Guisse V, Anderson J and Wiig S (2014) 'Patient safety risks associated with telecare: a systematic review and narrative synthesis of the literature', *BMC Health Services Research* 14, 588.
- Gurses AP, Hu P, Gilger S, Dutton RP, Trainum T, Ross K and Xiao Y (2006) 'A preliminary field study of patient flow management in a trauma center for designing information technology', *AMIA Annual Symposium Proceedings* 2006, 937.
- Hailey D, Roine R, Ohinmaa A and Dennett L (2011) 'Evidence of benefit from telerehabilitation in routine care: a systematic review', *Journal of Telemedicine and Telecare* 17, 281–7.
- Hendy J, Chrysanthaki T, Barlow J, Knapp M, Rogers A, Sanders C, Bower P, Bowen R, Fitzpatrick R, Bardsley M and Newman S (2012) 'An organisational analysis of the implementation of telecare and telehealth: the whole systems demonstrator', *BMC Health Services Research* 12, 403.
- Hex N, Tuggey J, Wright D and Malin R (2015) 'Telemedicine in care homes in Airedale, Wharfedale and Craven', *Clinical Governance: An International Journal* 20(3), 146–54.
- HM Treasury (2015) *Spending Review and Autumn Statement 2015*. HM Government. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/479749/52229\\_Blue\\_Book\\_PU1865\\_Web\\_Accessible.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/479749/52229_Blue_Book_PU1865_Web_Accessible.pdf). Accessed January 2016.
- House of Commons Committee of Public Accounts (2013) *The Dismantled National Programme for IT in the NHS: Nineteenth report of session 2013–14*. The Stationery Office. [www.publications.parliament.uk/pa/cm201314/cmselect/cmpublicacc/294/294.pdf](http://www.publications.parliament.uk/pa/cm201314/cmselect/cmpublicacc/294/294.pdf). Accessed December 2015.

- HSCIC (Health and Social Care Information Centre) (2015) *Checklist Guidance for Reporting, Managing and Investigating Information Governance and Cyber Security Serious Incidents Requiring Investigation*. HSCIC. [www.igt.hscic.gov.uk/Resources/HSCIC%20SIRI%20Reporting%20and%20Checklist%20Guidance.pdf](http://www.igt.hscic.gov.uk/Resources/HSCIC%20SIRI%20Reporting%20and%20Checklist%20Guidance.pdf). Accessed January 2016.
- Huckvale K, Tomás Prieto J, Tilney M, Benghozi P-J and Car J (2015) 'Unaddressed privacy risks in accredited health and wellness apps: a cross-sectional systematic assessment', *BMC Medicine* 13, 214.
- IBM (2012) 'Cleveland Clinic and IBM work to advance Watson's use in the medical training field', news release, 30 October. [www-03.ibm.com/press/us/en/pressrelease/39243.wss](http://www-03.ibm.com/press/us/en/pressrelease/39243.wss). Accessed December 2015.
- IBM (2015a) 'Manipal Hospitals adopts Watson for oncology to help physicians identify options for individualized, evidence-based cancer care across India', news release, 2 December. [www-03.ibm.com/press/us/en/pressrelease/48189.wss](http://www-03.ibm.com/press/us/en/pressrelease/48189.wss). Accessed December 2015.
- IBM (2015b) 'IBM and partners to transform personal health with Watson and open cloud', news release, 13 April. <https://www-03.ibm.com/press/us/en/pressrelease/46580.wss>. Accessed December 2015.
- IBM (2015c) 'Boston Children's Hospital to tap IBM Watson to tackle rare pediatric diseases', news release, 10 November. [www-03.ibm.com/press/us/en/pressrelease/48031.wss](http://www-03.ibm.com/press/us/en/pressrelease/48031.wss). Accessed December 2015.
- Isosec and Imperial College Healthcare NHS Trust (2015) 'Imperial College NHS & Isosec transform postnatal maternity care: a case study'. [www.isosec.co.uk/IsosecWeb/files/MIAMaternityCaseStudy.pdf](http://www.isosec.co.uk/IsosecWeb/files/MIAMaternityCaseStudy.pdf). Accessed December 2015.
- Jaspers MWM, Smeulers M, Vermeulen H and Peute LW (2011) 'Effects of clinical decision-support systems on practitioner performance and patient outcomes: a synthesis of high-quality systematic review findings', *Journal of the American Medical Informatics Association* 18(3), 327–34.
- Jee C (2015) 'Electronic prescriptions in NHS could save 20,000 lives a year', CIO website, 12 June. [www.cio.co.uk/news/enterprise-apps/electronic-prescriptions-could-save-nhs-20000-lives-year-3615544/](http://www.cio.co.uk/news/enterprise-apps/electronic-prescriptions-could-save-nhs-20000-lives-year-3615544/). Accessed January 2016.
- Jensen J (2004) 'United hospital increases capacity usage, efficiency with patient-flow management system', *Journal of Healthcare Information Management* 18(3), 26–31.
- Kaiser Permanente (2015) 'Advancing care through telehealth', *Kaiser Permanente Policy Stories* 4(3), [www.kpihp.org/wp-content/uploads/2015/07/KPStoryVol-3-No-4-Telehealth.pdf](http://www.kpihp.org/wp-content/uploads/2015/07/KPStoryVol-3-No-4-Telehealth.pdf). Accessed December 2015.
- Kawamoto K, Houlihan CA, Balas EA and Lobach DF (2005) 'Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success', *British Medical Journal* 330, 765.
- Kmietowicz Z (2015) 'Identify sepsis in patients by using early warning scores, doctors are urged', *British Medical Journal* 351, h6237.

