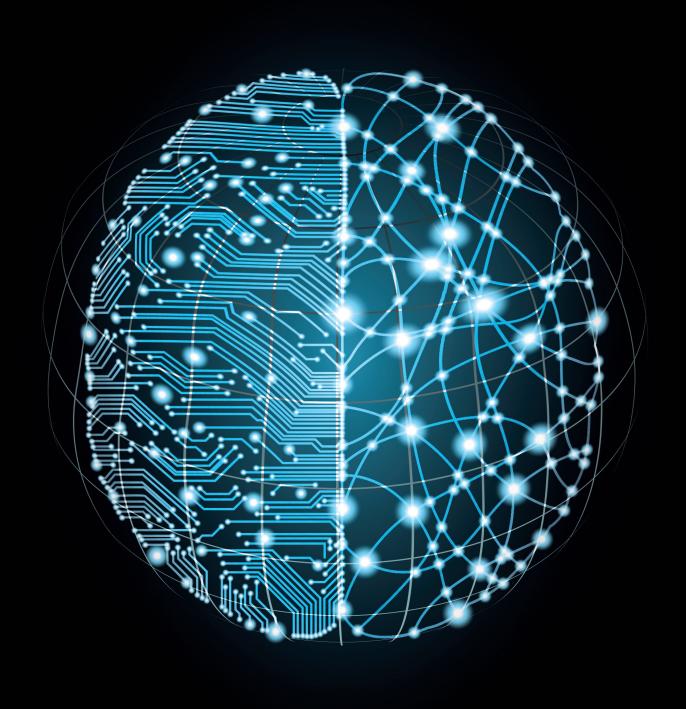
Deloitte.



Closing the digital gapShaping the future of UK healthcare

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Deloitte Centre for Health Solutions

The Deloitte Centre for Health Solutions

The Deloitte Centre for Health Solutions is the research arm of Deloitte LLP's Life Sciences and Healthcare practices. Our goal is to identify emerging trends, challenges, opportunities and examples of good practice, based on primary and secondary research and rigorous analysis.

The UK Centre's team of researchers seeks to be a trusted source of relevant, timely and reliable insights that encourage collaboration across the health value chain, connecting the public and private sectors, health providers and purchasers, patients and suppliers. Our aim is to bring you unique perspectives to support you in the role you play in driving better health outcomes, sustaining a strong health economy and enhancing the reputation of our industry.

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Foreword

Welcome to this new report from the Centre for Health Solutions, Shaping the future of UK healthcare, which highlights the opportunities and future potential of digital and information technologies to tackle some of healthcare's most intractable challenges.

The report highlights a number of key steps to improve the adoption of digital technologies. It acknowledges the importance of technology in bridging the gap between demand for healthcare and the capacity of healthcare services to meet that demand and provides an objective view of the current state of NHS digitalisation and what the future of healthcare might look like.

Successive policy documents over the past five years have recognised the need to get the basic digital architecture right, to improve the quality of data and information flows and deliver more timely, efficient, and safe care. Staff and patients need confidence that their data is held securely and used appropriately. Guiding principles include developing open standards, having secure identity and interoperability standards, ensuring the right data gets to the right place at the right time; and that services are designed around user needs. These principles form part of the NHS Long Term Plan which aims to accelerate the redesign of patient care to future-proof the NHS for the decade ahead. It expects digitally-enabled care to go mainstream across the NHS, advancing to a core level of digitisation by 2024, helping clinicians to work more efficiently and effectively, improving the patient experience and optimising health outcomes.

While a number of digital and technology systems and services are being delivered in some parts of the NHS, our research shows that technology adoption in many hospitals, primary care and community settings is slow with a gap in the digital maturity of providers. Although most providers have some form of electronic health record platform, the functionalities vary widely. The next step for digital transformation is to be able to access, share and use health information seamlessly. For healthcare to realise this will require a radical shift in the culture and mind-set of healthcare stakeholders. It will also require a review of how digital transformation is funded.

The insights provided in this report are drawn from an extensive literature review; a comprehensive survey of 1,500 doctors, nurses and allied health professionals; structured interviews with 65 key stakeholders across the health ecosystem; and the experience of our colleagues across Deloitte who have worked with clients on digital transformation projects in the UK and other comparable countries.

Karen Taylor
Director
Centre for Health Solutions

Bill Hall Partner Health Technology Sara Siegel Lead Partner Public Sector Health

Healthcares digital gap

The NHS long term plan

2024:

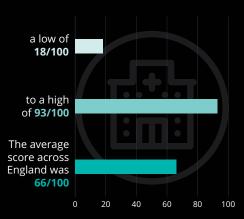
Every patient will have the right to online GP consultations





The Digital Maturity of NHS trusts

In 2018 Trusts in England self assessed their maturity



Funding has been concentrated on only **25%** of the more digitally mature NHS trusts

Senior healthcare leaders top 3 challenges facing the NHS's digitalisation journey



38%

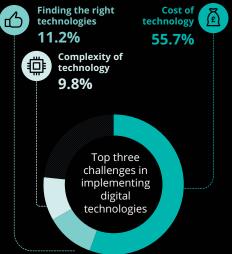
Leadership



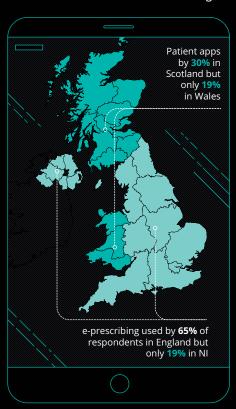
Leadership **22%** Interoperability
22%

staff across UK healthcare

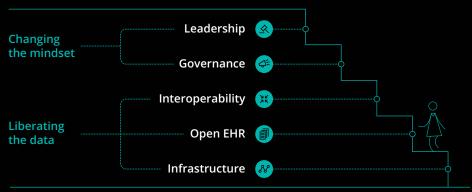
Survey of 1,500 front line clinical



Wide variation in use of basic technologies:



Key steps to close the gap



SMART digital solutions transforming healthcare today



Straightforward and easy-to-use

Technology assisted home based urine self-testing reduces outpatient visits for people with hypertensive pregnancies by **60%**



Measurable impact

Telehealth applications in care homes reduced hospital admissions due to falls and infections by **7.7%**



Agile solutions

RFID-tagging of staff, bed based medical devices enables tracking of patients and staff reduced on- the- day surgical cancellations from 40 to 5 a day and breeches of four hour waits by **70%**



Reliant on industry collaboration

From 2013 to 2017, AHSNs leveraged over £330 million to improve healthcare, rolled out some 330 innovations, and helped create over 500 new jobs



Tailored to end-user needs

Early detection of acute kidney injury via an app tailored to staff needs reduced the workload of specialist nurses by **two hours** each day, releasing time to care



Liberating the power of data to deliver a future that is:

Predictive Preventive Personalised

Executive summary

Information and digital technologies have long been acknowledged as key enablers in transforming the NHS, however, as yet, healthcare lags behind other industries in the adoption of technologies to improve the performance of staff and the consumer experience. Whereas the hospitality, transport, retail and banking industries are almost unrecognisable from ten years ago, and despite the proliferation of digital health solutions, the transformation of healthcare remains slow and fragmented, with a growing digital divide.

The possibilities for health technologies, which include preventing diseases, and predicting and managing population health needs, are endless. However, the fundamental role of digital technology is to improve the quality of data and information flow to deliver timely, efficient, effective and safe care.

Over the past decade, all four UK countries have explored, with varying degrees of success, the use of digital technologies to modernise services. In England, however, the cancellation of the National Programme for Information Technology (NPfIT) in 2011 has led to a largely localised approach to digitalisation, but Scotland, Wales and Northern Ireland have adopted a more national co-ordinated approach. While all four countries have experienced challenges in implementing digital solutions, England has seen wide variability in the extent, quality and scope of the solutions that have been adopted and the outcomes achieved.

A key challenge is the complex structure of the different health systems in the UK, and in particular the many internal and external stakeholders. These include local and national governments, regulators, commissioners, providers, suppliers and a wide range of end users with differing needs. This can often lead to misaligned interests, especially when it comes to sharing data and allocating resources. While the need for clinical autonomy and robust regulations to ensure patient safety is indisputable, it can impact the extent to which data is shared and innovation is adopted at scale.

Rational for digital transformation

Digital transformation in England was given an impetus in 2013 when the then Secretary of State for Health challenged the NHS to go paperless by 2018. In response, the NHS established the National Information Board's (NIB) digital strategy 'Personalised Health and Care 2020', identifying the need to exploit the 'information revolution' and was accompanied by an additional £4.2 billion in Treasury funding of which 1.8 billion was intended for service transformation.

In 2016 the independent Wachter Review, 'Making IT Work', emphasised that implementing health IT is a complex adaptive change and made recommendations to ensure a 'digital NHS that is fit for purpose'. It concluded that the funding allocated to digital transformation was insufficient to achieve the vision of a paperless, joined-up NHS. Nevertheless, it recommended that all NHS trusts should achieve a high degree of digital maturity by 2023 and that government subsidies should no longer be available after that date. It suggested that regulators should deem those trusts that have not reached a high level of digital maturity by then to be noncompliant on quality and safety grounds.

The NHS Long Term Plan (LTP), in February 2019 established 'a digital NHS' as a national policy priority and expects all providers, across acute, community, primary and mental health settings, to have advanced to a core level of digitalisation by 2024.

Current state of healthcare digitalisation

Our research included a survey of 1,500 clinical staff across the UK, comprising doctors, nurses and allied health professionals and interviews with senior stakeholders across the health ecosystem. Our findings suggest that there is a growing divide between policy ambition and the reality on the ground. Indeed, the reality for many trusts is that unless they are one of the twenty-five per cent of trusts selected as one of the Global Digital Exemplars, or a Fast Follower or Local Health and Care Record Exemplars, they have limited access to funding for digital transformation. Many also currently lack the leadership, capacity and capability to embrace digital transformation at scale, widening the digital gap.

Our research suggests that without additional investment in digital transformation, it is difficult to see how most trusts, many of which are reporting financial deficits in 2018-19, can achieve the expected level of digital maturity by 2024.

Our survey respondents said that the top three words that best describe digital transformation today are 'slow, expensive and inefficient'. Ninety-one per cent of respondents said that the technology they use most is the electronic health record, whereas less than ten per cent said they use some of the more innovative technologies, such as artificial intelligence, virtual reality, and robotics. Respondents were also unsure as to how these latter technologies might impact their efficiency, effectiveness and patient safety.

Our survey respondents identified the five largest barriers to the adoption of digital solutions as the cost of the technology (55 per cent); finding the right digital solutions (11 per cent); complexity of the technology (10 per cent); bureaucracy (8 per cent); and training (6 per cent). Our interviewees confirmed the findings of both our survey results and our literature reviews, that effective digitalisation at scale continues to prove elusive. Indeed, the majority of digital health leaders we interviewed think that to achieve a fully digital health system will take more than ten years, with the three major challenges to overcome being funding, leadership and interoperability.

The key steps needed to accelerate digital transformation

We identified five key steps to achieving a digitally mature healthcare system and improving the adoption of digital solutions:

 Create a robust health IT infrastructure for data storage, access to health data, and information sharing.

This infrastructure should include reliable network connectivity and sufficient data storage capacity. Interviewees, however, rated the current state of the NHS IT infrastructure as just 5 out of 10 on average, with the rating for secondary care being 7 and for primary care 4. Interviewees' concerns included the wide variation in digital maturity, cyber security, and patchy connectivity. Initiatives that are starting to improve the situation include:

- the free roll-out of WiFi across the NHS
- the new GP IT Futures framework aimed at ensuring that all IT systems in GP practices meet minimum connectivity standards and can communicate with each other
- moving patient data to cloud services to improve data storage and system integration by providing healthcare organisations with remote access to real-time, easy to use, data, paying only for what they use, such as storage, applications, and infrastructure services.
- 2. Implement accessible electronic health records and invest in the basic technologies needed for digital transformation. EHRs provide a primary source of 'point of care' data and are rated by our survey respondents as the top technology for helping to improve the efficiency and effectiveness of clinicians and patient care. However, there remains a high level of fragmentation between NHS organisations in the numbers, types and functionality of EHR platforms that are being used, with many lacking the ability to access data from other providers, or to share and use data internally, as well as externally.

Basic technologies that are needed to achieve an acceptable level of digitalisation include accessible electronic patient records, electronic (e-) prescribing, e-referral, e-diagnostics, e-rostering and e-discharge; secure communication systems; point of care diagnostics, digital imaging and electronic tracking of equipment, patients and staff. These are designed to keep patients safe and optimise clinical work flows by accelerating the flow and quality of information, enabling timely responsive care. However, adoption of these 'basic' technologies varies widely both in terms of use and in understanding the benefits they can bring.

able to establish connectivity and secure communication of data between multiple and often disparate IT systems, that are often structured in a way that is unique to each provider. Our interviewees identified interoperability as one of the top challenges for healthcare, after funding and leadership. NHS England and NHS Digital have encouraged interoperability through the development of the Local Health and Care Record Exemplar programme, launched in 2018. This currently involves eight successful applicants who were awarded between £5 and £10 million each to create an information-sharing environment to help health and care services 'raise the bar' and improve how the NHS, and its partners, share information safely and securely.

The consistent use of data standards and open application programme interfaces (APIs) and protocols across the UK can also help improve access to and interoperability of EHR systems by enabling the flow of data from different applications and platforms, while maintaining privacy and security standards. However, open API standards will take time to become fully established and some healthcare providers, especially those not backed by big IT suppliers and robust EHR systems, will need more funding and support.

4. Establish a robust governance framework to support a culture of digital transformation. Healthcare organisations must comply with the regulatory requirements that apply to data and technology in general, and to data security and privacy in particular. In May 2018 the European Union's General Data Protection Regulation (GDPR) established new rules for protecting personal data which allow individuals to have more control over how their data is used by third parties. Informed consent and the right to withdraw data access at any time are at the core of the new regulations. GDPR compliance has significantly increased healthcare data security. When asked how they rate the ability of the NHS to protect patient data our interviewees scored it a

7 out of 10 on average, with the highest scores given by those in secondary care (9) and the lowest (5) by IT providers and digital health organisations.

NHS England and NHS Digital launched a number of initiatives aimed at establishing a governance framework for digital transformation. These include: a 2018 'code of conduct for data driven healthcare', comprising ten principles to enable the development and adoption of safe, ethical and effective data-driven healthcare technologies; and guidance clarifying the approach to data ownership, patient consent and patient education. Today, patients increasingly expect to know who is accessing their data, when and why. Indeed the 2016 Caldicott Review on Data Security, Consent and Opt-Outs made it clear that the case for data sharing still needs to be made, including patient education on consent. Furthermore, the 2017 WannaCry cyber-attack highlighted the vulnerability of the NHS to cyber threats leading to a programme of work to strengthen cyber resilience. However, there are wide variations in the response of individual organisations.

5. Develop digital leadership skills and improve the digital literacy of staff and patients. Implementing digital solutions successfully requires: leaders with a clear vision about the role of digital technology in service transformation; clinical staff who feel consulted, empowered and trained in the use of the technology; and patients supported to develop their digital literacy. Both our interviewees and survey respondents had a mixed view about the current level of digital skills and talent in the NHS with an average rating of 5 out of 10. Our survey found that Scotland is providing the highest levels of staff training and Wales had the highest percentage of respondents with no formal training; with primary care having the highest percentage of staff indicating that they had no digital health training.

The National Information Board's 'Building a Digital Ready Workforce programme', Health Education England's 'Technology Enhanced Learning' programme, and the NHS Digital Academy are all aimed at improving the digital capabilities of the health and care workforce. The February 2019 Topol review identifies the next steps needed to improve the digital and genomic literacy of healthcare staff and patients. For patients, the NHS's 2013 Widening Digital Participation programme is one of a number of initiatives helping to improve the digital literacy of the population and is currently piloting 20 different ways to embed digital inclusion into healthcare.

SMART solutions transforming healthcare today

Today, innovative technologies are used in pockets of the NHS, but have the potential to be disruptive if adopted at scale. For end users to adopt innovation, devices and solutions need to meet safety, security and regulatory requirements and provide evidence of outcomes. Our research identified the following SMART characteristics that can help encourage adoption:

- **S**traightforward and easy to use. Many interviewees identified the complexity of technology as one of the top three barriers to adoption. For innovation to be adopted at scale, the technologies need to be intuitive to use and easy to integrate into clinical workflows. These findings are backed up by a 2016 peer review study which found that health informatics interventions are more effective and more readily adopted if they engage users and are easily integrated into daily routines.
- Measurable improvement in the efficiency, effectiveness and/or quality of patient care. Payers and providers expect evidence of improvements in productivity and outcomes, or reductions in costs, and for adoption to give health and care staff more time to care. However, estimating the impact of next-generation technologies can be complex and by the time an evaluation has been carried out, the technology is likely to have evolved. The new National Institute of Health and Care Excellence standards, launched in March 2019, provide an evidence framework to help technology providers understand the evidence requirements needed to improve adoption.
- Agile and affordable. The adoption of innovative technology by
 healthcare providers is more challenging than in most other sectors
 due to: constraints in NHS funding and resource allocations;
 the complexity of NHS procurement and payment models; and
 stringent regulatory requirements. Integrating agile solutions that
 can be upgraded easily and maintained at low cost is strategically
 less risky and a key factor in speeding up adoption of innovation.
 While many new emerging technologies are inherently inexpensive,
 NHS organisations often find it difficult to identify funding for digital
 transformation with our interviewees suggesting the need for more
 agile, iterative funding models.

