The Health Policy Partnership

[research, people, action]

Digital health in the management of non-communicable diseases in the UK

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Executive summary

Optimising the management of non-communicable diseases (NCDs) is one of the greatest clinical and economic challenges facing our health systems. The four most prevalent types of NCD – cardiovascular disease, cancer, chronic respiratory diseases and diabetes – account for more than 80% of all deaths.[1] Losses to the global economy attributable to these diseases, along with mental illnesses, are estimated to reach USD $47 trillion over the next two decades – equivalent to 75% of the global GDP in 2010.[2]

The traditional model of hospital-centric, reactive care delivery is not fit for purpose to manage NCDs, nor is it economically sustainable. Approximately 15 million people in England are living with one or more chronic NCDs that require prompt diagnosis, effective treatment and continuous monitoring and follow-up care.[3] New models of proactive care are needed to optimise ongoing quality and continuity of care and minimise reliance on in-person hospital visits. Digital technologies (electronic tools that produce, store and process data) which promote self-monitoring and management, supported by timely and appropriate medical intervention, should be at the heart of these models.

15 million
people in England are living with one or more NCDs

Digital technologies have potential application across all stages of NCD prevention and care, and can confer significant benefits to patients and clinicians. They can empower people to engage and manage their own health,[4] giving them a safety net to help them connect with their clinicians even when they cannot see them in person. Digital tools can also aid clinical decision-making, providing clinicians with a rich array of patient data in real time. This can allow them to tailor care to individual needs[5] and help detect abnormalities and flare-ups that might otherwise be missed,[6] helping to facilitate timely escalation of care and minimising patients' risk of deterioration and emergency hospital admissions.

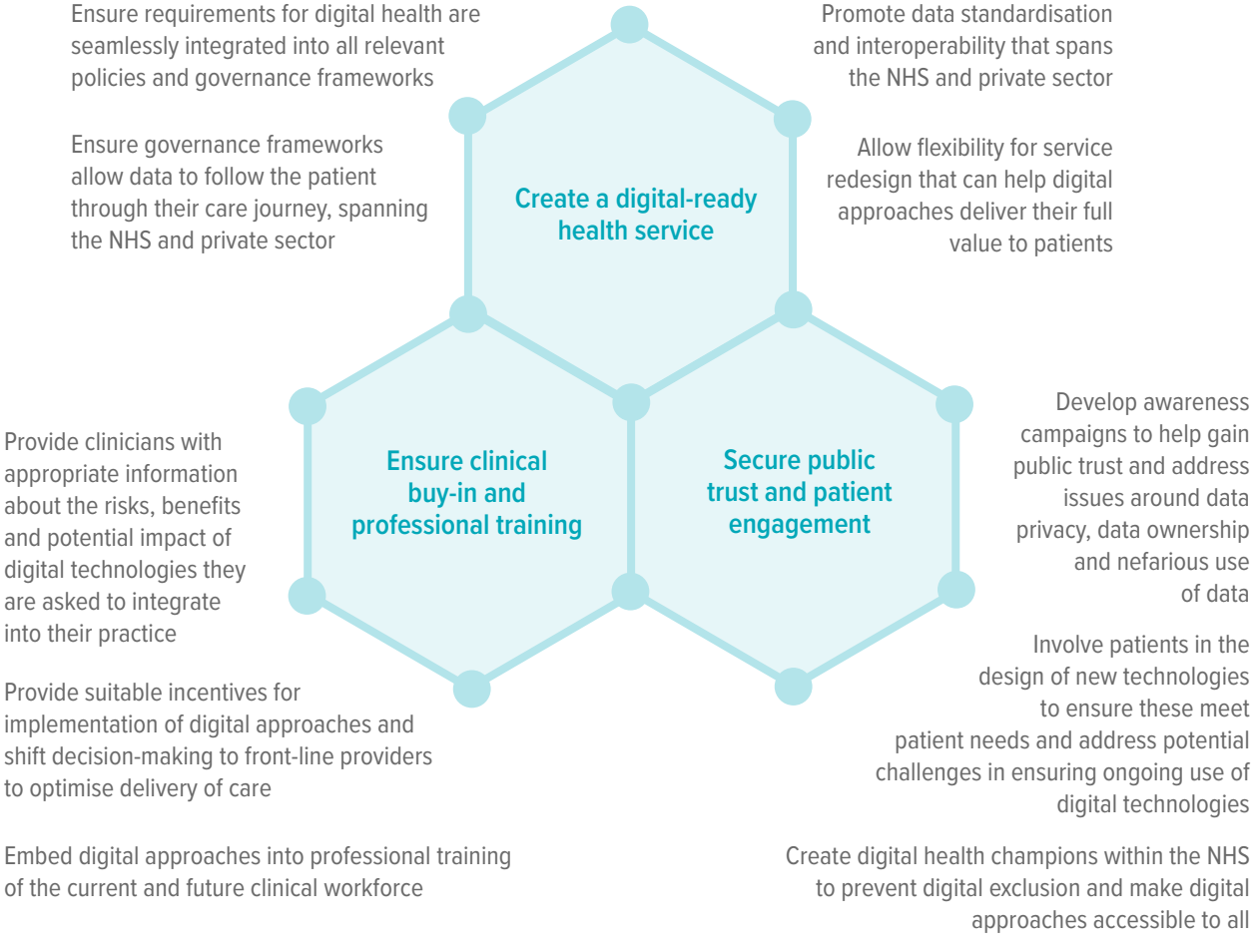
Digital approaches could clear the NHS backlog in a matter of
months
rather than years