- Kris MG, Gucalp A, Epstein AS, Seidman AD, Fu J and others (2015) 'Assessing the performance of Watson for oncology, a decision support system, using actual contemporary clinical cases', *Journal of Clinical Oncology* 33, <http://meetinglibrary.asco.org/content/150420-156>. Accessed January 2016.
- Kumar S, Merchant S and Reynolds R (2013) 'Tele-ICU: efficacy and cost-effectiveness approach of remotely managing the critical care', *The Open Medical Informatics Journal* 6, 24–9.
- Lewis PJ, Dornan T, Taylor D, Tully MP, Wass V and Ashcroft DM (2009) 'Prevalence, incidence and nature of prescribing errors in hospital inpatients', *Drug Safety* 32(5), 379–89.
- Lilly CM, Cody S, Zhao H, Landry K, Baker SP, McIlwaine J, Chandler MW and Irwin RS (2011) 'Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes', *Journal of the American Medical Association* 305(21), 2175–83.
- Lovett PB, Illg ML and Sweeney BE (2014) 'A successful model for a comprehensive patient flow management center at an academic health system', *American Journal of Medical Quality*. [www.ncbi.nlm.nih.gov/pubmed/25550446](http://www.ncbi.nlm.nih.gov/pubmed/25550446). Accessed January 2016.
- Macias C, Panch T, Hicks YM, Scolnick JS, Weene DL, Öngür D and Cohen BM (2015) 'Using smartphone apps to promote psychiatric and physical well-being', *Psychiatric Quarterly* 86(4), 505–19.
- MacNeill V, Sanders C, Fitzpatrick R, Hendy J, Barlow J, Knapp M, Rogers A, Bardsley M, Newman SP (2014) 'Experiences of front-line health professionals in the delivery of telehealth: a qualitative study', *Br J Gen Pract* 64(624), e401–7.
- Meeusen AJ and Porter R (2015) 'Patient-reported use of personalized video recordings to improve neurosurgical patient–provider communication', *Cureus* 7(6), e273.
- Mistry H (2012) 'Systematic review of studies of the cost-effectiveness of telemedicine and telecare: changes in the economic evidence over twenty years', *Journal of Telemedicine and Telecare* 18(1), 1–6.
- Mitchell C, Meredith P, Richardson M, Greengross P and Smith GB (2015) 'Reducing the number and impact of outbreaks of nosocomial viral gastroenteritis: time-series analysis of a multidimensional quality improvement initiative', *BMJ Quality and Safety*, doi: 10.1136/bmjqs-2015-004134 (epub ahead of print).
- Nagendran M, Gurusamy KS, Aggarwal R, Loizidou M and Davidson BR (2013) 'Virtual reality training for surgical trainees in laparoscopic surgery', *Cochrane Database of Systematic Reviews*, 27 August, CD006575.
- National Audit Office (2015) *The Management of Adult Diabetes Services in the NHS: Progress review*. National Audit Office. [www.nao.org.uk/wp-content/uploads/2015/10/The-management-of-adult-diabetes-services-in-the-NHS-progress-review.pdf](http://www.nao.org.uk/wp-content/uploads/2015/10/The-management-of-adult-diabetes-services-in-the-NHS-progress-review.pdf). Accessed January 2016.
- National Voices (2013) *A Narrative For Person-Centred Coordinated Care*. NHS England. [www.england.nhs.uk/wp-content/uploads/2013/05/nv-narrative-cc.pdf](http://www.england.nhs.uk/wp-content/uploads/2013/05/nv-narrative-cc.pdf). Accessed January 2016.