- Reliant on working collaboratively with industry innovators and academia. Many of our private sector interviewees reported difficulties in selling their products due to lack of capital funding and lengthy decision-making processes in the NHS. Innovate UK, NHS Innovation and Academic Health Science Networks, are connecting the technology developers and funders with the healthcare system, helping them to understand the needs and complexity of the NHS so that they develop the right products at the right cost and deliver evidence-based solutions.
- Tailored to the needs of clinicians and patients. The most successful
 and easily-adopted digital health solutions require input from
 end-users. Innovators that use design thinking methodologies,
 where problems are explored and re-framed and co-developed
 with patients and clinicians, produce dynamic solutions that are
 more likely to be adopted. Clinician involvement can also improve
 confidence that the technology meets the requisite regulatory and
 data protection standards.

Strategic deployment of digital solutions

A number of clinical processes can be improved by digital interventions including remote monitoring, Al-enabled clinical decision support and triage and virtual education and training. Clinical leadership is critical in helping to remove siloes, increase organisational agility and interaction and help clinical staff to work differently. The adoption of digital solutions is also changing the way patients interact with healthcare, particularly in primary care.

Shaping a predictive preventive and personalised future

The healthcare system of tomorrow will look completely different to today. The main focus will shift from managing acute diseases to predominantly maintaining good health and controlling chronic conditions. The changes now taking place are driving healthcare towards large-scale disruption that will impact both traditional and emerging stakeholders, with the boundaries between stakeholders blurring as innovation propels the future of health forward.

Within five to ten years, interoperable 'always-on' data will promote closer collaboration among stakeholders. Patients will expect to own their complete health record and manage their own health, via mobile devices and chat bots. Interventions and treatments will be more precise, more reliable, less invasive, and cheaper. Clinical staff, will have access to real-time physiological data and will intervene much less frequently, releasing time to care. At the organisation level, proactive and preventative healthcare will reduce demand and allow for more cost-effective services and better financial management. Fully interoperable data systems

will be a game-changer for population health management (PHM), driving new performance-based payment models.

The hospital of the future will also look quite different from the hospital of today. Already a growing number of inpatient services are being delivered at home and in outpatient facilities. Hospitals will evolve to be the preserve of acute, complex and very ill patients. Many people will expect to receive care when and where they want it. Technology will also have a significant impact on the future of work. Enablers will include new value based funding and payment models, and new risk reward structures that take into account the value added from clinical innovation.

Conclusion

In 2019, digital transformation of healthcare lags well behind where it needs to be if the NHS is to remain sustainable and affordable and deliver the ambition of the Long Term Plan. The variable state of the IT infrastructure and difference in rates of adoption of technologies requires a more concerted emphasis on change management to accelerate and improve the quality of information flow, and close the digital gap.

While the ambitions in the LTP are aimed at accelerating transformation, the recommendations need more specificity and to be costed. Two questions require immediate attention:

- how the gap in the capacity and capability of IT and digital technology adoption will be quantified and resourced, priorities identified, and progress monitored, especially in light of the significant financial challenges faced by the NHS
- how the current, much beleaguered workforce, will be afforded the time to develop their digital skills and be supported to identify and adopt technology-enabled care in the ways envisaged.

As an imperative, policymakers need to consolidate and increase their support for IT and digital innovation, including prioritising and ring-fencing funding as part of the next spending review. At the same time the UK's existing health and care providers need to adopt a digital first mind-set and embrace the transformation needed to deliver a modern and responsive health and care system, or face being left behind and replaced by new incumbents with a more agile, innovative and accessible approach to care delivery.

1. The rationale for digital transformation

Over the past decade many customer-facing industries, such as hospitality, transport, communications, retail and banking, have been transformed almost beyond recognition by the adoption of digital technologies, particularly in relation to self-service access to services and improving the customer experience.

Today, healthcare is at least ten years behind these industries in transforming the ways services are provided. However healthcare is an extremely complex organisational construct, including a large degree of clinical and managerial autonomy. As a result, progress towards digital transformation has been fragmented and has resulted in wide variations in the extent, quality and scope of the solutions that are implemented and the outcomes achieved.

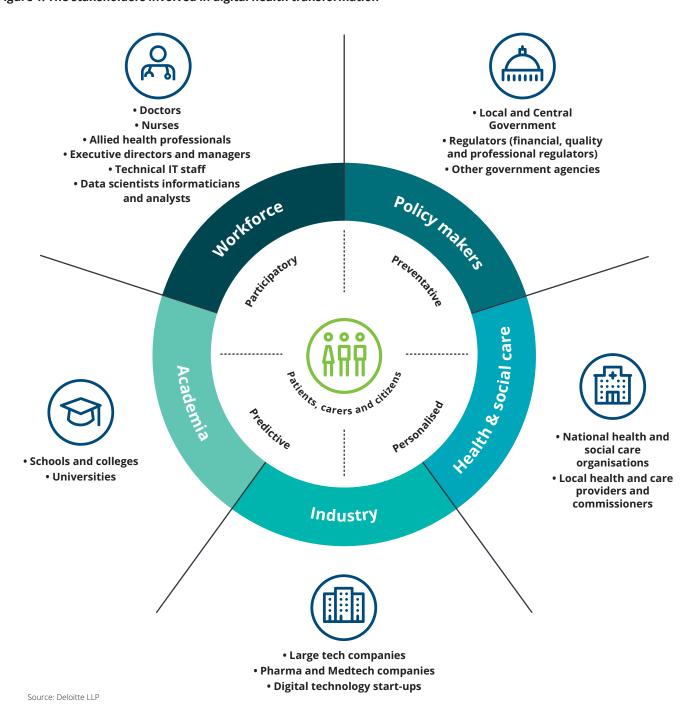
Our research is based on:

- extensive literature reviews and analysis of datasets across the UK
- interviews with 65 senior stakeholders across the healthcare ecosystem (Figure 1), including policy makers, healthcare commissioners and providers, academics, and other industry stakeholders (IT vendors and technology companies developing digital solutions for healthcare)
- a survey of 1,500 clinical staff across the UK, comprising doctors, nurses and allied health professionals working in primary, secondary and community care
- insights from Deloitte colleagues working on digital transformation projects in the UK and in other countries.

This report presents an analysis of the current state of digital transformation across primary, community and secondary care, and identifies what needs to happen to achieve the vision of a fully digitalised and integrated healthcare service. While our research focuses, predominantly on the changing policy landscape in England, our survey and interviews are UK focused; enabling us to compare developments in the other UK countries, where the devolved governments have developed their own, largely centralised, approaches and timelines for digital transformation. The report highlights strategic actions and case examples of evidence-based good practice to accelerate digitalisation of healthcare across the UK.

The report highlights strategic actions and case examples of evidence-based good practice to accelerate digitalisation of healthcare across the UK.

Figure 1. The stakeholders involved in digital health transformation



Digital transformation and the Internet of Medical Things

Over the past decade, healthcare has been shaped by the emergence of a growing number of scientific (life-extending and precision) therapies and technological innovations, leading to measurable improvements in health outcomes. More recently, the pace and scale of innovation has accelerated with the development of health technologies such as digital medicine (health apps, wearables, implantables and digital diagnostics), genomics, robotic and artificial intelligence (including machine and deep-learning).

The medical technology industry (medtech) is a key stakeholder in the digital health ecosystem. Increasingly, medtech is deploying advances in wireless technology, miniaturisation and computing power to drive innovation. In particular, medtech is developing medical devices that can generate, collect, analyse, transmit and store large amounts of health data. These data and the devices themselves are combining with IT systems and software, connectivity technologies and health systems and services to create the Internet of Medical Things (IOMT).¹ The IOMT is now beginning to accelerate the transformation of healthcare through the development of a wide range of digital technologies aimed at diagnosing, monitoring, treating and managing patients more effectively (Figure 2).

The demand and capacity challenges affecting healthcare in the UK

Over the past decade, the challenges facing healthcare providers and payers have become more profound and complex, leading to fundamental questions about the operational and financial sustainability of the NHS. These challenges include:

- increasing demand from a growing and ageing population²
- greater medical complexity due to the prevalence of chronic diseases and more people living longer but with multiple longterm conditions³
- increasing levels of demand across primary, community, mental health and acute care services coupled with a crisis in workforce recruitment and retention, with an estimated 100,000 staff shortages in England alone⁴⁵
- increasing numbers of providers and payers in financial deficit and challenges in delivering the required levels of efficiency and cost effectiveness in the face of increasing demand for services.⁶

Improved drug management

Decreased costs

Enhanced patient experience

patient outcomes

Improved diagnosis and treatment

Improved disease management

Remote monitoring of chronic diseases

Figure 2. The benefits that digital technologies can bring to patients

Source: Deloitte LLP

A growing number of government initiatives, policy documents, and academic and policy research organisations agree that digital transformation is a necessary solution to the above challenges. However, achieving transformation at scale has proved elusive. A key barrier being the need for transformation funding and a failure to agree effective ways of sharing patient health information and achieve a more integrated approach to healthcare delivery, including a lack of digital skills and system leadership.

The evolution of IT deployment in England

The NHS's deployment of Information Technology (IT) has evolved over 40 or more years, with some successes interspersed with many failures. The King's Fund digital health policy timeline identifies key milestones from the early stages of digitisation in the 1960s to 2016. Of particular note is that the GP sector began digitising in the 1980s, and by 2006 was nearly 100 per cent digital, but the secondary provider sector has had a much more fragmented experience. §

For example, the most ambitious programme to digitise secondary care in England, the National Programme for Information
Technology (NPfIT), launched in 2002, was aimed at delivering a fully-integrated care records system and reforming the way that the NHS in England used data and information. However, after a number of enquiries into delays and operational challenges, it was cancelled in 2011, having failed to achieve a number of its goals. Independent reviews of the NPfIT criticised the programme for being too centralised, lacking provider engagement (especially clinical staff), and poor cost control. This cancellation left many secondary care providers without a care record system and with widely variable levels of digital maturity. However, some national elements were delivered successfully, including the NHS Spine, N3 Network, NHSmail, Choose and Book, Secondary Users Service and Picture Archiving and Communications Service.⁹

This rest of this section focuses on the policy landscape driving the digital transformation of healthcare in England, with a brief section on developments in the devolved administrations of Scotland, Wales and Northern Ireland, which since 1997 have adopted separate approaches to funding and developing their IT infrastructure and digital transformation strategies.

The acceleration of digital health policy 2013 - 2018

The need for the digital transformation of healthcare achieved a new impetus in 2013, when the new Secretary of State (SoS) for Health, Jeremy Hunt MP, issued a challenge for the NHS to go paperless by 2018. ¹⁰ Subsequently, the NHS commissioned a number of independent reviews to identify the technology-enabled care changes needed and, in response, the Department of Health and Social Care (DHSC) and NHS England (NHSE) launched a number of policy initiatives to help achieve a digital-first NHS (see Appendix 1).

The defining policy landscape in 2019

In January 2019, following the appointment in July 2018 of Matt Hancock, the new SoS for Health and Care, NHS England published the NHS Long Term Plan (LTP), building on feedback to the SoS's 'future of healthcare' consultation document.11 The LTP was developed in partnership with frontline staff, patients and their families, and other experts. It promises an additional £20.5 billion (over five years, 2019-20 to 2023-24) to aid the transformation of care. In return, NHS England expects all providers and commissioners to become part of an integrated care system (ICS) based around population health and prevention. The LTP proposes a key role for primary and community care services, which will receive an additional £4.5 billion to establish a digital-first primary care sector, expanding community teams to work alongside new primary care networks. In return, primary care is expected to create joined-up systems and digital patient records, link genomic and clinical data and improve the use of 'apps' and advanced technologies such as artificial intelligence (AI).12

The LTP expects digitally-enabled care to go mainstream across the NHS, helping clinicians use the full range of their skills, reduce bureaucracy, stimulate research and enable service transformation. All UK citizens will also have a single, secure, digital identification, making it simpler for them to access their digital health records and services. The LTP recognises that there has been progress in achieving a number of the ambitions in the Five Year Forward View (FYFV) and the Wachter report. These include: access to information through the nhs.uk website; over 70 approved apps in the NHS Apps Library; the national roll-out of the NHS App and the Electronic Prescription Service; and the ability to book online appointments via the NHS e-Referral Service. In Importantly, the LTP sets a number of key digitalisation milestones for the next five years:

- By 2024, every patient should have the right to online digital' primary care consultations (video and voice calls) and all clinicians will be able to access and interact with patient records and care plans wherever they are.
- By 2024, technology should have helped redesign services to avoid up to 30 million (a third) outpatients visits a year, using online booking systems, digital appointments and appointments closer to home, saving £1 billion a year.
- Specific digital transformation commitments include: use of 'smart inhalers', education and digital self-management tools for diabetes, remote patient monitoring and supported self-care and rehabilitation tools – integrated with EHRs and NHS services within the next five years.
- The use of AI to interpret CT and MRI scans; offering all children with cancer the chance to sequence their genomes; and expanding maternity digital care records.
- The NHS App will create a standard online method for people to access the NHS. The app is designed to work seamlessly with other services at national and local levels and, where appropriate, be integrated into patient pathways.
- There will be a simpler, clearer system for medtech, including a new funding mandate, so that proven and affordable innovations reach patients faster.
- All providers, across acute, community and mental health settings, need to reach a core level of digitalisation by 2024, with a CCIO or CIO on the board of all NHS organisations.

In February 2019, the independent Topol review published its final report, 'Preparing the healthcare workforce to deliver the digital future'. It identifies the skills and technologies that healthcare workers will require to equip them for a digital age. The review makes 43 recommendations to aid digital transformation. It recognises that the NHS is at a tipping point with regard to the adoption of digital technologies and that some 90 per cent of all healthcare jobs will require some element of digital skills within the next 20 years. Key requirements include: developing a culture of inter-professional lifelong learning, based on collaboration and multi-disciplinary problem solving; developing digital leadership skills; improving digital and health literacy of staff and patients; and speeding up the implementation of technology-enabled practices. It emphasises the need for collaboration with academia and industry, and for attracting global technical talent (robotic engineers, data scientists and other technical specialists).14

Also in February 2019, in acknowledgement that responsibility for digital, data and technology, was highly fragmented, with accountability split across multiple agencies, teams and organisations, the SoS announced the establishment of a new organisation, NHSX, to lead the NHS digital strategy and take digital transformation forward by bringing together, all the levers of policy, implementation and change including experts in technology, digital data and cyber security. NHSX began operating in shadow form in April and assumes its full responsibilities in July 2019.¹⁵

Financing digital transformation

Over the past five years DHSC and NHSE have introduced a number of funding initiatives to drive the information and technology transformation of the NHS acute sector. However, it is extremely difficult to verify how much funding has actually been spent as intended. Four consecutive reports by the National Audit Office on the financial sustainability of the NHS have concluded that extra in-year cash injections to trusts have been spent on coping with financial pressures rather than the transformation required to put the health system on a sustainable footing. Also that capital budgets have been repeatedly raided to support revenue spending. As digital transformation currently relies on capital funding, lack of access to digital transformation funding is a significant barrier to progress.

The independent review led by Professor Robert Wachter 'Making IT Work' (known as the Wachter report) emphasised that implementing health IT is a complex adaptive change requiring substantial and long-lasting engagement between leaders implementing the change and front line staff.