These benefits can translate into greater system efficiency and help address some of the ongoing resource challenges facing the NHS. Appropriate use of digital health can help alleviate long-standing workforce shortages in both primary and secondary care. It has been estimated that digital approaches could clear the NHS backlog in a matter of months, rather than years. Digital technologies can also help optimise workflows (for example, through the introduction of virtual clinics), help reduce waste and save patients' and clinicians' time, ultimately optimising health service efficiency and enabling improved investment and resource allocation.

There have been many promising examples of digital health innovations in the management of NCDs in recent years, but we now need to transition from pockets of innovation to widespread integration. Scaling up digital technologies will require more than simply making them widely available. We need to ensure that digital health is fully integrated into all aspects of the health system – addressing system-wide barriers such as governance and interoperability, digital inequalities, clinical buy-in, public trust and patient involvement (*Figure 1*).

The COVID-19 pandemic has compromised outcomes for thousands of people living with NCDs, calling for an urgent response. This gives us an unprecedented opportunity to rethink chronic disease care, and requires taking a long-term view: we need to see beyond pilots and create pathways that can enable upscaling in a sustainable way. This will require guaranteeing a roadmap to implementation, forged through long-term public–private partnerships involving those developing digital innovations, those implementing them and decision-makers who oversee system change. We simply cannot afford to let the unique position we are in turn into a missed opportunity.

Figure 1. Achieving full integration of digital health across the NHS: what is needed



Introduction

Digital health interventions have long held the promise of complementing face-to-face care. Ambitions to digitally transform the NHS have existed for many years (*Box 1*), but implementation has historically been tempered by slow uptake owing to barriers around interoperability, governance, a lack of agreement on common technologies and lack of public trust.[7] The COVID-19 pandemic, however, has accelerated the deployment of digital approaches in a completely unprecedented way, revolutionising service delivery.[8]

At the same time, the pandemic has exacerbated many challenges that have long faced the NHS. These include limited capacity to absorb growing demand for services, falling numbers of general practitioners (GPs) and nurses,[9] [10] and extended waiting times for referrals and hospital care. Looking specifically at cancer, NHS England states that, following an urgent GP referral, 85% of patients should receive their first treatment within two months;[11] this target has not been met since 2013.[11] Three million fewer eligible people attended cancer screening programmes between March and September 2020,[12] and 3.4 million fewer cancer diagnostic tests were conducted between March and April 2020, than in the same periods the previous year.[13] This translated to 31,000 fewer people starting cancer treatment across the UK between April and August 2020 than during the same period the previous year.[13] Following the disruptions inflicted by the pandemic, almost all healthcare services are now facing a considerable backlog, which may take many years to resolve.

31,000

fewer people started cancer treatment during April–August 2020 than April–August 2019

Given these pressures, policymakers should be looking to greater deployment of digital health to help ensure the sustainability of the NHS and restore services to pre-pandemic capacity by moving away from a reactive care model and towards a proactive one. A key area of focus for this deployment should be in the management of non-communicable diseases (NCDs), which remain one of the greatest threats to health system sustainability globally. Approximately 15 million people in England are living with NCDs that can be managed but not cured,[3] and it is anticipated that health systems will be unable to cope with the rise of NCDs in years to come. The reactive, hospital-centric model on which most health systems are based is not fit for purpose for the management of chronic conditions. New models of care are needed, with digital approaches fully integrated – not merely as pockets of innovation, but as fundamental components of mainstream care.

This think piece explores what is needed to realise the potential benefits of digital health for the management of NCDs. We look first at the potential of digital health to improve disease management, and then at what is needed to ensure digital technologies can be fully integrated within the NHS and scaled up sustainably. We hope this think piece can help incite readers to think critically about the future of digital health and what is required to allow the promised 'digital revolution' to become a reality.