- NCEPOD (National Confidential Enquiry into Patient Outcome and Death) (2015) *Sepsis: Just say sepsis!* NCEPOD. [www.ncepod.org.uk/2015sepsis.htm](http://www.ncepod.org.uk/2015sepsis.htm) . Accessed December 2015.
- NHS England (2014) *The Five Year Forward View*. NHS England. [www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf](http://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf). Accessed December 2015.
- NIB (National Information Board) (2014) *Personalised Health and Care 2020: Using data and technology to transform outcomes for patients and citizens: A framework for action*. HM Government. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/384650/NIB\\_Report.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384650/NIB_Report.pdf). Accessed January 2016.
- NIB (2015a) *Personalised Health and Care 2020: Work stream 4 roadmap: Build and sustain public trust*. NIB. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/465068/Work\\_Stream\\_4\\_Final.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/465068/Work_Stream_4_Final.pdf). Accessed January 2016.
- NIB (2015b) *The Forward View into Action: Paper-free at the point of care – completing the digital maturity self-assessment*. NIB. [www.england.nhs.uk/digitaltechnology/wp-content/uploads/sites/31/2015/11/dig-maturity-guid-11-15.pdf](http://www.england.nhs.uk/digitaltechnology/wp-content/uploads/sites/31/2015/11/dig-maturity-guid-11-15.pdf). Accessed January 2016.
- NIB (2015c) *Personalised Health and Care 2020: Work stream 5 roadmap: Bring forward life-saving treatments and support innovation and growth*. NIB. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/465069/Work\\_Stream\\_5\\_Final.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/465069/Work_Stream_5_Final.pdf). Accessed January 2016.
- NIB (2015d) *Personalised Health and Care 2020: Work stream 6 roadmap: Support care professionals to make the best use of data and technology*. NIB. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/465070/Work\\_Stream\\_6\\_Final.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/465070/Work_Stream_6_Final.pdf) . Accessed January 2016.
- NIB (2015e) *National Information Board Prospectus: September 2015*. NIB. [www.gov.uk/government/publications/national-information-board-nib-interim-report-2015/national-information-board-prospectus-september-2015](http://www.gov.uk/government/publications/national-information-board-nib-interim-report-2015/national-information-board-prospectus-september-2015). Accessed January 2016.
- Office for National Statistics (2014) *Internet Access – Households and Individuals 2014*. Statistical Bulletin. Office for National Statistics. [www.ons.gov.uk/ons/dcp171778\\_373584.pdf](http://www.ons.gov.uk/ons/dcp171778_373584.pdf). Accessed December 2015.
- O’Reilly D, Tarride J-E, Goeree R, Lokker C and McKibbin KA (2012) ‘The economics of health information technology in medication management: a systematic review of economic evaluations’, *Journal of the American Medical Informatics Association* 19(3), 423–38.
- Palen TE, Ross C, Powers J and Xu S (2012) ‘Association of online patient access to clinicians and medical records with use of clinical services’, *JAMA* 308(19), 2012–2019. doi:10.1001/jama.2012.14126.
- Pearl R (2014) ‘Kaiser Permanente Northern California: current experiences with internet, mobile, and video technologies’, *Health Affairs* 33(2), 251–7.
- Purdy S (2010) *Avoiding Hospital Admissions: What does the research evidence say?* The King’s Fund. [www.kingsfund.org.uk/sites/files/kf/Avoiding-Hospital-Admissions-Sarah-Purdy-December2010.pdf](http://www.kingsfund.org.uk/sites/files/kf/Avoiding-Hospital-Admissions-Sarah-Purdy-December2010.pdf). Accessed November 2015.