It welcomed the £4.2 billion that the Treasury made available in 2016 to promote digital transformation, but concluded that this was insufficient to deliver the digital transformation of all NHS trusts. Especially as only half (some £1.8 billion) was targeted at implementing systems to achieve the goal of a 'paper-free' NHS. It therefore recommended a phased approach, focused initially on trusts prepared to digitise or those already digitised and ready to reach higher levels of digital maturity. It identified that another tranche of government funding would be needed to support the second phase. Nevertheless, it recommended that all trusts should achieve a high degree of digital maturity by 2023 and that government subsidies should no longer be available after that date. Moreover that the Care Quality Commission should deem trusts that have not reached a high level of digital maturity by 2023 to be non-compliant on quality and safety grounds.¹⁷ In the event, unplanned factors have made calls on the transformation money, such as the urgent response to cyber security.18

Since 2016, access to, and allocation of funding has been largely on a small number of NHS providers that were judged to be well advanced in digital transformation. For example:

- During 2018, NHSE selected 26 wave one Global Digital Exemplars (GDEs) – 16 acute, three ambulance and seven mental health trusts to develop blueprints for other trusts to follow – and provided them with funding of up to £10 million. In March 2019, a further 17 acute and 8 mental health trusts were identified as Fast Follower (FFs) – partnering with GDEs to accelerate their digital maturity.¹⁹
- In May 2018, the first phase of Local Health Care Record Exemplars (LHCREs), was announced, providing three areas (Manchester, Wessex and London) with £7.5 million each, spread over two years. ²⁰ Yorkshire and Humber and Thames Valley and Surrey were announced in June. In February 2019, NHS England awarded another three second wave sites (Share2Care, the Great North Care Record and the South West) with £15 million and doubled the funding for the London LHCRE. ²¹

This approach to concentrate technology funding on those trusts that show the most progress in digital transformation, specifically the GDEs and FFs (some 25 per cent of trusts), and the LHCREs (covering 40 per cent of the English population) have if anything widened the digital maturity gap (see analysis in Part 2). Nevertheless, the NHS LTP expects all providers, across acute, community and mental health settings, to have advanced to a core level of digitalisation by 2024.²²

Digital transformation in the devolved countries

Since 1997 Scotland, Wales and Northern Ireland have taken separate approaches to funding and developing their IT infrastructure and establishing EHRs but during the past decade they have also had to respond to similar demand and supply challenges; and like most other countries they have acknowledged the need for more rapid digitalisation. Consequently, each of the three countries has developed its own digital strategy for digitalising its healthcare services:

- Scotland. In 2018 NHS Scotland published its *Digital Health and Care Strategy*, which recognises that digital technology is a critical component of service transformation. The strategy outlines a transition process transform Scottish healthcare. This includes rolling out digital maturity assessment across Scottish health and social care; ensuring that all current and future services are resilient and adhere to national standards and specifications; working with the Scottish Government's Digital Connectivity team on technology opportunities (such as rolling out WiFi to address connectivity and bandwidth issues and supporting the transition from analogue to digital telecare); and developing a technical transition plan. In addition, a key element of the 2018 the strategy is the development of a National Digital Platform to enable data sharing and interoperability of existing and emerging technologies.²³
- Northern Ireland. In 2016 Northern Ireland's Department of Health published its *eHealth and Care Strategy*. This is built around the key objectives of using digital technology to support people, share information, use information and analytics, foster innovation, modernise the eHealth infrastructure, and ensure good governance. Underpinning the strategy are five key principles: developing citizen centre care; establishing connectivity across Northern Ireland and ensuring that healthcare information is in the right place at the right time; consistency in rolling out across the country technologies that have proved useful in improving healthcare delivery; driving innovation and promoting best practice; and investment in those technologies that are deemed cost effective in adding value and supporting efficiency.²⁴
- Wales. In December 2015 the Welsh Government published its Digital Health and Social Care Strategy for Wales, outlining how digital tools will enable individuals to have more control over care and improve access to information and services. Wales has since adopted a 'Once for Wales' approach, to provide all hospitals with common systems and established a common interface, the Welsh Clinical Portal, providing access to patient information from various sources including test results and clinical notes, aiming to create a seamless digital patient record.²⁵

2. The current state of digital health

The number of reviews and policy initiatives described in Part 1 and Appendix 1, demonstrate the ambition of government and leaders across healthcare to make the most of emerging technologies to improve the productivity and sustainability of the clinical workforce and achieve better health outcomes. However, to realise these ambitions, cultural and operational changes are needed.

The pace of technological change and explosion in the numbers and types of digital health technologies available in the market have created a complex landscape that has left clinicians and patients across the UK struggling to determine how best to invest their time and money. Results from our survey of 1,500 clinicians indicate that the top three challenges that their organisations are currently facing in implementing digital technologies are: the cost of the technology (56 per cent), finding the right technologies (11 per cent) and the complexity of technology (10 per cent) – see Figure 3. There was little difference in responses from staff in the different UK countries or sectors of care.

Figure 3. What are the top 3 challenges your organisation is currently facing in implementing digital technologies?



Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019.

Our interviews with senior stakeholders identified the top three challenges impacting the implementation of digital transformation as: funding (38 per cent), leadership (22 per cent) and interoperability (20 per cent). Cultural challenge (16 per cent), staff competencies (14 per cent) and ease of use (14 per cent) were the next most frequently mentioned challenges.

Views of frontline staff on the digital strategies of their organisation

Having a robust digital strategy is key to helping healthcare systems and individual organisations address digitalisation (not just digitising existing processes but also process change) in a coordinated and proactive manner. Digital strategies can also help staff understand and engage with their organisations digitalisation agenda. The results from our staff survey, indicate that 61 per cent felt 'not at all' or only 'a little' informed about their organisations digital strategy, staff from Wales were the least informed and those in England the most (see Figure 4).

Figure 4. Healthcare staff views on how informed they are about their organisation's digital strategy



Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Survey question: "How well informed are you about your organisations digital strategy?"

Progress towards digital transformation

Our survey respondents' views on the current state of digitalisation were largely negative, with 'Slow, Expensive and Challenging' being the three most frequently mentioned words. However some also recognised that it was exciting and was improving accessibility and efficiency (see Figure 5). Likewise, the sentiment expressed by our interviewees on the current state of digitalisation is predominately negative (describing it as slow, fragmented and lacking interoperability). However they also identified digital transformation as an opportunity to improve services.

The digital maturity gap

A persistent concern raised by interviewees is the wide gap in digital maturity within and across the different sectors of care. In England, the National Information Board (NIB), following publication of its Personalised health and care 2020 – a framework for action, in 2015, required all NHS trusts to undergo a validated, digital maturity self-assessment (DMA). The aim of the DMA was to understand the strengths and weaknesses of each provider in utilising digital technology to achieve a health and care service that is paper-free at the point of care. Each trust was assessed in 2016 and again in 2018, across the three key themes of readiness, capabilities and infrastructure.26

Following the 2016 assessment, trusts with higher DMA scores, that also met other criteria (such as being innovative, having a strong financial position, and good Care Quality Commission rating)

Figure 5. Front line clinical staffs' views on progress towards digitalisation



Negative sentiment

Positive sentiment

Neutral sentiment

Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Survey question: "What three words come to mind when you think of UK healthcare's journey towards digitisation?"

Note: Figure 4a is representative of the top 60 words used by participant. Size of word reflects number of times mentioned

were invited to apply to become GDEs.²⁷ Deloitte compared the 2016 and 2018 DMA results across all trusts as well as the 25 per cent designated as GDEs and FFs.

We found that the overall digital maturity of providers across English regions has improved (average scores for readiness from 73 to 76; capabilities from 40 to 48, and enabling infrastructure from 68 to 75). However, there is a growing digital maturity gap (see Figure 6). Moreover, targeting national funding at the GDEs has left many other providers lagging even further behind.

There is currently no equivalent assessment of digital maturity in primary care, though there are plans to develop one. It is acknowledged, however, that almost all General Practices (GPs) have benefited from having an EHR for more than 20 years.²⁸ The Royal College of GPs estimates that up to 80 per cent of primary care IT systems could soon be outdated and unsuitable for the future models of care delivery.²⁹ Moreover, primary care funding methods mean that GPs have lacked the financial incentives to invest in the digital technologies that the LTP identifies as some of the basic technologies needed for the digital transformation of primary care. Furthermore, our interviewees identified that key barriers are the lack of interoperability between primary and secondary care systems and the resistance of GPs to sharing data.

Since 2005, the international Healthcare Information and Management System Society (HIMSS), has conducted an independent assessment of the digital maturity of healthcare providers, using the Electronic Medical Record Adoption Model (EMRAM). The assessment ranges from Stage 0 (very limited digitalisation) to Stage 7 (complete EMRs, data analytics, governance, privacy and security) and is extant for three years. The model is commonly used in North America with 6,144 hospitals assessed and 2,013 (33 per cent) of providers achieving Stage 6 and 329 (5 per cent) Stage 7. In Europe, some 1,449 hospitals have been assessed and 190 (13 per cent) organisations achieving Stage 6 and five (0.4 per cent) achieving Stage 7. In the UK, three providers are currently assessed as at Stage 6.30 The Cambridge NHS Hospitals Foundation Trust is currently a Stage 6 and expects to be rated as a Stage 7 during 2019 (see Case study 1).

The other UK countries are currently working on their own digital maturity assessments, although the results have not, as yet, been published.3132 There are no HIMSS 6 or 7 hospitals in the other UK countries.

Figure 6. Digital maturity assessment scores of all NHS trusts, including those trusts designated as Global Digital Exemplars and Fast Followers Average DMA score for GDEs in 2018 (2016 North score)/ number of GDEs ☆ 79 (71)/9 Highest: 90 Average DMA score for **3** 72 (68)/7 Average: 67 Fast Followers in 2018 **68** (66)/67 Lowest: 48 (2016 score)/ number of Fast Followers Average DMA score excluding GDEs and Fast Followers in 2018 (2016 **England** Highest: 93 score)/ number of trusts **6**4 (61)/16 Average: 66 65 (59)/223 Lowest: 18 Midlands and East ☆ 78 (71)/7 Highest: 93 **6**0 (54)/4 Average: 66 64 (59)/70 Lowest: 18 London ☆ 70 (72)/4 Highest: 80 **4**9 (53)/4 Average: 64 £ 62 (57)/33 Lowest: 40 South West ☆ 73 (64)/1 Highest: 87 **South East** 68 (59)/19 Average: 68 ☆ 75 (66)/3 Highest: 81 Lowest: 51 **5**5 (65)/1 Average: 66 **67** (61)/25 Lowest: 49 **South Central** Source: Deloitte analysis of NHS England DMA data ☆ 74 (72)/2 Highest: 81 Note: The highest and lowest scores are an average of the 2018 DMA scores across the measurements of readiness, capabilities and enabling infrastructure. The average is the average 2018 DMA score **6**8 (48)/1 Average: 65 **57 (0)/9** Lowest: 41 across the region.

Case study 1. Cambridge University Hospitals (CUH) NHS Foundation Trust – A world-class example of digitalisation in UK secondary care accredited by HIMSS



CUH implemented its integrated electronic patient record (EPR) system in 2014 with Epic, providing the software and Hewlett Packard the infrastructure – the contract is worth £200 million over ten years. The digital transformation involved a complete refresh of the computing estate: 5,500 old computers replaced by around 8,000 new computers and 800 laptops, new networks, 1,300 WiFi access points installed in clinical areas, 400 integrated workstations on wheels, 420 handheld devices, medical device integration in 40 theatres and 148 critical care beds, and up to 3,700 staff using a Bring Your Own Device Service. The EPR and supporting IT infrastructure enable mobile working in clinical areas and offsite. As a result, CUH has successfully moved away from paper-based and manual clinical processes to fully digital ways of recording and accessing patient information. Staff are able to view and record clinical information in one place, in real-time, wherever and whenever they need it.

After one year CUH was accredited with HIMSS EMRAM Stage 6. In 2016 it was rated as having the highest capabilities in the DMA and, in 2017, was selected as a GDE. In October 2018, CUH became the first UK trust to be validated against the new, more stringent HIMSS EMRAM Stage 6 criteria, which focuses heavily on the implementation and adoption of key practices including closed-loop barcode medication administration (BCMA) and closed-loop human milk administration.

Improvements in interoperability:

- In April 2018, CUH delivered a UK interoperability breakthrough, linking its Epic EPR with West Suffolk Hospitals' Cerner EPR, enabling real-time sharing of some 400 patient records a month to advance patient care. CUH also connects globally with other hospitals using Epic EPRs to advance the care of internationally shared patients
- Since May 2018 GPs and community nurses across Cambridgeshire's largest primary care service can access the hospital records of their patients through a secure digital portal.

The CUH Patient Portal (MyChart) is used by over 6,000 patients and is populated automatically with information from the EPR; including appointment details and clinical correspondence, vital signs and the automatic release of test results. Patients have real-time access to their information via a computer, laptop, smartphone or tablet device and will soon be linked to wearables or home devices. Examples of outcomes of the digital transformation strategy:

- 99% reduction in paper records (£460,000 annual savings in staff time) by eliminating manual retrieval of paper notes
- 4,500 appointments freed-up in orthopaedics clinic as clinicians view clinical notes and x-rays virtually assessing if a patient needs hospital treatment, or an alternative treatment method (improving patient experience)
- 42% reduction in Trust wide sepsis mortality, with alerts and clinical decision support created within the EPR, through collaboration between clinicians and the in-house digital team
- 16% of allergy-related e-prescribing alerts leading to a change in prescription, avoiding some 850 significant adverse medication reactions annually (2,500 inpatient beds saved equivalent to some £1 million annual savings)
- 100% reduction in sedation-related prescribing errors in paediatric intensive care, saving at least 50 intensive care beds and 100 regular bed days per year
- 50% reduction in the time taken to prepare discharge medications through integrating the EPR with the medication dispensing robot in pharmacy.

Accelerating the digitalisation of healthcare

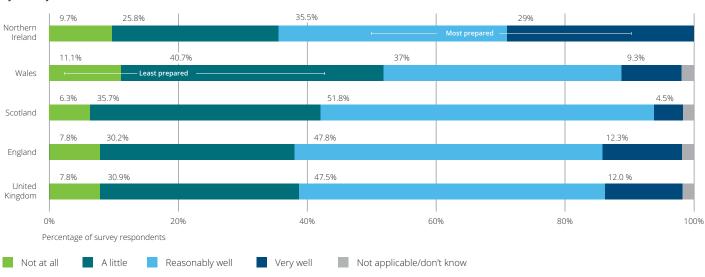
Our research identified the need to create a level playing field in terms of the willingness of healthcare providers to adopt technologies. Around three fifths of survey respondents believe their organisations are reasonably or well prepared, with Northern Ireland staff feeling the most prepared and Wales the least (see Figure 7). Staff in secondary care felt their organisation was the least prepared while those in primary care felt the most prepared.

Two recent initiatives are aimed at accelerating the adoption of digital technologies by helping healthcare, IT and digital technology companies understand what levels of evidence and information are needed and to work with the NHS:

- the March 2019 National Institute of Health and Care Excellence (NICE) Evidence standards framework to make it easier for innovators and commissioners to understand the evidence that should be available, or developed, for digital health technologies to demonstrate their value in the UK health and care system. This includes evidence of effectiveness relevant to the intended use(s) of the technology and evidence of economic impact relative to the financial risk.³³
- the launch in April 2019 of the NICE HealthTech Connect, to help identify and support new health technologies be it medical devices, diagnostics or digital health technologies, to access support and potential routes to national evaluation programmes, as they seek to move from inception to adoption in the UK health and care system.³⁴

Figure 7. How well prepared is your organisation for adopting digital technologies?





Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Survey question: "How well prepared is your organisation for adopting digital technologies?"

3. Key steps to close the digital gap

Expectations about digital health technology range from prevention to prediction and from personalisation to improving population health. However, this is only made possible by it's ability to increase the quality of data and information flows, leading to more efficient, effective and timely care, while improving the experience of patients and staff, and saving lives. As a result, the healthcare data sector has many large technology companies and start-ups with innovative data tools and technology products. However, a current challenge lies in closing the digital maturity gap and accelerating the adoption of these technologies at scale.

We have identified the following five key steps to help deliver digital transformation at scale:



create a robust health IT infrastructure for storage and access to health data and for sharing information



implement accessible electronic health records (EHRs) and invest in basic digital technologies that accelerate digitalisation



address the challenge of interoperability



establish a robust governance framework to support a culture of digital transformation



develop digital leadership skills and improve the digital literacy of staff and patients.

Step 1. Create a robust health IT infrastructure for storage and access to health data and for sharing information

A modern IT infrastructure is needed to enable shared access to real time patient health data and efficient deployment of digital technologies within primary and secondary care (for example, to support vital signs monitoring, telehealth and virtual consultations). This infrastructure comprises network connectivity, data storage and security, IT systems and software, end user devices and open (free access) Application Programming Interfaces (APIs) or software-to-software interaction.

We asked our interviewees to rate the current state of the IT infrastructure across UK healthcare. The average rating overall was five out of ten, with seven for secondary care and four for primary care. Commenting on secondary care, interviewees highlighted concerns about the wide variation in digital maturity within the infrastructure, the general lack of investment in interoperability of electronic health records, and concerns over cyber security. More specifically, interviewees consider that a key component of a modern IT infrastructure is fast, uninterrupted connectivity, based on reliable and secure WiFi or broadband; but they commented that currently this is very patchy.

In 2015, in recognition of the fact that some hospitals were charging for access and others were not even providing WiFi, the government committed money from a £1 billion technology fund to provide free WiFi in all NHS buildings, with the aim of improving treatment and the patient experience, and guided by principles of universality, equity and quality. Information from NHS Digital in April 2019 indicates that all GPs have had access to WiFi since 2017, and that by April 2019, 98 per cent of acute, mental health and community trusts will have free Wi-Fi (the remaining two per cent of trusts have experienced delays due to wider network changes, but expect to be offering free NHS WiFi by December 2019). However, broadband speeds vary with location, and just under half the country still relies on a slower and less reliable copper-based infrastructure.

Interviewees commented that problems with the infrastructure in primary care include inadequate internet speeds and an overall lack of data sharing and incentives to invest in digitalisation as a barrier to transformation. The prevailing view is that the current NHS IT market, with just two main providers, has impeded digitalisation by creating long-term contracts which have failed to incentivise GP practices to innovate.