Box 1. Policymaking in digital health: where are we now?

Discussions around how digital strategies can improve health system efficiency have been ongoing for two decades, but of late they have been given more urgency in the public and private sector. In 1998, the NHS identified a need to share data seamlessly by 2005 and achieve a paperless NHS by 2018.[14] Later attempts to digitise the health service, carried out between 2002 and 2011, were expensive and unsuccessful, and the National Audit Office described the NHS IT Strategy of 2014 as having 'unclear' objectives.[14] But there now appears to be renewed commitment to deliver on those earlier goals. The Department of Health and Social Care and NHS England and NHS Improvement have stated that digital services will play a pivotal role in new working strategies.[14] The National Information Board has recognised that, in the face of unprecedented financial constraints, technology can enable people to use services less frequently while supporting healthier lives and alleviating health service pressure.[15] The board developed the Personalised Health and Care 2020 framework to drive forward the ambitions of various digital strategies.[15] The private sector faces similar issues, including barriers to access and a lack of governance, hindering the use of data-rich sources.[16]

The proposed transition to digital-first approaches and integrated care systems (ICSs) in the NHS may further advance digitalisation. Primary care is being supported to move towards a digital-first approach, allowing people to report symptoms, upload photos, book and cancel appointments, receive advice and referrals, obtain prescriptions and access all primary care services online.[17] ICSs are new partnerships between hospitals and primary care, physical and mental health, NHS and council services, organised within a given area.[18] By facilitating a seamless connection between them, ICSs aim to improve population health, reduce health inequalities and avoid disjointed care.[18] Interoperability of data systems and integration of digital solutions are key areas of focus in their implementation. The NHS has committed to rolling out ICSs across England, with 42 expected to be fully functional by April 2022.[19]

How can digital health improve NCD prevention and care?

Revolutionising all stages of NCD care pathways

The past decades have seen successful applications of digital health across all stages of NCD care pathways, from prevention to long-term monitoring. The integration of digital technologies can offer continuity of care to people living with NCDs without the need for frequent clinical visits – aiding the transition away from episodic and reactive care to long-term disease control and maintenance of good health (*Table 1*). Tools such as remote monitoring can facilitate more person-centred care[20] by providing individual data that can be used to tailor interventions to people's needs at every stage of care, even before they become patients.

Table 1. The role of digital technologies in improving care for people with NCDs

Prevention
• **Customised preventive interventions:** digital technologies can gather and combine patients' clinical data, digital biomarkers (e.g. physical activity levels obtained from wearables and sensors) and population health data (e.g. housing status and conditions). These data can be analysed jointly to develop tailored preventive interventions, which can improve health outcomes (reducing hospitalisations, morbidity and mortality) and reduce healthcare costs.
Diagnosis
• **Improved speed and efficiency of diagnosis:** digital technologies may reduce duplicative tests if they are applied in environments that enable data-sharing and interoperability. • **More accurate diagnosis:** digital technologies may allow us to detect the presence of concurrent symptoms (symptom clusters), reducing the need for further investigations.
Treatment and follow-up
• **Better continuity of care:** remote monitoring tools can allow clinicians to be alerted to any worrying symptoms or potential deterioration of a patient's condition in real time, allowing them to take rapid action. • **Enabling patient engagement:** digital technologies offer the opportunity to provide real-time data on patients' perspectives regarding their care, particularly in the form of patient-reported outcome and experience measures (PROMs and PREMs). The collection of these data can encourage people to be more actively involved in their own care. • **Personalised care:** PROMs data can be both diagnostic and predictive, helping to develop personalised treatment approaches that are best suited to the needs of the individual.

Benefiting patients and clinicians

There is growing evidence that both people with NCDs and clinicians appreciate the benefits of remote monitoring through digital technologies. One study found that being continuously monitored gave people a sense of security without invading their privacy, while the majority of healthcare professionals thought that the digital technology was trustworthy and enhanced the care they provided.[21] Remote monitoring is being used increasingly among people with cancer, with several studies demonstrating that it is safe and acceptable to patients, is as effective as face-to-face monitoring and does not increase use of GP services.[22-27]

The adoption of digital technologies can support clinical decision-making. The richness of health data obtained through remote monitoring, including patient-reported outcome and experience measures (PROMs and PREMs), gives clinicians a better picture of a person's illness and overall wellbeing in real time,[5] allowing them to detect abnormalities that might otherwise present late or be missed.[6] Timely alerts can enable the clinician to proactively intervene and escalate care, minimising the risk of deterioration and offsetting potential complications.[28] This directly benefits people with NCDs: the uninterrupted nature of remote monitoring gives them a 'safety net' and can reduce their need for emergency admissions for routine disease management, improving quality of life.