- Radley DC, Wasserman MR, Olsho LEW, Shoemaker SJ, Spranca MD and Bradshaw B (2013) 'Reduction in medication errors in hospitals due to adoption of computerized provider order entry systems', *Journal of the American Medical Informatics Association* 20(3), 470–6.
- Roshanov PS, Fernandes N, Wilczynski JM, Hemens, BJ, You JJ and others (2013) 'Features of effective computerised clinical decision support systems: meta-regression of 162 randomised trials', *British Medical Journal*, 346, f657.
- Rowlands G, Protheroe J, Price H, Gann B and Rafi I (2014) *Health Literacy: Report from an RCGP-led health literacy workshop*. Royal College of General Practitioners. [www.rcgp.org.uk/news/2014/june/-/media/Files/Policy/RCGP-Health-Literacy-2014.ashx](http://www.rcgp.org.uk/news/2014/june/-/media/Files/Policy/RCGP-Health-Literacy-2014.ashx). Accessed December 2015.
- Royal College of Physicians (2015) *Using Apps in Clinical Practice: Important things that you need to know about apps and CE marking*. Royal College of Physicians.
- Royal College of Psychiatrists (2015) *Guidance for the Use of Audio-Visual Recording in Child Psychiatric Practice*. Royal College of Psychiatrists. [www.rcpsych.ac.uk/files/pdfversion/CR198.pdf](http://www.rcpsych.ac.uk/files/pdfversion/CR198.pdf). Accessed December 2015.
- SBRI Healthcare (2014) 'Tackling respiratory disease with home-based services and solutions could improve the lives of six million people in the UK', news release. [www.sbrihealthcare.co.uk/wp-content/uploads/2014/01/A8081-v-1-8-FINAL-PR-SENSOR-project-underway-in-Portsmouth-a-collaborative-project-with-Aseptika-QA-UoP.pdf](http://www.sbrihealthcare.co.uk/wp-content/uploads/2014/01/A8081-v-1-8-FINAL-PR-SENSOR-project-underway-in-Portsmouth-a-collaborative-project-with-Aseptika-QA-UoP.pdf). Accessed January 2016.
- Schmidt PE, Meredith P, Prytherch DR, Watson D, Watson V and others (2015) 'Impact of introducing an electronic physiological surveillance system on hospital mortality', *BMJ Quality and Safety* 24, 10–20.
- Sharma U and Clarke M (2014) 'Nurses' and community support workers' experience of telehealth: a longitudinal case study', *BMC Health Services Research* 14, 164.
- Skhal KJ and Koffel J (2007) 'VisualDX', *Journal of the Medical Library Association* 95(4), 470–1.
- Steele AM and DeBrow M (2008) 'Efficiency gains with computerized provider order entry', in Henriksen K, Battles JB, Keyes MA and others (eds) *Advances in Patient Safety: New directions and alternative approaches* (Vol. 4: Technology and Medication Safety). Agency for Healthcare Research and Quality (US).
- Swan M (2015) *Blockchain: Blueprint for a new economy*. O'Reilly Media.
- Taylor J, Coates E, Brewster L, Mountain G, Wessels B and Hawley MS (2014) 'Examining the use of telehealth in community nursing: identifying the factors affecting frontline staff acceptance and telehealth adoption', *Journal of Advanced Nursing* 71(2), 326–37.
- TeleTracking (2014) *World's First 'Real Time' Hospital Increases Hand Washing Monitoring 1000% in One Month*. TeleTracking. [www.teletracking.com/proven-success/#Case-Studies](http://www.teletracking.com/proven-success/#Case-Studies). Accessed December 2015.
- The Health Foundation (2011) 'Continuous remote monitoring of ill children: Birmingham Children's Hospital NHS Trust. Project page. [www.health.org.uk/programmes/shine-2011/projects/continuous-remote-monitoring-ill-children](http://www.health.org.uk/programmes/shine-2011/projects/continuous-remote-monitoring-ill-children). Accessed January 2016.