These views are reflected in the rationale for the new GP IT Futures framework aimed at ensuring that all IT systems in GP practices meet minimum connectivity standards and can communicate with each other.³⁷ It promotes modularity, making it easier for new market entrants to provide services to primary care. Patient data will also be moved to cloud services to enable data and system integration. Contractors that do not meet the quality criteria for the new IT system should expect to lose their contract.^{38 39}

A solution to the connectivity problem is implementation of fibre optic broadband. In October 2018 the Government began talks with broadband providers about equipping GP practices in England with fibre optic cabling, to replace copper cabling and ensure that there is enough bandwidth and speed to support video consultation when patients do not need a face-to-face GP visit.⁴⁰

In Scotland, broadband connection has been designed to support data-heavy solutions such as telemedicine, to provide adequate care in the country's many rural areas. ⁴¹ The Digital Scotland Superfast Broadband programme has rolled out fibre optic broadband to 95 per cent of premises since 2014. ⁴² Another requirement is assurance about the safety and security of the connectivity.

5G technology, with its low latency, low power and lower costs, could provide 'a strong foundation for innovation and inventions, enabling the interplay between health sensors, algorithms and smart devices and support telemedicine and remote monitoring more efficiently and effectively. The potential use of 5G technology and its impact on heath and care services is being piloted in Liverpool: the Sensor City Consortium, comprising public health suppliers, the NHS, university researchers and local SMEs have formed the Liverpool 5G Testbed programme for health and social care. With £3.5 million funding from the Department for Digital, Culture, Media and Sports (DCMS), the testbed aims to use 5G supported health technologies to help people manage long-term conditions such as diabetes and epilepsy at home.

Examples include:

- Safehouse Sensors to detect falls, changes in temperature and unusual behaviour patterns
- PAMAN provides a video link to a local pharmacy, supporting people to take medicines safely at home
- Push to Talk' a loneliness app for isolated carers, which puts them in touch with other carers in a similar position
- 'Loneliness Gaming and Quizzing App', being trialled by people with a learning disability
- 'telehealth in a Box', designed to aid communication between the Royal Liverpool and Broadgreen University Trust and patients in the community.⁴³

The 5G network enabling these developments is able to integrate into existing fibre infrastructure and on objects, such as lampposts. As a result, the technology can be delivered cost effectively across a dense urban environment. In April 2019, the testbed programme was given additional £1.5 million in funding, and extended for another 12 months. 44 5G technology will be available commercially by the end of 2019. 45

Cloud computing technology is increasingly seen as a solution to improving the IT infrastructure, due to its ability to process and deliver data in an efficient, collaborative, manner and analyse data into meaningful information. Cloud technology enables healthcare organisations to move from a highly centralised approach in which each organisation acquires and maintains the requisite hardware, software and staff, regardless of whether the resources were used at full capacity, to a decentralised approach in which healthcare organisations can access real-time, easy to use, remote access to data, paying only for what they use, such as storage, applications (software as a service), and infrastructure services.⁴⁶

Step 2. Implement accessible electronic health records (EHRs) and invest in a basic level of digital technologies to accelerate digitalisation

Most NHS primary and secondary care providers now have some form of EHR in place. While hospitals have largely digitised their patients' records, patients still have their health and care information stored in various settings. For example, general practices generally use one of two main EHR systems, but in secondary care there is a wide variety of types of electronic records used within and between hospitals.⁴⁷ Since 2018, 'The Summary Care Records' initiative has enabled a minimum level of information from GP medical records to be seen by authorised staff in other areas of the health and care system.⁴⁸

Our survey highlighted EHRs as the most widely adopted technology across all regions and sectors of care. Ninety-eight per cent of clinical staff in GP practices, and 92 and 87 per in community care and secondary respectively, said they use EHRs.

Our analysis also shows that respondents from Northern Ireland had the highest rate of adoption (100 per cent) followed by Scotland (96 per cent) and England (91 per cent). A lower adoption rate (78 per cent) was reported in Wales (see Figure 8).

The high adoption rating of EHRs by Northern Irish clinicians is linked to the perceived success of its EHR, the Northern Ireland Electronic Care Record (NIECR), and its ease-of-use portal for clinicians to access relevant information from primary, secondary and social care (see Case study 2).

Figure 8. The views of clinical staff on the use of digital technologies in the UK

	UK	England	Wales	Scotland	Northern Ireland
Electronic health record	91%	91%	78%	96%	100%
E-prescribing	61%	65%	32%	39%	19%
Point of care diagnostics	42%	43%	44%	28%	48%
E-rostering	41%	42%	41%	29%	23%
Patient apps	29%	29%	19%	30%	29%
Remote vital sign monitoring	25%	26%	20%	15%	23%
Telemedicine	17%	17%	9%	22%	16%
Voice recognition for clinical documentation	15%	15%	13%	16%	3%
Automation of clinical tasks	13%	13%	7%	9%	13%
Wearables	12%	12%	9%	12%	10%
Robotics	7%	7%	9%	4%	3%
Radio frequency Identification tags (RFID)	4%	4%	7%	5%	3%
Virtual reality	3%	3%	2%	3%	-
Artificial intelligence	3%	3%	-	2%	-

Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Interview question: "Which of the following digital technologies do you use to support care delivery?" Note: Data arranged by UK values from largest to smallest

Case study 2. Integrating care records using Northern Irelands Electronic Care Record Programme (NIECR) $\,$



Prior to 2013, the healthcare data of nearly 1.8 million patients in Northern Ireland (NI) was held in multiple disparate systems spread across the six Health and Social Care trusts in NI (HSCNI). This made the continuity of care and staff access to relevant and up-to-date healthcare information very difficult. To combat this, the NIECR programme, which was fully rolled out in 2013 following a trial in 2009/10, aimed to unite the numerous disparate systems across HSCNI into a single, web-based, easy-touse solution, displaying comprehensive clinically-relevant information that is updated in real-time and accessible from anywhere within HSCNI. The information provided in the Record includes demographics, lab and radiology results, medications, allergies, diagnoses, encounters and clinical correspondence. Further enhancements have also provided a number of other functionalities including:

- eTriage:primary to secondary care e-referrals for fully digital, auditable, faster and more reliable referrals
- Radiology Order Comms: for standardised data collection, reduction in duplicated tests, better order tracking and a single approach to ordering radiology across the region

- Regional Mortality and Morbidity System: to create a single pathway for recording and discussing learning from patient deaths in Northern Ireland
- Results Sign Off: the ability to review and sign off laboratory and radiology reports within NIECR, for improved quality and safety, and reduced variation in processes
- Diabetes Pathway; a single, region-wide pathway for adult and paediatric diabetes patients, enabling multidisciplinary, collaborative recording of clinical encounters and treatments.

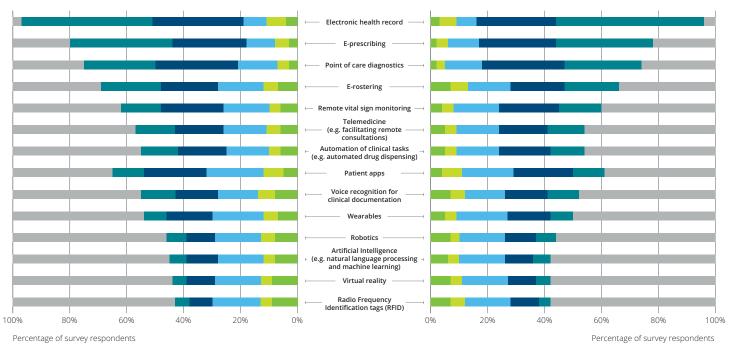
In January 2018 the NIECR system recorded 700,000 user log-ins, and it is currently in use by more than 98 per cent of clinicians, with 95 per cent of NIECR users confirming that the platform has saved them time. 49 As a result of its successful implementation, the NIECR platform won the 2014 HSJ award in 'Enhancing Care by Sharing Data and Information' and in 2016 the 'Building Better Healthcare Award' for best Administration, Information or Data System (eTriage). 50

However, the views of clinicians on adoption of EHRs by clinicians shows only one side of a much more complex situation. Our research indicates that in England and Wales, unlike the NIECR, there is a high level of fragmentation between NHS organisations in the numbers, types age and functionality of EHR platforms that have been implemented, with legacy systems lacking the ability to access data from other providers, or to share and use data internally, as well as externally. The LTP states that 'the information technology revolution in the NHS needs to make it a more satisfying place for our staff to work. At present, too much of the technology in the NHS is a burden on our staff – slow to log in, clunky to use and unreliable in moments of crisis'.

Additionally, EHRs were also rated the top technology in helping to improve the efficiency and effectiveness of clinicians, and for improving patient care. However, when respondents were asked about the use of other digital technologies, and their impact on efficiency and effectiveness, the scores were very low (see Figure 9).

Figure 9a. Health care staff views on what digital technologies improve their efficiency , UK

Figure 9b. Health care staff views on what digital technologies improve their effectiveness, UK



Very well

Source: Deloitte research and analysis based on survey commissioned from Sermo. 2019

Neutral

Reasonably well

Interview question: "On a scale 1-5 how would you rate the following technologies in improving your efficiency?"

A little

Not at all

Definition of effectiveness: How well are inputs (effort or cost of labour, capital or equipment) converted into outputs (such as numbers of patients treated, GP, outpatient appointments or diagnostic tests undertaken). Specifically, the degree to which the use of technology has freed up your time to see and or treat more patients.

The above views illustrate that if staff aren't using a technology they were more likely to state that they wouldn't expect them to improve efficiency and effectiveness, and also patient safety Indeed the uncertainty scores on the questions relating to benefits increased with the more advanced technologies. As technologies such from vital signs monitoring to voice recognition are some of the more basic technologies for digital transformation and others, such as AI, RFID and virtual reality, are seen as critical to the future of health (see part 5), especially given their role in accelerating the flow and quality of information and enabling timely responsive care. This suggests that the Topol recommendations on staff education and training, including raising awareness of the benefits of these technologies can bring, need to be implemented as soon as possible.⁵¹

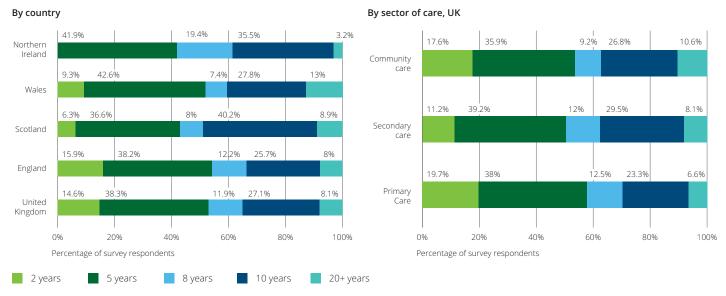
Interview question: "On a scale 1-5 how would you rate the following technologies in improving your effectiveness?"

Not applicable/don't know

Definition of effectiveness: How well do outputs (patient discharges, GP appointments, and prescriptions) achieve the intended outcomes (such as better medication management or shorter lengths of stay)? Specifically, the extent to which the use of the technology(s) has enabled you to deliver better patient outcomes (such as improved their management of their chronic condition or enabled patients to be treated at home rather than requiring a hospital admission).

When we asked survey respondents when they expect the NHS to become fully digital or 'paperless', the views were split with 38 per cent believe that their organisation will be fully digital within five years, but 36 per cent believing it will take ten years or more (Figure 10). In contrast, two-thirds of our interviewees believe it will take more than ten years to achieve this goal.

Figure 10. How long do you think it will take your organisation to become a fully digital organisation (paperless)?



Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Survey question: "How long do you think it will take for your organisation to be fully digital organisation?"

Step 3. Address the challenge of interoperability

Our interviewees identified interoperability as one of top three challenges for the healthcare system, after funding and leadership. Interviewees from IT and digital technology providers identified interoperability as their biggest challenge. As discussed in our 2018 report, *Medtech and the Internet of Medical Things*, interoperability in healthcare is extremely complex: it relies on establishing connectivity and the secure communication of data between multiple and often disparate IT systems into EHRs that are often structured in a way that is unique to each provider.⁵²

Since 2014, as part of the FYFV new models of care programme, NHSE has encouraged interoperability mostly through the development of shared local care records (LCR).⁵³

An independent survey of 141 respondents across 149 unique care settings in England in 2018, found that the most widespread and effective sharing of patient data in the NHS is within the 61 local care record LCR) initiatives, facilitated by health information exchange (HIE) technology.⁵⁴ Though still early, LCRs are aggregating data from numerous sources and presenting it to clinicians – usually via a separate portal. It notes that InterSystems and Cerner are the main providers of HIEs due to the relative ease with which they can connect disparate data sources and their ability to share information between care settings.⁵⁵

The new Local Health and Care Record Exemplar (LCHRE) programme launched by NHS England in 2018 is intended as the next step in achieving interoperability. The aim is to create an information sharing environment that helps health and care services continually 'raise the bar' in how the NHS, and its partners, share information safely and securely to help deliver better care for our populations. In order to be selected as a LHCRE, selected applicants had to demonstrate that they had a robust governance framework, a citizen opt-out standard, adoption of technical and data interoperability standards, compliance with data and cyber security standards and conformation with national services, particularly record locators. 56, 57, 58 A key element of the approach is to establish and maintain trust in data sharing. LHCREs also need to interoperate through Open APIs, so information can be accessed as patients move across geographical boundaries or organisations. Currently there are eight LHCREs (see page 13). Case study 3 illustrates the development of the Leeds Care Records, and its journey towards becoming part of the Yorkshire and Humber LHCRE.

Case study 3. The development of the Leeds Care Record

Since 2003 Leeds Teaching Hospitals have been working on developing their own EHR system, a secure virtual health and social care record system, called PPM+, to improve services to patients and staff across the region. PPM+ has created an integrated and easily accessible care record connecting 35 different health and care systems across the Leeds area. Over the past five years, the Leeds Care Record has provided a local integrated care record for 2.8 million patients, while also serving as the EHR of Leeds Teaching Hospitals NHS Trust.

PPM+ serves as the platform for the Leeds Care Record which brings together information from GPs, local hospitals, community healthcare, social services and mental health teams across Leeds. The system also supports the 100,000 Genome oncology project across the region.

Currently, PPM+ is accessed every 3.8 seconds and delivers over 50 million pieces of information every month while providing additional functionality such as e-prescribing and electronic observations.

In recognition of its success, the Board of Leeds Teaching Hospitals NHS Trust has provided further support to the project by enabling the team to continue developing the system until at least 2022. PPM+ also won the 'Using technology to improve efficiency' award at the AHSN Yorkshire and Humber 'Innovation, Improvement, Impact' conference in January 2018.⁵⁹

Results from a 2018 study on NHS interoperability in the UK showed most interviewees felt that organisational issues were the main challenge with supplier competition an additional factor. Others issues included finance, skill sets and staffing levels. Interoperability projects cost money and the fragmented nature of health systems and access to funding conspires against collaborative working models. While interoperability roadblocks can often be human, they are increasingly becoming budget issues.⁶⁰

An ambition in the NHS LTP is to create a national shared records database that will be available across the whole country by 2024. However, many trusts have still not reached a level of internal interoperability creating a risk of incomplete and inaccurate records. Despite there being no easy solution to the problem, Figure 11 identifies some of the key actions that can promote and accelerate positive changes towards interoperable EHRs in support of new models of care.

'Cloud technology' as well as helping to tackle the IT infrastructure challenge can also help improve interoperability, by placing critical IT infrastructure in virtual, offsite data centres, where data can be pooled, accessed and analysed securely. In 2018, NHS Digital issued national guidance approving the use of cloud services for storing patient information. This included a framework for assessing and managing risk, establishing standards for how data should be stored and used, and identifying the considerations that need to be applied when choosing a supplier.⁶¹

Figure 11. Key actions healthcare stakeholders should consider when attempting to improve interoperability



Over the last two years, the three leading public cloud providers – Microsoft Azure, Amazon Web Services and Google Cloud Platform – have all opened dedicated UK-based hosting zones within their public cloud provision. These cloud providers are directly accessible via the NHS N3 network, allowing for more reliable, scalable and secure services – while significantly lowering costs. Examples of use of cloud include:

- In 2018, the Greater Manchester Health and Social Care (GMHSC)
 Partnership, which was awarded £7.5 million as part of LHCREs
 funding scheme, began investing in a cloud strategy involving 20
 NHS and local government organisations with aim of moving their
 EHRs of 2.8 million people to the cloud.⁶²
- In May 2019, NHS Digital, as part of its cloud-first approach, announced plans to assume a cloud-broker like role so organisations across the NHS and wider public sector can gain access to cloud services to take advantage of economies of scale.⁶³

Other examples of successful interoperability include:

- Placing ownership of the EHR data in the hands of patients, accessed via a portal or platform, to improve patient engagement and experience. Empowered patients will begin to push for access to their health records and, in some instances, they already have such access.
- In 2019, the NHS Wales Informatics Service (NWIS) has partnered with Patients Know Best (PKB), to provide a platform in which patients control the use of their own health data to self-manage their condition, and decide what information to share and who can access it.⁶⁴
- Co-ordinate My Care (CMC) is an urgent care plan platform, recording key information about patients with long-term conditions or approaching the end of their lives and shares this information with the doctors, nurses, ambulance staff and others who look after them. Normally, the plan has to be started by a hospital doctor or GP, but in May 2019, CMC publicly launched myCMC so that patients can start their own plans to take more control of their care and how they wish to be treated in an emergency. The plans are accessible through a web browser, using desk or mobile devices, and patients can view and amend their own plans at any time.⁶⁵

Step 4. Establish a robust governance framework to support a culture that embraces digital transformation

Another key challenge identified by interviewees is the stringent regulatory requirements that apply to technology in general, and in particular to data security and privacy. Examples cited include the May 2018 European Union's General Data Protection Regulation (GDPR) which came into force, establishing new rules to protect personal data privacy and allow individuals to have more control over how their personal data is used by third parties. 66 Informed consent and the right to cancel data access and use at any time are at the core of the new regulations. NHS Digital, as guardians of health and care data in England, supports the NHS to ensure that the rights under the GDPR are properly implemented. In addition, the DHSC and NHSE have launched a number of initiatives aimed at establishing a governance framework for digital transformation. These include:

· Clarity over data ownership, patient consent and patient **education.** The 2013 independent review of Information governance in the health and care system and subsequent appointment of Dame Fiona Caldicott as the first statutory National Data Guardian for Health and Care was a key step in establishing a robust governance framework. Historically, ownership of patient information has been seen as belonging to the organisation that generated or stored the data. This has created a reluctance to share data assets freely.⁶⁸ One solution is for patients to own their own data. Today, this is rarely the case; however patients increasingly expect to know who is accessing their data, when, and why. Indeed the 2016 Caldicott Review on data security consent and opt-outs identified that the case for data sharing still needs to be made and that there is also a need for patient education on consent.⁶⁹ One platform that works on the principle of the patient owning their own data is Patients Know Best (PKB), see Case study 4.

- Establishing the security, safety and ethical standards for new digital solutions. The NHS has created a library of validated digital health apps, for which safety and security are ascertained prior to inclusion in the library (in line with standards designed by NHS Digital). The clinical safety, data protection, security and usability of all novel digital solutions are assessed by approved assessors. This is particularly important in relation to Al algorithms, which will be used increasingly and applied in conjunction with other technologies.
- A code of conduct for data-driven healthcare. In recognition of the need to improve the quality and safety of care including data-driven technologies in September 2018, the Government published a code of conduct for data driven health and care technology as a consultation document. In February 2019 the DHSC and NHSE launched the code of conduct, comprising ten principles, to enable the development and adoption of safe, ethical and effective data-driven health and care technologies. These ten principles are:
 - understand users' needs
 - define the outcome and how the technology will contribute to it
 - use the minimum personal data necessary to achieve the desired outcomes
 - be fair, transparent and accountable about what data is being used (data protection by design principles)
 - make use of open standards
 - be transparent about the strengths and limitations of the data used and algorithms deployed
 - demonstrate the learning methodology of the algorithm being built and how outcomes are validated
 - generate clear evidence of the effectiveness and economic impact of a product or innovation
 - safeguard data and integrate appropriate levels of security into the design of devices, applications and systems
 - consider only entering into commercial terms in which the benefits of the partnerships between technology companies and health and care providers are shared fairly.

Case study 4. PKB new model of care for inflammatory bowel diseases: Flare to timely care



Inflammatory bowel disease (IBD) is a chronic lifelong, long term condition often presenting in late teens, affecting around 300,000 people in the UK. Symptoms of IBD can flare up at any time requiring prompt treatment. East Surrey Hospital (ESH) IBD service looks after approximately 4,000 patients from across the Surrey and Sussex Healthcare Trust. Stretched staff resources had resulted in long waiting times for outpatient care and adverse outcomes, such as emergency admissions, surgeries and poor quality of life.

In 2014, the service was radically redesigned to provide open access through telephone and email support. This was based on the adoption of the Patients Know Best (PKB), web-based, patient management portal, which gives patients full control of their medical record and allows patients to record their symptoms and communicate with the IBD team remotely. It also enables access to timely advice and clinical review, with escalation to face-to-face consultations where necessary. PKB interaction is primarily triaged by trained administrative staff supported by nurses with overall oversight by the consultant. This removes pressure and time from the nurses and consultants releasing time to care and helps separate complex cases from more stable or minor issues. The capacity that is

released by using the on-line triaging enables more severe disease to be seen earlier and improves outcomes.

Supported by the Kent, Surrey and Sussex Academic Health Science Network, PKB was rolled out to all IBD patients across the Trust. Some 80 hospital admissions, 136 emergency department attendances and 440 outpatient appointments have been avoided with savings of around £232,320 per year on hospital admissions. Waiting times for patients to access to specialist care has reduced from six weeks to one week. Time to obtain advice has reduced from over six weeks to within 48 hours. From an environmental point of view, considering that an average patient journey is approximately 23 miles, this equates to a carbon saving of around 60 tonnes CO2 per annum. In total the ESH considers it has saved £4 million using PKB in just one Department.

A survey of 100 patients before and after using the 'Flare to timely care' PKB service evaluated patient activation and patient related outcome measures (PROMS). The perception who reported that their IBD was well controlled rose from 60 to 71 percent after using PKB for four months, 68 percent felt the service had a positive impact on their IBD, whilst 77 per cent felt more confident in managing their own health.⁷¹

Protecting patient data, including cyber security

Within the NHS the huge increase in the volume of healthcare data has heightened concerns over cyber security, especially since the 2017 WannaCry cyber-attack. This impacted on the operations of a number of NHS trusts with the aftermath felt across the NHS. Since the attack, the DHSC has undertaken taken a number of steps to increase its cyber resilience, including publishing 'Your Data: Better Security, Better Choice, Better Care' in July 2017 in which it formally accepted the National Data Guardian's 10 security standards, and detailed an implementation plan on securing data and cyber security.72 Since 2017, the Government has invested £60 million to address key cyber security weaknesses, and in April 2018 pledged a further £150 million, over three years to improve security and resilience across the health and care system. However a Freedom of Information Survey with responses from 159 trusts conducted between in 2018 found the NHS trusts lack in-house cybersecurity talent and many are falling short of training targets, while investment in security and data protection training is patchy at best.73,74

When our interviewees were asked how they would rate the ability of the NHS to protect patient data they scored it a 7 out of 10 on average, with the highest scores awarded by those interviewees operating within secondary care (9) and the lowest score given by IT providers and digital health organisations (5). Interviewees also suggested that the focus on protecting patient data so rigorously might in fact undermine innovation, by deterring organisations from sharing healthcare data, particularly between primary and secondary care. Similarly, even if the GDPR establishes an encryption compliance for migrating data to the cloud, and cloud systems can demonstrate high levels of compliance, some still see the cloud as an unprotected environment for data sharing. Moreover, blockchain technologies have been acquired by some leading digital heath companies in England aimed at providing a safe and effective way of assuring and recording patient consent. 76,77,78

Step 5. Develop digital leadership skills and improve the digital literacy of staff and patients

Implementing digital solutions successfully within any healthcare organisation requires leadership with a clear vision about how to use digital technology to support clinical care and the wider organisation. Clinical staff also need to feel consulted, empowered and well trained in using the technology. To realise these ambitions, cultural and operational changes are required, particularly in the ways that staff are educated, developed and deployed. Our interviewees and survey respondents presented a mixed view of the level of skills and talent to use digital technology across UK healthcare. On average interviewees rated the skills and talent of UK healthcare as 5 out of 10, with the skills in secondary care rated as 6.

The highest percentage of survey respondents reporting they received education and training on the use of technology was in Scotland. Wales has the highest percentage of staff with no formal training (18.5 per cent). Staff in hospitals are the most likely to receive (only 11 per cent of staff indicated that they receive no formal training) and those in primary care the least likely (27.6 per cent), see Figure 12. Given the ambition of the LTP for primary care to lead digital transformation, this is something that will need urgent attention

Moreover, blockchain technologies are being implemented by some leading digital health companies in England to provide a safe and effective way of assuring and recording patient consent.

Figure 12. What training, if any, does your organisation provide to enable you to use technology?

By country

Most amount of training provided in Scotland, followed by England, Wales and Northern Ireland. One off training is provided the most.

	UK	England	Wales	Scotland	Northern Ireland
Online training manuals and courses	48.1%	48.3%	57.1%	40.7%	19.4%
Continuous support to use technology	35.7%	36.3%	31.3%	31.5%	35.5%
One off training workshops	54.6%	53.7%	60.7%	63%	54.8%
No formal training	16.7%	16.7%	16.1%	18.5%	16.1%
Other	1.2%	1.3%	0.9%	-	-

By sector of care, UK

Most amount of training provided for secondary care, followed by midwives and healthcare assistants, community care and primary care.

	Primary care	Secondary care	Community care
Online training manuals and courses	36.6%	54.3%	50.7%
Continuous support to use technology	29.4%	39.8%	36.6%
One off training workshops	44.5%	59.8%	57%
No formal training	27.6%	10.7%	14%
Other	0.6%	1.4%	1.4%

Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019.

Primary care clinicians also felt the least equipped to adopt technology (only 44 percent felt reasonably of fairly well equipped) and were least satisfied with the training provided (only 47 per cent were reasonably or well satisfied), see Figure 13. Overall 55 per cent of staff felt adequately trained and only 7 per cent saw themselves as Tech experts.

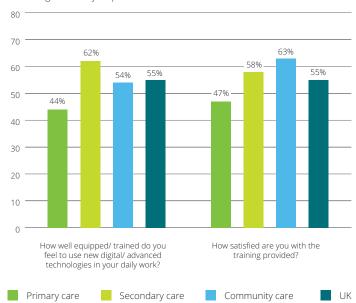
Interviewees identified that the most valuable digital solutions in healthcare are created by teams of mixed expertise with both technical and clinical capabilities. The presence of a digitally sound leadership is crucial in promoting this change, with 22 per cent of interviewees indicating strong leadership in digital transformation as a top three challenge. Indeed, having an engaged and collaborative leadership team can transform the way clinical staff view digital transformation (see Case study 5).

Building a digital ready workforce

The National Information Board's Building a Digital Ready Workforce programme and HEE's Technology Enhanced Learning programme are working in partnership to improve the digital capabilities of the health and care workforce. Part of this work is to promote digital literacy and digital capabilities of everyone working in health and care. In addition, HEE has set up the NHS Digital Academy, a nationally funded, virtual organisation, providing health informatics training to some 300 digital leaders to drive the information and technology transformation of the NHS.

Figure 13. Health care staff views on how well equipped/ trained they feel in being able to use digital technologies in their daily work, by UK sector of care

Percentage of survey respondents



Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Note: The values displayed in the chart for the question "How well equipped/ trained do you feel to use new digital/ advanced technologies in your daily work?" the rating is the cumulative value of the responses "Adequately trained" and "Tech expert". For the question "How satisfied are you with the training provided?" the rating is the cumulative value of the responses "Reasonably satisfied" and "Very satisfied".

The first cohort of 100 delegates from commenced in April 2018 and includes Chief Clinical Information Officers (CCIOs), Chief Information Officers (CIOs) and others charged with leading digital change, from both clinical and non-clinical backgrounds. Applications for the second cohort commenced in April 2019, and applications for the third opens in September 2019.⁷⁹

Survey respondents and interviewees views on what words they would hope to use to describe the state of NHS digitalisation in five years' time

Figure 15 shows that survey respondents were largely positive about the future, and the top three words they used to describe the state of NHS digitalisation in five years' time were: Efficient (28 per cent), Effective (17 per cent) and Safe (12 per cent). Our interviewees were also positive, or 'cautiously optimistic' – their top three words being: Connected (20 per cent), Easy-access (18 per cent) and Cutting-edge (16 per cent) – See Figure 14.

Figure 14. Health care staff's views on the three words they would hope to use to describe the state of health care digitalisation in 5 years time



Source: Deloitte research and analysis based on survey commissioned from Sermo, 2019 Survey question: "In 5 years' time what three words would you hope to use to describe the state of digitisation within UK healthcare?"

Note: Figure is representative of the top 60 words used by participant. Colour key: Purple: Negative sentiment; Green: Positive sentiment; Grey: Neutral sentiment

Case study 5. The role of leadership in the digital transformation of Morecambe Bay NHS Foundation Trusts



Morecambe Bay NHS Foundation Trusts sees technology as 'a golden thread' linking hospitals and community services to enable them to work together, to provide patient care across the system. Recent years have seen an increase in the pace and scale of digital change led by clinicians, nurses and the team. Staff use the Lorenzo Electronic Patient Record (EPR) system from admission, via the Emergency Department (ED) or outpatient clinic, until they are discharged home via an electronic discharge letter. The EPR system supports the triage of patients across many areas of the hospitals. Teams in our ED's use the system to triage day case patients to our ambulatory care units (ACU's). By triaging these patients to the ACUs, they receive the right level of care and reduce the volume of patients coming into the ED. From nurses carrying out comfort rounds using iPods to midwives using laptops remotely to access the latest information relating to a woman's care - embedded technology is positively helping staff and patients. The eMeals system. Provides staff with more time to spend on patient care, reduces food wastage by 45 per cent and offers greater patient satisfaction. The innovative online STRATA system has also helped to facilitate the movement of patients around the local healthcare system, including the discharge of patients from hospitals into community health services and also to Local Authority services. The Emis web electronic record system used in general practices and across many community services gives GPs the ability manage care for patients across sectors. The iPlato myGP app allows patients to book appointments with their GP practice and order prescriptions online instantly.

4. SMART solutions transforming healthcare today

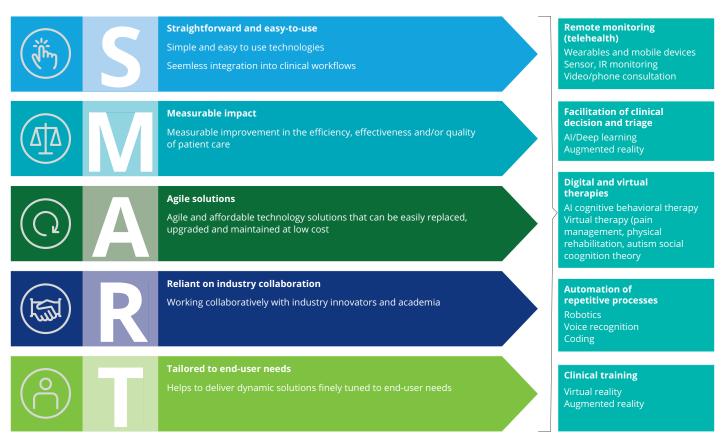
This part of the report evaluates the innovative technologies that are already providing effective solutions across a number of clinical environments and which have the potential to be disruptive if adopted at scale.

Our analysis and discussions with interviewees identified that the following key SMART characteristics are needed to encourage adoption at scale. See also Figure 15.

- Straightforward and easy-to-use. Many of our interviewees identified the complexity of technology as one of the top three barriers to adoption and commented that for innovation to be adopted at scale the technologies should be simple and easy to use, and capable of integration into clinical workflows (see Case study 6).80 These findings are backed up by a 2016 peer review study, which found that health informatics interventions are more effective, and more readily adopted, if they engage users and are easily integrated into daily routines: user-friendly features and reliability are the two key factors.81
- Measurable improvement in the efficiency, effectiveness and/or quality of patient care. Although evaluating the impact of digital health technologies can be a complex process, payers and providers expect evidence of improvements in patient outcomes or costs, or evidence that can provide staff with more time to care (see Case study 7). However, assessing the impact of innovative next-generation technologies can take time, and by the time a peer review evaluation has been conducted, the technology (especially if it involves machine learning) will have evolved. Be The new NICE standards provide an evidence framework for helping technology providers to navigate the healthcare system in such circumstances. Be a complete in such circumstances. Be a complete in patient of the p
- Agile and affordable. The development of new digital solutions is escalating rapidly creating a dilemma for providers as to which investments will be the best value for money. Integrating agile solutions that can be replaced, upgraded and maintained easily and at low cost is strategically less risky, and at the same time can help speed up innovation adoption. Many new emerging technologies are inherently inexpensive and flexible. RFID tracking and analytics devices exemplify how low cost digital solutions can have a positive impact for healthcare organisations (see Case study 8). However, our interviewees noted that many providers find it difficult to identify appropriate funding principally due to the NHS expectation that technology solutions should be funded out of capital allocations.

- Reliant on working collaboratively with industry innovators and academia. Small and medium-sized enterprises (SMEs) are at the heart of digital health innovation. Many of our private sector interviewees reported difficulties in selling their products to the NHS, due to the limitations on available capital funding and lengthy decision-making processes. The role of NHS Innovation and the Network of AHSNs is increasingly important in connecting the healthcare system with the private sector, and identifying significant financial support for digital health developers. For example between 2013 and 2018 AHSN had supported the development and roll out of some 330 innovations, leveraged over £330 million to improve healthcare and helped create over 500 new jobs.84 Tech giants are also disrupting the market. DeepMind is a UK AI and machine-learning pioneering company that was acquired by Google, which has led research into disruptive and state-of-the-art AI solutions in collaboration with NHS organisations for early diagnostics and prevention of a number of conditions including blindness (see Case study 9).85
- Tailored to the needs of clinicians and patients. The most successful and easily-adopted digital health solutions are usually developed with input from the end-users. Design thinking methodology, where problems are explored and re-framed with input from patients and clinicians, can help align the needs of end-users with the views of developers. Ref These and similar approaches can have a significant impact on the development and adoption of more effective digital health solutions (see Case study 10). Clinical staff also need to be able to convey the benefits of the digital technology to patients, and involvement in the design can help with this. Involvement can also help to reassure clinicians and patients that the technology meets the required regulatory and data protection standards.