- The King's Fund (2014) *Imperial Child Health General Practice Hubs*. The King's Fund. [www.kingsfund.org.uk/sites/files/kf/media/imperial-child-health-general-practice-hubs-kingsfund-oct14.pdf](http://www.kingsfund.org.uk/sites/files/kf/media/imperial-child-health-general-practice-hubs-kingsfund-oct14.pdf). Accessed December 2015.
- The Royal Wolverhampton Hospital NHS Trust (2014) 'Pioneer scoops innovation award for patient safety work using tracking technology', press release, 14 January. [www.royalwolverhamptonhospitals.nhs.uk/pdf/Innovation%20Award.pdf](http://www.royalwolverhamptonhospitals.nhs.uk/pdf/Innovation%20Award.pdf). Accessed December 2015.
- Tsulukidze M, Durand MA, Barr PJ, Mead T and Elwyn GP (2014) 'Providing recording of clinical consultation to patients – a highly valued but underutilized intervention: a scoping review', *Patient Education and Counseling* 95(3), 297–304.
- Vassilev I, Rowsell A, Pope C, Kennedy A, O'Cathain A, Salisbury C and Rogers A (2015) 'Assessing the implementability of telehealth interventions for self-management support: a realist review', *Implementation Science* 10, 59.
- Veslemøy G, Anderson J and Wiig S (2014) 'Patient safety risks associated with telecare: a systematic review and narrative synthesis of the literature', *BMC Health Services Research* 14, 588.
- Wachter R (2015) *The Digital Doctor: Hope, hype, and harm at the dawn of medicine's computer age*. McGraw-Hill Professional.
- Walker J, Meltsner M and Delbanco T (2015) 'US experience with doctors and patients sharing clinical notes', *British Medical Journal* 350, g7785.
- WebGP (2014) *WebGP: the virtual general practice: pilot report (May 2014)*. <http://webgp.com/documents/e-consult-pilot-report-2014.pdf>
- Yao W, Chu CH and Li Z (2010) 'The use of RFID in healthcare: benefits and barriers', RFID-Technology and Applications (RFID-TA), 2010 IEEE International Conference.
- Young LB, Chan PS and Cram P (2011) 'Staff acceptance of tele-ICU coverage: a systematic review', *Chest* 139(2), 279–88.
- Zhou YY, Kanter MH, Wang JJ and Garrido T (2013) 'Improved quality at Kaiser Permanente through e-mail between physicians and patients', *Health Affairs* 29(7), 1370–5.

## Infographic References

### Consumer IT

- 'In 2015, 71% of all UK citizens had a smartphone; 88% of adults used the internet'. Ipsos MORI (2015) *Ipsos Connect Tech Tracker Q3 2015*. [www.ipsos-mori.com/Assets/Docs/Publications/Ipsos\\_Connect\\_Tech\\_Tracker\\_Q3\\_2015.pdf](http://www.ipsos-mori.com/Assets/Docs/Publications/Ipsos_Connect_Tech_Tracker_Q3_2015.pdf)
- 'The average adult spends almost 2 hours a day online on their smart phone; 33% of users see their smartphone as the most important device for going online'. Ofcom (2015) *The Communications Market Report*. August. [http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr15/CMR\\_UK\\_2015.pdf](http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr15/CMR_UK_2015.pdf)

‘Only 2% of the population report any digitally enabled transaction with the NHS’. National Information Board/UK Government (2014) *Personalised Health and Care 2020: Using Data and Technology to Transform Outcomes for Patients and Citizens. A Framework for Action*. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/384650/NIB\\_Report.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384650/NIB_Report.pdf)

‘43,000 medical apps are now available on iTunes; 500 million people around the world will use a healthcare app this year’. Becker’s Healthcare (2013) Becker’s Health IT and CIO Review: ‘How to Further Integrate Patient-Facing Apps in Healthcare (and the Top-Rated Apps)’. <http://www.beckershospitalreview.com/healthcare-information-technology/how-to-further-integrate-patient-facing-apps-in-healthcare-and-the-top-rated-apps.html>

‘50% of the UK population use the internet for self-diagnosis, while 75% search the web for health information’. Department of Health and UK Trade and Investment (2015) ‘The UK: your partner for digital health solutions’. <https://www.gov.uk/government/publications/the-uk-your-partner-for-digital-health-solutions>

‘A 2012 survey of 7,000 patients found that...’. Patient.co.uk (2012) Patient survey, 2012.

## Telehealth

‘108 out of 176 CCGs in the UK were commissioning telehealth services in 2013/14: a total spend of £15.2 million in that year.’ Good Governance Institute (2014) *Keeping the NHS Great: Delivering technology-enabled care services*. [www.good-governance.org.uk/wp-content/uploads/2014/09/Keeping-the-NHS-Great-report.pdf](http://www.good-governance.org.uk/wp-content/uploads/2014/09/Keeping-the-NHS-Great-report.pdf)

‘Just 14% of over-65s in the UK have access to telecare services (e.g. fall alarms etc)’. Empirica and WRC (2010) *ICT & Ageing European Study on Users, Markets and Technologies: Final Report*. [http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc\\_id=952](http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=952)

‘4.7 million people in Europe used a connected care system in 2013. This is projected to grow to 13.7 million by 2019’. Berg Insight (2014) *Connected Care in Europe*. [www.bergsight.com/ReportPDF/ProductSheet/bi-cc1-ps.pdf](http://www.bergsight.com/ReportPDF/ProductSheet/bi-cc1-ps.pdf)

## Electronic Health Records

‘Over 96% of GP practices have installed digital clinical record systems; under 4% offer patients online access to their records’. National Information Board/UK Government (2014) *Personalised Health and Care 2020: Using Data and Technology to Transform Outcomes for Patients and Citizens. A Framework for Action*. [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/384650/NIB\\_Report.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384650/NIB_Report.pdf)

‘Worldwide, 40% of health care organisations reported a cyber-attack in 2013 – double that reported in 2009’. WinterGreen Research (2015) *Telemedicine And M-Health Convergence: Market Shares, Strategies, And Forecasts, Worldwide, 2013 To 2019*. <http://www.reportsnreports.com/reports/268227-telemedicine-and-m-health-convergence-market-shares-strategies-and-forecasts-worldwide-2013-to-2019.html>

‘Between 2011 and 2014 the NHS suffered over 7,000 breaches of data; that’s six data breaches every day’. Big Brother Watch (2014) *NHS Data Breaches: A Big Brother Watch Report*, November. [www.bigbrotherwatch.org.uk/wp-content/uploads/2014/11/EMBARGO-0001-FRIDAY-14-NOVEMBER-BBW-NHS-Data-Breaches-Report.pdf](http://www.bigbrotherwatch.org.uk/wp-content/uploads/2014/11/EMBARGO-0001-FRIDAY-14-NOVEMBER-BBW-NHS-Data-Breaches-Report.pdf)



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