Figure 15. The SMART characteristics of digital technologies that can help improve adoption at scale



Source: Deloitte LLP, 2019

Case study 6. Healthy IO- A simple solution to a complex and time consuming problem

Urine analysis is the second most common diagnostic test in the UK with 42 million tests undertaken annually. It is used in all sectors of healthcare, including key clinical pathways such as chronic kidney disease (CKD), diabetes screening, antenatal care, urinary tract infections (UTIs), and paediatrics and outpatient management.⁸⁸

'Traditional' urine analysis involves a urine dipstick with different chemical pads that react to the composition of the urine by changing colour. The colour change on the dipstick is then compared to a reference chart which indicates the presence of specific analytes, aiding the diagnosis of a condition. The manual and subjective nature of the test, makes it prone to errors in diagnosis or require the patient to return to the clinic for repeat tests. This is both inconvenient for the patient and costly for the healthcare provider.

Healthy.IO is a healthcare start-up, based in Israel with a global presence, that has developed technology combining smartphone cameras, a mobile app and a home-based urinalysis test kit, to enable patients to self-test at home and share the results with their care provider through the mobile app. Healthy.IO has two urinalysis solutions currently: Dip. io which is similar to a typical urine test, and ACR which tests for micro albumin and creatinine levels within urine.⁸⁹ The use of the technology is improving a number of key clinical pathways, including:

- CKD: Home-based screening of albumin and creatinine (ACR) for people with diabetes or high blood pressure has increased adherence to NICE clinical guidance and the diabetes care process by successfully reaching 72 per cent of eligible previously untested patients. This resulted in 11 per cent newly found cases of elevated protein, indicating previously unknown kidney disease.
- UTI: Self-testing for UTI can shift uncomplicated UTI management from the GP to the community pharmacy setting and can reduce unplanned hospital admissions among people with chronic conditions.⁹⁰
- Antenatal: Dip.io is currently used for self-management in hypertensive pregnancies by Israel's leading health maintenance organisations, and has demonstrated strong positive outcomes. Digital home-testing has the potential to reduce outpatient appointments by 60 per cent and reduce antenatal consultation time by 25 per cent.

Both products have been CE-approved and ISO 13485, and are used in partnership with a number of key NHS organisations within both primary and secondary care.⁹¹

Case study 7. DrDoctor is working with the NHS to create smart, data driven value-based healthcare systems, with patients at the centre and patient engagement as the driving force

England there were around one million hospital outpatient appointments where the patient failed to attend. As each outpatient appointment costs approximately £120, the cost of missed appointments was close to £960 million.92

The DrDoctor Patient Portal is a tool that allows patients to book and change medical appointments online, through notifications via their communications channel of choice. Once patients have been onboarded to the platform, they are encouraged to use it to take control of their own health.

DrDoctor is currently live in 16 NHS Trusts across the country, scheduling over 9 million appointments and serving almost 5 million patients.

Trusts using the DrDoctor tool estimate that they are each saving around £2 million a year, with the number of missed appointments falling by a third, and cutting their postage costs by more than a quarter. Other outcomes include:

- improvements in clinical utilisation
- improvement in patient and staff satisfaction with over 90 per cent of patients and staff recommending the service
- improved attendance
- one Trust reported financial benefits of £2.6 million in 2016-17, with further savings in the ensuing years
- one Trust reported a 50 per cent reduction in phone calls and waiting lists cleared, and a third highlighted patients enabled to self- manage are freeing nursing teams to see more patients.⁹³

Hospitals using the DrDoctor tool estimate that they are each saving around £2 million a year, with the number of missed appointments falling by a third, and cutting their postage costs by more than a quarter.

Case study 8. Increasing patient safety by using Real Time Locating Technology (RTLS) across all hospital areas: The Royal Wolverhampton NHS Trust



To improve performance around patient flow and prevention and control of hospital-acquired infections, the Trust implemented 'SafeHands' (TeleTracking), a Department of Health part-funded innovation project using real-time locating system (RTLS) hardware and software to improve patient safety. The Trust installed more than 5,000 infrared beacons and virtual walls across its acute hospital site, establishing virtual rooms. This allows tracking of badges worn by staff, patients and medical devices at bed level in multi-bed bays. The Trust distributed 4,000 individualised badges to clinical staff, and all in-patients are badged on admission. The system also allows staff to identify where patients are at any time and captures staff-patient interaction, as well as staff-device interaction, in real time. The software captures and stores location data and can provide analytics indicating where equipment is located that needs preventative maintenance, as well as registering which members of staff have interacted with which patients. This accelerates identification of at-risk staff where a patient is diagnosed with an infectious disease. Staff can call for assistance from colleagues by pressing a button on their badge, triggering an audible alarm and flagging the location and patient identification in a message sent to staff on the ward. Patients badges are removed on discharge from the hospital, which automatically triggers a message to housekeeping asking for the patient bed to be cleaned and discharges the patient from the patient administration system.

All admissions and transfers are managed centrally via the command centre, which enables patients to be placed in the right bed first time. The programme has helped to deliver quantifiable efficiencies, including:

- Breaches in ED 4 hour waits (due to bed capacity) reduced from 50% to 15% in 2016 and has stayed at that level, despite an increase in ED attendances and admissions.
- The number of medical patients in surgical beds has significantly reduced, with the patients in the right bed first time in 95% of cases, as a result of increased visibility and availability of specialty beds.
- There has been a statistically significant reduction in the number of cancelled operations due to lack of bed availability from 40 per month to about 5.
- With real time locating, RWT tracks 102,000 total interactions with patients or 1.5 years of staff to patient interactions per day.⁹⁴

Case study 9. Use of AI at Moorfields Eye Hospital



In the UK two million people are living with sight loss, and 360,000 people are registered blind or partially sighted. By 2050 the projected number of people suffering from sight loss in the UK is expected to double. However many cases are preventable or can be managed effectively if diagnosed and treated early. Since 2016, Moorfield Eye Hospital in London has been collaborating with DeepMind Health to explore whether AI can help clinicians improve the way sight threatening conditions are diagnosed and treated, in order to improve patient care.

In August 2018, Moorfields and DeepMind Health announced ground-breaking results of the first stage of the partnership. The results showed that the AI system developed by DeepMind Health researchers could match world-leading experts in diagnosing a range of eye conditions, recommending the correct referral decision for over 50 eye diseases with 94 per cent accuracy.95 It has also been used to develop new treatments. The next phase of this work is to see whether AI models can not only detect eye disease, but predict it. To do this work reliably and at scale, researchers will use Google's secure cloud computing infrastructure. The successful development and implementation of this technology could help ophthalmologists in the future to identify eye conditions earlier, and provide effective treatment before the damage caused by a condition becomes irreversible.96

Case study 10. STREAMS for Acute Kidney Injury: Royal Free London NHS Foundation Trust



Acute Kidney Injury (AKI) affects one in five hospitalised patients in the UK, causing at least 40,000 deaths each year and with costs for the NHS exceeding one billion pounds. When diagnosed on time, it is a largely treatable condition, and it has been estimated that more than 25 per cent of AKI deaths are preventable. 97 Since 2017 the Royal Free London NHS Foundation Trust, a large tertiary referral hospital with a dedicated renal response team, has been using Streams, an app developed by DeepMind Health. The Streams app detects the early signs of AKI and delivers real-time clinical insights, enabling an immediate intervention. By the end of February 2017, more than 26 nurses and doctors at the Royal Free were using it, with clinicians alerted to an average of 11 patients at risk of acute kidney injury per day. The application is easy to use, providing real-time access to the most relevant clinical information, such as blood test results and medical history. The availability of the information at a glance allows doctors and nurses to make informed decisions and act within a few minutes rather than several hours.

Early anecdotal evidence suggest that the workload of nurses using Streams is reduced by two hours every day, releasing time to care for patients. Healthcare professionals reported that the new interface was userfriendly and only takes a few minutes to learn how to use. They also commented that smartphone technology "is something that you are familiar with out of work as well as in work". "The app is delivering cultural change to the way technology is being used to improve patient care. The technology is no longer passive, but is actively helping us to provide better and timelier care to patients": Chris Laing, a renal consultant who has worked with DeepMind to develop Streams. In November 2018, it was announced that, with the aim of scaling up Streams, Google, which acquired DeepMind in 2014 will be directly leading the team working behind the app.98

Strategic deployment of digital solutions

Within a clinical setting, specific processes are ideal targets for digital health interventions. Clinical staff with proper training can be supported and encouraged to identify key steps in the clinical workflow that could be improved with the use of new technologies. Clinical leadership is critical in helping to remove siloes, increase organisational agility and interaction and help staff to work differently.

The following digital technologies have demonstrated measurable improvements in processes, enabled by digital technologies:

- Remote monitoring (telehealth). Wearables, mobile and sensor devices, and video consultations are able to monitor and modify patient behaviour in real time, managing chronic conditions such as asthma, diabetes, and high blood pressure with unprecedented levels of accuracy. The generation of intelligent and measurable information is helping to improve the speed and accuracy of earlier diagnosis, improve prevention and target treatments, and reduce hospital readmissions. Examples include the following:
- The latest smart watch developments include FDA approved electrocardiogram capabilities that can be performed in few seconds and irregular heartbeat rhythm detection for the prevention of strokes or hearth failures.⁹⁹
- Dartford and Gravesham NHS Trust has adopted an Al-enabled wearable device for vital sign monitoring of recently discharged chronic patients reducing home visits by 22 per cent. Training staff to use the technology took less than one hour¹⁰⁰
- Remote monitoring via ambient infrared and optic sensors has also been developed which detects movement and activity, and can also measure changes in vital signs using a sophisticated Al predictive algorithm.
- Turnstall, has developed a number of tailored digital solutions to support older people with chronic conditions and mobility issues. ¹⁰¹ This includes sensors that can detect falls, epileptic fits and bed occupancy. ¹⁰² It has developed a Connected Care platform that has been deployed and evaluated across a number of sites in the UK. For example one NHS commissioner has reduced variations in practice across care homes through upskilling and empowering staff and patients to use telecare and telehealth services. Of the 38 care homes involved there was a 7.7 per cent reduction in hospital related admission relating to falls and infections between 2016-17 and 2017-2018, saving £200,000 per year. ¹⁰³

- Clinical decision support and triage. There is a growing body of evidence that AI, and in particular deep learning, enables clinicians to keep pace with advances in research and treatment protocols. It also augments clinical decision making and improves the accuracy and speed of diagnosis in medical imaging and pathology. 104 105 106 For example;
- Augmented reality scanners for intravenous injections can improve vein detection by up to 3.5 times, in a procedure were clinicians fail 40 per cent of the time.¹⁰⁷
- Viz LVO is a FDA cleared, computer-aided triage software that uses an Al algorithm to analyse images for indicators associated with a stroke. The application is designed to analyse CT images of the brain and send a text notification to a neurovascular specialist if a suspected large vessel blockage (LVO) has been identified. The algorithm will automatically notify the specialist at the same time as the first-line provider is conducting a standard review of the images saving between 6 and 206 minutes, and with an average time saving of 52 minutes.¹⁰⁸ Viz LVO works across a hub and spoke network, enabling specialists early involvement even when the patient is in a rural setting. Given that millions of neurons are lost every minute a stroke is left untreated, time savings of this nature can significantly reduce disability and death.
- Kheiron Medical helps radiologists detect breast cancer earlier using deep learning. Its software has received CE marking (Class IIa) and is undergoing clinical trials in an NHS Test Bed. The technology aims to ease the workload on overstretched screening units by serving as a second reader to support breast screening programmes, saving valuable clinician time.
- Clinical training. Al and virtual and augmented reality solutions can provide training to clinicians in settings, such as ophthalmology, radiology and surgery to reduce errors and improve interpretations. The advantages include a higher and faster level of learning resulting in better knowledge and skills. One UK company's award winning, Al enabled, augmented reality digital app for surgery, has been used by 2.5 million users globally. It

New technologies have the potential to promote equity and fairness by reaching a larger number of people at a lower cost, with various solutions having a significant impact in supporting the elderly, mentally ill and socially disadvantaged.

Advanced technologies to help improve equity and access to services

For a sustainable and fit-for-the-future health care system digital resources need to be patient centric and lead to a better patient experience by reducing visits to care providers while guaranteeing access to services 24/7, limiting face to face visits to the most urgent cases. For example, digital and virtual reality therapies can provide an effective, alternative treatment to drug therapies or face-to-face coaching in areas such as mental health. Specifically, digital cognitive behaviour therapy (see Case study 11).¹¹²

Digital solutions also need to be inclusive or risk increasing health inequalities for those with lower levels of digital literacy. New technologies have the potential to promote equity and fairness by reaching a larger number of people at a lower cost, with various solutions having a significant impact in supporting the elderly, mentally ill and socially disadvantaged. For example, mobile devices and apps are increasingly used by seniors, although elderly patients tend to prefer a computer tablet to a smartphone because of the larger screen and keyboard. Smartphones specifically designed for use by the elderly are now more readily available. In addition, digital technologies connecting family and friends and carers improve dementia patient engagement and therapy outcomes.

Case study 11. SilverCloud: Easing the burden on patients and mental health services



Mental health and wellbeing is increasingly recognised as an urgent problem. In the UK one in four adults experience a common mental health problem such as such as anxiety or depression at some point in their lives, and one in five adults will consider taking their own lives.¹¹³

In the UK, there is a serious shortage of mental health staff, which has a detrimental impact on the ability of patients to access care and support. To fill this care gap, a number of Al-enabled digital solutions have been developed to provide patients with the critical and timely care they need to help them best manage their condition.

SilverCloud is a secure and safe mobile platform that provides clinical support to patients, which can be accessed 24 hours a day seven days a week. The platform provides evidence-based cognitive behavioural therapy (CBT) support across a range of mental health illnesses, such as depression, anxiety and obsessive compulsive disorder (OCD). The platform is currently used in over 240 organisations, and outcomes include:

- up to 70 per cent of patients using the platform achieve clinical recovery
- patient capacity has increased by up to 21 per cent
- return on investment ranging between from 53 and 85 per cent.¹¹⁵

SilverCloud has been included on the NHS Apps Library as a clinically-recommended treatment for patients suffering for mental health conditions and has been recognised as the highest grade of evidence and impact (Tier 3B) by NICE in the Evaluations Framework for Digital technologies.¹¹⁶

Other important digitally-enabled initiatives for individuals in difficult circumstances include therapy management applications and automated drug dispensing devices for remote monitoring of treatments. There is strong business case for healthcare to consider prescribing the use of technology-enabled-care solutions under the new social prescribing banner. A proactive approach to improving digital literacy is also crucial given that patients with low health literacy tend to use digital health tools much less. The digital health tools much less.

Specific initiatives aimed at improving people's digital literacy include the Widening Digital Participation programme. The first phase, from March 2013 to March 2016, was aimed at helping to improve digitally excluded people's confidence and skills to enable them to access and use digital health services. At the time, an estimated 12.6 million people in the UK did not have the basic skills needed to make use of these services. A review of the achievements of the first phase demonstrated a significant impact on health services and calculated a return on investment of £6.40 for every £1 invested in year three of the programme. Phase two, operating over the next four years, sees NHS Digital working with the Good Things Foundation, to pilot 20 different ways to embed digital inclusion into healthcare.¹²⁰ Today, the adoption of the above digital solutions is starting to change the way patients interact with the healthcare system particularly in primary care (see Case study 12). Within the next five years most people's experience of accessing healthcare is likely to be digital-first, primary care led (see Figure 16).

Within the next five years most people's experience of accessing healthcare is likely to be digital-first, primary care led.

Case study 12. DoctorLink working with NHS England to relieve pressure on GP practices



Across the UK, demand for GP services is high and growing. Indeed, in England alone between November 2017 and October 2019, there were an estimated 307 million appointments in general practice with 82 per cent of these appointments occurring face-to-face.

The number of digitally driven improvement initiatives used, in primary care has increased in line with the proposals in the GP Forward View, launched by NHS England in 2016. Doctorlink, founded in 2016, is a clinically approved online triage tool, specifically designed to integrate into NHS GP surgeries, connecting patients with NHS primary healthcare services, to help GPs manage demand while improving the primary care experience for patients. Doctorlink serves as a digital front door that empowers patients to access the help they need confidently and conveniently, and supports those patients, who are willing and able to do so, to self-manage their illness. Through its algorithms, symptom checker and service finder tool, Doctorlink is able to ascertain the priority level of a patient's presenting illness and determine the best course for referral, depending on acuity and skills required, be it self-care or a virtual or face-to-face appointment with a GP, nurse or pharmacist. Doctorlink estimates that if 20 per cent of patients registered with a 7,000 patient practice, signed-up to the service, the practice could save 1,043 hours and £38,500 of costs.121

In October 2018, NHS London announced that Doctorlink is rolling out its clinical triage services across the South West London Health and Care Partnership, covering 1.6 million patients across 242 surgeries. Results from practices that have been using Doctorlink for six months show up to 25% reduction in demand for face to face appointments, with patients being re-routed to self-care, pharmacy, or emergency care. 122, 123

Figure 16. The future patient experience: digital-first, primary care led e-Prescribing | e-Icu | e-Discharge Bedside monitoring e-Triage **Smart** Digital Hospital ♦ GP multi professional practice **Pharmacy Telehealth** and care Rehabilitation coordination clinic centre **Smart Home** ---- Virtual two-way communications Patient visit

5. Shaping a predictive, preventive and personalised future

Tomorrow's healthcare system will look completely different to today. Individuals will understand their genetic profile and health risks, embrace prevention and expect to receive personalised care when and where they want it. Today, digital transformation is being driven by a wide range of companies – from both inside and outside the healthcare sector – are making strategic investments that will form the foundation for the future of healthcare. The changes now taking place are driving healthcare towards large-scale disruption that will impact both traditional and emerging stakeholders, with the traditional boundaries between stakeholders blurring as exponential innovation propels the future of health forward (see Figure 17).¹²⁴

Technological development The human factor Technology development feeds and **Social connection Well-being** Mobile phones The number of mobile phones worldwide doubled in the last 48 months. **DNA sequencing** What once cost \$2.7billion and took 13 years to accomplish now costs less than \$100 and can be done in less than 1 hour. Data storage Decentralisation From \$569 per GB to **<\$0.01** Reality is exponential In healthcare, regulatory Trends underlying exponential growth bodies (e.g., FDA) are working to keep up with Nanotechnology the pace of change spearheaded by innovative entrants. **Robotics Biomedical engineering** Cost of data storage Connectivity **Perception is linear** 3D printing In traditional models of change, tech leads the charge followed by business models, and then regulation.

Directional

Unknown

21 vears

14 vears

Figure 17. Exponential change that will accelerate the pace of disruption in healthcare

7 vears

Note: All dollar amounts are given in US dollars Source: Deloitte analytics

Understood

Present

New digital technologies that harness the power of data, such as Al and deep learning, open platforms and interoperable data, will underpin much of this healthcare transformation, improving the quality of people's lives, and making the job of working within the health and care system more rewarding. Many devices and services that are breakthrough innovations now, will become mainstream in years to come, such as: POC diagnostics in primary care, personalised medicine and identifying and treating people at home before symptoms surface. 126

Harnessing digital technologies will lead to better diseases intervention, and improve the efficacy of prevention, diagnosis and treatment. It will also transform the experience for end-users:

- empowering clinicians through improving their knowledge and training, supporting their decisions and reducing errors
- equipping patients to manage their own physical and mental health.

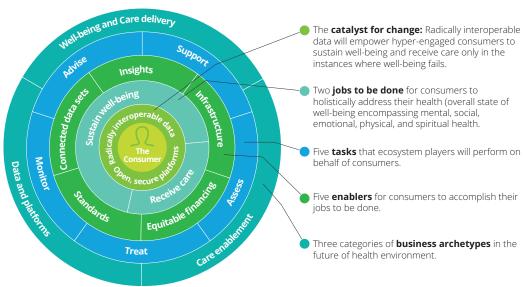
Over the next decade or so, the healthcare industry will shift from largely managing acute diseases to predominantly maintaining good health and controlling chronic conditions. Unlike today, care will be organised around the consumer, rather than around the institutions that drive existing healthcare system.

Interoperability and open platforms liberating the power of data

Today, interoperability in healthcare is several clicks behind financial services. However, imagine a future where our complete health history exists in one place and can be accessed by computer or phone as easily as bank account details. 127 Interoperable, always-on data will promote closer collaboration among industry stakeholders, with new combinations of services offered by incumbents and new entrants (disruptors). Interventions and treatments are likely to be more precise, less complex, less invasive, and cheaper. Digital transformation – enabled by interoperable data, Al, and open, secure platforms – will drive much of the change (Figure 18). 128

Figure 18. The future of health will be driven by digital transformation enabled by radically interoperable data and open, secure platforms





Source: Deloitte analysis

Patients will access their own their complete health record to help manage their own health, via empowered mobile devices, Al solutions and chat bots. Interoperable data sets will be used to drive micro-interventions that help keep people healthy. Clinical staff, while remaining indispensable, will have access to real-time physiological data and will need to intervene much less frequently, releasing time to care, and enriching their daily work experience. At the organisation level, digital technologies will reduce demand and allow for more cost-effective services and better financial management. Advanced analytics will pave the way for population health management and personalised medicine. A wide range of companies Tech giants and other informatics companies are already investing in this promising market segment and leading the transition from 'big data' collection towards an age of 'data intelligence'.

Genomics and its future use in medicine

The first human genome was sequenced more than 20 years ago at a cost of \$2.7 billion dollars. Today we can sequence a genome for less than a £1,000, enabling genomics to become a mainstream application of healthcare.¹²⁹ Genomic data, empowered by Al and gene editing techniques, are leading the way to curing genetic diseases and pharmacogenetic knowledge will be harnessed for personalised interventions in many other conditions.

The availability of full genome sequences will allow more precise clinical therapies and speed up drug development. In addition, susceptibility to diseases will be detected in advance allowing prevention and early intervention. Coupled with AI technologies and digital devices for life style and vital sign monitoring, genomics applications will be at the core of new self-management and prevention tools.

Following the success of the UK's 100,000 Genomes Project, focused on participants with rare disease, their families and people with some cancers, the NHS Genomic Medicine Service was announced in 2018, aimed at introducing genomics into healthcare and improving outcomes for patients.¹³⁰ The ambition in the UK over the next five years is to complete up to five million genomic analyses, extend genetic diagnostics across diverse specialities, and improve health outcomes well beyond the initial focus on rare diseases and cancers.¹³¹

The 2019 Topol review, noted that if the NHS is to capitalise on the insights and associated technologies of genomics, all clinical staff will need to have an understanding of its broad principles. It identified the need for a clear framework for staff to use genomic data in a way that safeguards patient confidentiality and inspires the support and confidence of citizens. It also noted that although there will be elements of healthcare that will remain the domain of specialists (such as the management of rare genetic diseases), many genomic applications will become embedded in daily healthcare (for example the targeted prevention of common diseases).¹³²

In 2019, Genomics England commissioned Ipsos MORI to undertake a series of public dialogue workshops to explore how the public feel that genomic medicine should best be 'mainstreamed' into the NHS. It found that advances in genomic medicine are likely to change public expectations around donating their data; and that clinicians and researchers will need to be equipped with 'genomic literacy' to support patients and donors and explain the ever-closer relationship between research and clinical care. The workshops identified widespread enthusiasm and support for genomic medicine, but that the public also have clear limits for how their genomic data, and information derived from it, should be used. Participants wanted assurances that there is a robust governance framework and consent process in place that clarifies the intended use of their data. 133

Diagnostics 4.0

Machine learning-enabled early warning systems that alert clinicians to patients at risk of deterioration in the hospital already perform better than existing clinical risk scores. Deep-learning technologies designed for automated image interpretation have shown expert-level performance in medical image analysis. The disciplines of radiology, pathology and ophthalmology are already being influenced by Al tools, due to the availability of digitised data and interoperability standards. The spread of digitalisation, supported by the appropriate infrastructure, will change clinical diagnostics, benefitting both clinicians and patients.¹³⁴

Deep-learning is reshaping the future of diagnostics. Molecular biomarkers and vital signs, while still relevant, will be augmented by monitoring psychometric signs such as tone of voice, speech patterns, eye movements, gait and mobility. Analysing these signs using Al-enabled tools will provide a more precise indication of an individual's health status and an accurate diagnosis of any disease, including dementia and mental health conditions. Information from wearables (implantables and ingestibles) will be integrated with EHR data, for a tailored detection of changes to an individual's condition. Tech giants are already investing in the diagnostics sector to develop state-of-the-art solutions. The ability to detect and monitor conditions outside the clinical space using POC diagnostics, available 24/7, will be an important feature of the next generation diagnostic tool-kit.¹³⁵

Population health management and new models of care delivery

Population health management (PHM) is concerned with gathering data and insights about population health and wellbeing across multiple care and service settings, to identify the main healthcare needs of the community and design services accordingly. The adoption of a shared, interoperable, EHR is a critical enabler for PHM. Today, major advances in data analytics, machine learning and digital technologies are providing more effective ways for linking data and targeting healthcare interventions. Our March 2019 report 'The transition to integrated care. Population health management in England' highlights the challenges and opportunities facing the NHS in establishing a PHM approach and identifies four building blocks (infrastructure, insights, impact and intervention) which, together with examples of good practice, can help deliver the LTP expectation that ever commissioner and provider will be part of an ICS by 2021 and adopt PHM as the best way to deliver the 'quadruple aim' of healthcare. 136

The potential of innovative, simple technologies to drive new models of care has been shown in a study of the management of asthma in the US, where sensors imbedded in the inhalers of 1,147 patients, collect data on the time, frequency of use, and location of each inhalation. Liking these data with information on environmental conditions, has helped reduce the need for treatment in 82 per cent of participants, and lowered the cost of medication. The approach also led to tailored initiatives to improve the local environment on the basis of the data.¹³⁷ In the future, the availability of interoperable data systems will be a game changer for PHM helping drive new models of care.

Value-based care

At the core of value based care (VBC) is an ambition to optimise value for patients and payers by achieving the best outcomes at the lowest cost. This requires a move away from a supply-driven healthcare system organised around what physicians do, towards a patient-centered system organised around what patients need. The increasing pressure to contain costs means that payers are reducing reimbursements and moving away from fee-for-service, towards performance-based payment models. As healthcare systems transition to VBC models there are important implications for medical innovation. New VBC payment models shift financial risk from payers to providers and other stakeholders, changing how they assess and adopt innovation. For example, the approach to population health management in Israel is based on a novel and disruptive value based care approach, using social impact bonds as a financial incentive to reduce the incidence of diabetes.¹³⁸

In the UK, the NHS RightCare programme is promoting a shift towards VBC aimed at addressing the problems of overuse of resources that do not add value, and of underuse of resources in tackling prevention or health inequalities. As part of the 2019-20 funding settlement, all healthcare systems in England are expected to work with the NHS RightCare programme to implement national priority initiatives for cardiovascular and respiratory conditions. They will also be expected to address variation and improve care in at least one other pathway.¹³⁹

The digital hospital of the future

The hospital of the future will look quite different from the hospital of today. Rapidly-evolving technologies and growing consumerism, along with demographic and economic changes, will transform hospitals. Already a growing number of inpatient services are being delivered at home and in outpatient facilities, with hospitals evolving to become the preserve of acute, complex and very ill patients. Emerging features include:

- centralised digital centres that enable decision making, continuous clinical monitoring, targeted treatments (such as 3D printing for surgeries), and the use of smaller, portable devices
- digital and AI technologies enabling on-demand interaction and seamless processes to improve patient experience
- robotic process automation (RPA) and AI allowing carers to spend more time providing care and less time documenting it
- digital supply chains, automation, robotics, and next-generation interoperability, driving operations management and back-office efficiencies
- new hospital designs will improve the wellbeing of patients and staff, with an emphasis on the importance of environment and experience in healing.¹⁴⁰

Many of these concepts are already in play, with hospital planners considering how to integrate digital technology into newly-built facilities and retrofit into older ones (for example Deloitte has developed a number of AI enabled tools to augment the efficiency and effectiveness of healthcare delivery (see Case study 13). These and similar technologies will underlie most aspects of future hospital care. But care delivery, especially for complex patients and procedures, will still require hands-on human expertise.

If the future we envisage is to become a reality, governments, together with healthcare stakeholders, need to consider how to optimise inpatient and outpatient settings, how to connect with patients more effectively and how to integrate digital technologies into traditional hospital services to create a health system without walls.¹⁴¹

Deloitte has developed a number of AI enabled tools to augment the efficiency and effectiveness of healthcare delivery.

Case study 13. Deloitte AI enabled tools assisting health care providers improve efficiency and effectiveness





RITA - Referral & Intelligent Triage Analytics

RITA aims to use the latest in AI and robotics to automatically triage incoming patient referrals and assign patients to appropriate pathways. We have undertaken a proof of concept with a gastroenterology department in Scotland with promising results.

In the proof of concept, RITA analysed over 24,000 incoming referrals, using natural language processing to identify patterns between referral letter language and triage pathways. RITA displayed a high level of accuracy in triaging patients with suspicion of cancer (versus previous clinical decisions).

The project has now moved into a data gathering phase with information collected on triage outcomes in real time with plans to implement fully in line with regulatory requirements.



DeloitteAssist

DeloitteASSIST is an AI enabled patient communication solution enabling patients to request assistance without the need to press a button. Simply by speaking their request, nurses are alerted to their need, with AI prioritising and smart-routing requests to the right resource to meet the patient's needs. DeloitteASSIST has received positive feedback from nurses and patients in pilot hospitals. It has provided the care teams with insights previously unavailable. These include:

- 100 per cent of patients would like DeloitteASSIST to be available to them should they return to the hospital
- 92 per cent of patients are likely to recommend DeloitteASSIST to family or friends admitted to hospital
- 87 per cent of nurses felt more confident knowing how to respond to patient needs using DeloitteASSIST.



ALiCE: Automated Live Coding Engine

AliCE is a robotic and cognitive automation tool that automates manual clinical coding activity to the correct codes to facilitate payment.

By automating elements of the clinical coding process, this will reduce data entry and the administrative burden, allowing clinical coders to focus on the more complex records that require further manual input.

To date test modules have been built for ophthalmology and endoscopy, with promising levels of accuracy.



ATOM Advanced Theatres Optimisation Method

ATOM is an Al-enabled system that uses Natural Language Processing to read surgeons' patient notes to accurately predict procedure times, accounting for complexity and comorbidities, thereby enabling the optimal scheduling of theatre lists to maximise utilisation

- 17 successful NHS trust deployments
- 90 per cent accuracy
- Typical ROI of over 10:1
- Demonstrable productivity improvement of more than 14 per cent.

Appendix 1. Timeline of reviews and policy initiatives 2013 to 2018

The Caldicott independent review of information governance in the health and care system and in 2014 Dame Fiona Caldicott was appointed as the first statutory National Data Guardian for Health and Care .¹⁴²

2013

The UK established **Genomics England**, who commenced sequencing 100,000 whole genomes from around 85,000 participants with rare disease, their families and people with some cancers. The 100,000 Genomes Project, was backed by political and financial support which included over £200 million of investment to improve diagnostics and develop more personalised treatments. 143

15 Academic Health Science Networks (AHSN) were established by NHSE -to improve health outcomes, generate economic growth and spread innovation at pace and scale, supported by £39 million of Government investment via the Office for Life Sciences.¹⁴⁴

NHSE, together with a coalition of national bodies, published the **Five Year Forward View** (FYFV) identifying the need for new models of care to address three care gaps (health and wellbeing, care and quality, and funding and efficiency). It included an ambition to 'exploit the information revolution' and that clinically-focused health IT solutions had an important role to play in closing the three gaps.¹⁴⁵

2014

The **National Information Board (NIB)** published **Personalised health and care 2020** – a framework for action aimed at supporting the health and care system to deliver the digital transformation outlined in the FYFV. This gave a new impetus to digital transformation, supported by the investment of an additional £4.2 billion from the Treasury. 146 It established seven work streams with associated roadmaps and evidence-based plans for transformation through data and technology. 147

The DHSC and NHSE established the **National Advisory Group (NAG) on Health Information Technology**, chaired by Professor Robert Wachter, to advise them on what should be done to help the NHS reach its digitalisation goals.

2015

NHSD published its **Information and technology for better care** strategy for 2015-2020. The overarching aim being to revolutionise the way technology, data and information are used to transform the delivery of England's health and social care services. It aimed to: ensure every citizen's data is protected; establish a shared architecture and standards so everyone benefits; support health and care organisations to get the best from technology, data and information; and make better use of health and care information.¹⁴⁸

The National Data Guardian's Review of Data Security, Consent and Opt-Outs was published, covering the need to build trust and assurance on information sharing and a consolidated cross-system approach to patient consent.¹⁴⁹

2016

From January 2016, NHSE has required all health and social care organisations to operate as one of 44, geographically-based, **Sustainability and Transformation Programmes** (STPs). The main aim of STPs is to integrate services, encourage wider collaboration between organisations, agree system-wide priorities, and plan collectively how to improve health and care. A shared interoperable EHR is an essential enabler of effective service integration.¹⁵⁰

The **Wachter report 'Making IT Work'** advised the NHS to digitise the secondary care sector in stages and that in the short term returns on investment (ROI) from health IT were likely to come from improvements in safety and quality, and that cost savings might take ten years or more to emerge (the 'productivity paradox' of IT). Noting that savings would require a reconfiguration of the workforce, local adaptation to the use of digital technologies, and 'reimagining ways of working'.

It concluded that the current funding allocation for digital transformation was insufficient to achieve the vision of a paperless, joined-up NHS and recommended that all trusts should achieve a high degree of digital maturity by 2023. It highlighted key actions essential for future digitalisation:

- develop national standards for interoperability, with penalties for those standing in the way of appropriate data sharing, and an expectation of widespread interoperability by 2020
- privacy, while important, should not hinder data sharing
- the design of IT systems should include input from end users
- more leaders should be trained in both clinical care and informatics, with budgetary authority and organisational influence, in every trust, together with a Chief Clinical Information Officer (CCIO) reporting directly to the Board

2016

a national engagement strategy, robust independent evaluation and establishment of digital learning networks.

The **General Practice Forward View** (GPFV), was published together with a commitment of an extra £2.4 billion a year to support general practice services by 2020-21. The policy document places emphasis on GP practices to utilise new digital technologies and outlines extra investment for Clinical Commissioning Groups (CCGs) for the provision of IT and technology services for general practice, and a specific £45 million multi-year programme to support the uptake on online consultation systems.¹⁵²

NHSE established the **Global Digital Exemplar Programme**, selecting 27 digitally mature trusts to create a group of reference sites for NHS digitalisation and provide standardised blueprints for other trusts to follow. It provided funding support of up to £10 million for the 17 acute and three ambulance trusts, and up to £5 million for seven mental health trusts. 153

2017

Led by Health Education England (HEE), the 'Building a Digital Ready Workforce (BDRW) National Information Board (NIB) programme, established the **NHS Digital Academy** to accelerate the development of 300 senior NHS digital leaders (CIOs, CCIOs and other senior IT leaders) by 2021 through a combination of online, residential and work-based learning.¹⁵⁴

A review of the first five years of operation of **AHSNs**, identified that they had supported some 200 innovations, leveraged over £330 million to improve healthcare, awarded contracts to over 450 SMEs and helped create over 500 new jobs. NHSE consequently relicensed AHSNs for a second five year period with an annual budget of £45 million.

The NHS Digital Academy, comprising a partnership with Imperial College London, the University of Edinburgh and Harvard Medical School, accepted the first cohort of 100 delegates in April 2018. Applications for cohort two, commence in April 2019, and applications for cohort three opens in September 2019.¹⁵⁶

The Topol Review's interim report -Preparing the healthcare workforce to deliver the digital future was published as a Call for Evidence in June 2018 establishing three key principles, which should govern the NHS's future workforce strategy:

2018

- if willing and able to do so, patients will be empowered by new tools to become more actively involved and engaged in their care
- the introduction of any technology must be grounded in robust research evidence and a fit for purpose and ethical governance framework that patients, public and staff can all trust
- whenever possible, the adoption of technology should be used to give more time for care, creating an environment in which the patient-clinician relationship is enhanced.¹⁵⁷

In October, the new Health Secretary, Matt Hancock, published a consultation document, **The future of healthcare: our vision for digital, data and technology in health and care**, aimed at uniting the NHS around a common vision of how online services, IT and clinical tools could be used to support preventative, predictive and personalised care. It emphasised the need to focus on getting the basic digital architecture right so services users have confidence that their data is held securely and used appropriately. It established a set of guiding principles, including developing open standards; having secure identity and interoperability standards; ensuring the right data gets to the right place at the right time; and that services are designed around user needs. It also highlighted the importance of designing inclusive services.¹⁵⁸

2018

The Local Health and Care Record Exemplar (LHCRE) programme was established aimed at raising the bar and improving direct care of patients through technology through a more integrated regional health and care information capability. Core requirements included a robust information governance framework and a citizen opt-in standard, adoption of technical and data interoperability standards, compliance with data and cyber security standards, and conforming with national services, particularly record locators.¹⁵⁹

By end of 2018, 14 STPs were designated as **'Integrated Care System (ICS)'** responsible for managing resources, delivering NHS standards, and improving the health of their populations. For an STP to become an ICS it had to agree to take on a budget for the health provision of a defined population and demonstrate, that it is capable of implementing an integrated PHM strategy.¹⁶⁰

The 100,000th genome was sequenced,¹⁶¹ and **The NHS Genomic Medicine Service** was launched, aimed at introducing genomics into healthcare and improving outcomes for patients.

Appendix 2. Stakeholders interviewed for the report

Dr Charles Alessi, Chief Clinical Officer, HIMMS (International)

Dr Mohammad Al-Ubaydli, Chief Executive Officer and Founder, Patients Know Best

Karen Bridgeman, Digital Lead Midwife University Hospitals of Morecambe Bay NHS Trust

Tracy Carling, EPR Implementation Manager University Hospitals of Morecambe Bay NHS Trust

George Crooks, Chief Executive Officer, Digital Health and Care Institute Scotland

James Barlow, Chair in Technology and Innovation Management (Healthcare), Imperial College Business School

Emma Bradley, Product Strategy Lead, NHS England

Marcus Bradley, Clinical Lead for Imaging at North Bristol NHS Trust

Paul Burstow, President, TEC Services Association and Chair of the Social Care Institute for Excellence Mindy Daeschner, Chief Commercial Strategy and Marketing Office. DoctorLink

Alan Davies, Digital Health and Chair of the Digital Expert Group, Innovation Agency, The AHSN Network

Paul Duffy, Co-Director IT and Telecommunications, Belfast Health and Social Care Trust

Mark Duman, Director, MD Healthcare Consultants Ltd, UK

Mike Fuller, Head of UK Marketing, Intersystems

Andrew Gardner, Chief Executive Officer, Medvivo and DoctorLink

 $\mbox{\bf Pam Garside}, \mbox{\bf Partner at Newhealth, Fellow, Judge Business School University} \mbox{\bf of Cambridge}$

Trevor Gill, Co-Founder and Chief Financial Officer, nOink

Richard Gladman, Portfolio Director, NHS Digital

Fernando Gomes, Director of Runway and Spinouts at Jacobs Technion-Cornell Institute

Matthew Griffin, Chief Executive Officer, 311 Institute

Keith Grimes, Clinical Innovation Director, Babylon Health

Marc Hadwin, Head of Digital Services, University Hospitals of Morecambe Bay NHS Trust

Adam Hoare, Executive Director of Sociotechnical Systems, The Bayswater Institute

Simon Hooper, Director, RemindMecare

Lloyd Humphries, Head of Europe, SilverCloud Health

Martin Jeffries, Chief Marketing Officer, Tunstall Healthcare Group

Lyndon Johnson, Patients Know Best, Account Director and 8foldhealth Founder

Hugh-Lloyd Jukes, Chief Executive Officer, Oxehealth

Jason Kaene, Chief Executive Officer, PatientAccess.com

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Glossary of terms

Application Programming Interface (API) – is a set of definitions, communication protocols, and tools for building software. In general terms, it is a set of clearly defined methods of communication among various components. A good API makes it easier to develop a computer programme by providing all the building blocks, which are then put together by the programmer. An API may be for a web-based system, operating system, database system, computer hardware, or software library.

Artificial intelligence (AI) – refers to any advanced technologies that enable computer programmable machines and portable devices to complete tasks that normally require human intelligence. It describes machines that mimic 'cognitive' functions that humans associate with other human minds, such as 'learning' 'sensing' and 'problem solving'.

Augmented reality (AR) – is technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view, or uses interactive technology in which real-world perception is enhanced by a computer via sensory signals in an additive or masking manner altering the perception of reality.

Blockchains – use distributed ledger technology to record digital interactions in a way that is designed to be secure, transparent, highly resistant to outages, auditable and efficient. They provide a unique method to track the authenticity of online transactions and at the same time protect the privacy.

Blueprinting – is a key deliverable which has been built into the GDE programme. The idea is that GDEs and Fast Followers will create detailed plans of their implementation efforts, in order that other organisations can learn from them.

Chat Bot – short for chat and robot, comprising an Al applications using natural language processing that enable conversations via text, video or audio with the chatbot responding in a similar manner to how people would do. The human-like conversation requires different layers of Al complexity with basic knowledge for the initial interactions and deep learning algorithms to progressively personalise the answers.

Chief Clinical Information Officer (CCIO) – combines clinical knowledge and experience with the IT knowledge of a CIO role. CCIOs work with the CIO and wider IT teams on delivering technology products and programmes that improve the overall patient journey and quality of care. The CCIO brings a clinical perspective to the strategic use of technology in the organisation. The CCIO is also involved in supporting wider clinical engagement with the digital programme.

Chief Information/ Informatics Officer (CIO) – is a senior person within an organisation who leads the digital and technology work programme. In healthcare, the CIO is usually responsible for leading the IT department, planning how to use the data for the overall running of the organisation and working on issues such as interoperability. They are also involved in decisions about what technology solutions to purchase and what resources are required for successful deployment and sustainability.

Closed-loop medication administration – is a fully electronic process from ordering medication to administration which is designed to eliminate medication errors and improve patient safety. A fully electronic process requires electronic identifiers for the patient and the provider (such as a nurse) and a system such as barcoding for drugs

Deep learning – machine learning algorithms involving artificial neural networks inspired by the structure and function of the brain. Interconnected modules run mathematical models that are continuously tuned based on results from processing a large number of inputs. Deep learning can be supervised (requiring human intervention to train the evolution of the underlying models) or unsupervised (autonomously refining models based on self-evaluation).

Digitisation – process of converting information from an analogue format to a digital one, including the conversion of text, pictures, or sound into a digital form that can be processed by a computer.

Digitalisation – is the integration of digital technologies into everyday life, to change or improve a business model or process and provide new revenue and value-producing opportunities; it is the process of moving to a digital business and leveraging digitisation to improve business processes.

Digital health – is the convergence of digital technologies with health, healthcare, and society to enhance the efficiency of healthcare delivery and make medicines more personalised and precise. The discipline involves the use of information and communication technologies to help address the health problems and challenges faced by patients. Digital health encompasses subsectors such as: ehealth, mhealth, telehealth, health information technology and telemedicine, all of which aim to make digital transformation a reality.

Digital Maturity Self-Assessment (DMA) – is a self-assessment tool which measures the progress in how secondary care providers in England are making use of digital technology. Maturity is measured in a range of areas including readiness, capability and infrastructure. The DMA provides an overview of progress across the healthcare system as a whole, as well as support organisations to identify their own strengths and gaps.

Digital technologies – computer based technologies. Latest developments include analytics applied to large data sets (including genomics), artificial intelligence (including machine learning and deep learning) 3D printing, robotics, mobile and portable device technologies, blockchains, augmented reality, virtual reality.

Electronic Health Records (EHRs)/ Electronic Patient Record (EPR) – systematically collects patient and population health information and stores them digitally and is at the core of healthcare digital transformation. They can be used for: recording of longitudinal data produced by different clinical visits and by any other related health sources. EHRs can include a range of data, including demographics, medical history, medication and allergies, immunisation status, laboratory test results, radiology images, vital signs, and personal statistics like age and weight. At present the

Electronic Medical Record Adoption Model (EMRAM) – was created by HIMSS Analytics®. It is an eight-stage model that allows organisations to track their digital progress against others around the world. This eight-stage (0 – 7) maturity model measures the adoption and utilisation of functions required for digitisation to support patient care including security, electronic documentation, data analytics and clinical decision support.

EHRs landscape is fragmented with a wide variety of capabilities.

E-prescribing – the "utilisation of electronic systems to facilitate and enhance the communication of a prescription or medicine order, aiding the choice, administration and supply of a medicine through information and decision support and providing a robust audit trail for the entire medicines use process". The main aim of e-prescribing is to improve patient safety by reducing errors in drug administration and adverse events

Fast Healthcare Interoperability Resources (FHIR) – is an industry standard open API which is being adapted to create APIs suitable for sharing data in health and social care – known as Care Connect FHIR APIs. FHIR builds on the HL7 standards.

Genomics – is the study and mapping of human genomes or full DNA sequences of individuals, and the basis of precision medicine approaches or personalised preventative and therapeutic interventions including pharmacogenetics, gene editing and others.

Global Digital Exemplars (GDEs) – Secondary care organisations (acute trusts) identified as having an advanced world-class digital system entitling them to additional financial support from the NHS to develop their IT capability and capacity. Intention is that GDEs should obtain HIMSS Stage 7.

Healthcare Information Management Systems Society (HIMSS) – is an international not-for-profit organisation, originating in the United States, which works to improve healthcare through the use of information technology and management systems.

Health information technology (HIT) – is information technology, which is applied to health and health care settings. It supports health information management across computerised systems and the secure exchange of health information between patients and medical experts.

Health Level-7 or **HL7 –** refers to a set of international standards for transfer of clinical and administrative data between software applications used by various healthcare providers. The HL7 standards are produced by the Health Level Seven International, an international standards organisation, and have been adopted by other standards issuing bodies across the world. Hospitals and other healthcare provider organisations typically have many different computer systems which need to communicate with each other (or "interface") when they receive new information, or when they wish to retrieve information, HL7 specifies a number of flexible standards, guidelines, and methodologies to assist this communication.

Information Technology (IT) – involves the development, maintenance, and use of computer systems, software, and networks for the processing and distribution of data.

Integrated Care Systems (ICS) – are a collaborative of NHS organisations, working in partnership with local councils and others, taking collective responsibility for managing resources, delivering NHS standards, and improving the health of the population they serve. ICSs are crucial to the delivery of the NHS Long Term Plan, with NHS England expecting every health and social care organisation to be part of a geographically based ICS by 2021.

Interoperability – refers to the ability of different IT systems and software applications to communicate, exchange electronic data, and use that data and information in a standardised, secure and user friendly way. Interoperability is a key enabler in delivering new models of integrated care and requires accurate, reliable ways of patient identification to connect patients to their data.

Local Health Care Records (LHCRs) – Electronic Health Care records shared between local NHS organisations and GPs. First announced in June 2018 LHCRs brings together multiple organisations across STPs to enable data sharing across an entire geography. The NHS Long Term Plan contains a target for LHCRs to cover the whole country by 2024 as part of achieving a core level of digitisation across the whole healthcare system.

Healthcare Information and Management Systems Society (HIMSS) – "nonprofit organisation whose goal is to promote the best use of IT and management systems in the healthcare industry. The organisation provides thought leadership, professional and workforce development and public policy. HIMSS Analytics® has created the EMR Adoption Model (EMRAM), an eight-stage model that allows you to track your progress against other healthcare organisations around Europe and across the world."

Machine learning – is a way of teaching computers how to learn by designing code or programmes (algorithms) to teach computers things over time through experience. With machine learning technologies, computers can be taught to analyse data, identify hidden patterns, make classifications, and predict future outcomes. The learning comes from these systems' ability to improve their accuracy over time without explicitly programmed instructions.

Mobile Health (mHealth) – mobile and portable technologies applied to healthcare delivery, including health-related mobile applications (apps) and health-related wearable, or connected, devices for the management of health and related services (such as remote monitoring, telehealth, telemedicine etc). Enabling, for example, real time monitoring of blood pressure, glucose and other clinical signs. The latest smart watch developments include FDA cleared electrocardiogram capabilities that can be performed in few seconds and irregular heartbeat rhythm detection for the prevention of strokes or hearth failures.

Open Application Program Interface – is a publicly available set of requirements that govern how different applications interact with each based on open data and open standards. The purpose is to allow open access to different parts of software to communicate and work together.

Remote monitoring includes technology solutions that allow the monitoring of patients and individuals well-being at distance and outside the conventional clinical settings. Remote monitoring solutions include RFID and IR sensors, video and phone calls, chat applications, wearables.

Robotics – is an interdisciplinary branch of engineering and science that includes mechanical engineering, electronic engineering, information engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing.

Shared Electronic Health Record – is an Electronic Health Record shared between more than one organisation. Shared electronic health records opens a whole range of new possibilities for flexible and fruitful cooperation among health personnel in different health institutions, to the benefit of the patients.

Telecare – is the use of alarms sensors, and other equipment to help people live independently for longer, particularly those who require social care or health services. Telecare comprises assistive technologies and services tailored to individual needs. Sensors can trigger alarms and call for assistance if needed.

Telehealth – is the remote exchange of clinical data between a patient and a clinician to provide support and assistance to enable people to monitor and manage changes in their health condition in their own homes via devices and sensors that can monitor and detect changes in their vital signs and uses telehealth technologies to exchange these data with clinical staff who monitor trends and spot deterioration in the patients' condition. Telehealth technologies can also provide patients with health education and training.

Virtual Reality – is a three-dimensional computer generated environment which can be interactive and explorable. Virtual reality, creates an artificial environment, in which the computer-generated simulation of a three-dimensional image or environment can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.

WannaCry – was a May 2017 worldwide cyberattack. Computers running the Microsoft Windows operating system were targeted by a ransomware encrypting data and demanding ransom payments in the Bitcoin cryptocurrency. A report published by the National Audit Office (NAO) following their investigation suggested that 81 Of the 236 NHS Trusts in England were either directly or indirectly affected by the attack.

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