Timely alerts
can enable clinicians to proactively intervene and escalate care

Digital technologies can play a role in empowering people to manage their own physical and mental health, thereby increasing their autonomy and reducing their reliance on the health system – which is particularly important for people with NCDs. The instant feedback patients receive from remote monitoring can encourage behavioural change in real time,[4] reducing their risk of complications, giving them a sense of control over their health and encouraging self-management (*Case study 1*). Studies also suggest that patient satisfaction, motivation and interactions with clinicians are enhanced when people are given the opportunity to visualise their health data.[29]

One digital tool that can confer significant patient and clinical benefits is remote monitoring. In cancer care, people who undergo chemotherapy are typically required to attend hospital twice for each session, first for a blood test and then for treatment.[30] Depending on blood test results, some people will not be able to start chemotherapy, but they would still have had to attend hospital to have these tests taken; this wastes resources, effort and time for both the person with cancer and the hospital.[30] An innovative remote monitoring service for people with cancer is being piloted by The Christie NHS

Foundation Trust, where people can measure their white blood cell count, temperature and haemoglobin at home and are able to self-report symptoms, without the need for a hospital visit.[30] This can be particularly helpful for people undergoing ongoing treatment including chemotherapy, comforting them with the knowledge that clinicians are continuously monitoring their symptoms and wellbeing between clinic appointments (*Case study 2*). It also benefits clinical teams, optimising the use of resources.

Case study 1. Self-management and remote monitoring in prostate cancer[31]

A controlled multicentre study was conducted across four NHS prostate cancer treatment centres in England. The study compared outcomes of 293 men using remote monitoring and self-management with 334 men having traditional follow-up appointments at a clinic. The programme involved a healthcare professional acting as the first point of contact and coordinating follow-up care, with a uro-oncology clinical nurse specialist responsible for overseeing this and a supervising urologist/oncologist responsible for the patient overall. Participants did not have timed follow-up appointments; instead, an online system (My Medical Record) was accessible to the patient and the prostate cancer team. Periodic blood samples were taken at the patient's GP practice or a hospital to detect prostate-specific antigen (PSA), tracking recurrence of prostate cancer. Results were transferred to the online system and reviewed during virtual clinics, with contact made if required.

Findings:

- Coupling remote surveillance with self-management was cost-neutral, with no net gain or loss.
- The programme was found to be acceptable to patients.
- Patient-reported outcomes of the programme were similar to those for appointment-based follow-up care.
- The programme empowered people with cancer by highlighting their role in the management and maintenance of their own health.

Case study 2. Trial to monitor chemotherapy side effects remotely[32]

The European multicentre randomised controlled trial (eSMART) was conducted in Austria, Greece, Ireland, Norway and the UK to evaluate the impact of remote monitoring of chemotherapy side effects on patients' symptom burden, anxiety, work limitations, supportive care needs and quality of life.

In eSMART, 829 people with non-metastatic breast cancer, colorectal cancer, Hodgkin's lymphoma and non-Hodgkin's lymphoma, who were receiving adjuvant chemotherapy or chemotherapy for the first time in five years, were randomised to the Advanced Symptom Management System (ASyMS) or standard care (six cycles of chemotherapy). Participants in the ASyMS group completed a daily symptom questionnaire on a handheld device. Alerts were sent to clinicians if action was warranted and self-care advice was given to patients on how to manage their symptoms.

Findings:

- Symptom burden was controlled effectively and found to be at pre-chemotherapy levels in the ASyMS group, while an increase in symptoms was observed from cycle one onwards in the control group.
- The ASyMS group experienced:
  - » a reduction in physical and psychological symptoms of distress associated with each symptom
  - » lower scores for anxiety and higher scores for health-related quality of life
  - » higher confidence and ability to engage in their care
  - » lower supportive care needs, including physical, psychological and daily living needs (potentially attributable to daily reporting, clinician feedback, and reduced anxiety and physical symptoms).

Helping address long-standing challenges in the management of NCDs

Addressing chronic workforce shortages and reducing backlog

The COVID-19 pandemic has caused serious disruptions to NCD management, with cancer and cardiovascular services hit particularly hard. Disruptions to cancer screening, diagnosis and care seen during the pandemic are predicted to cause an excess of up to 35,000 cancer deaths in the UK within a year.[33] Virtually every aspect of cardiovascular care has been heavily disrupted by the pandemic. The British Heart Foundation expects this to generate a ripple effect that may continue to put lives at risk for years to come.[34]

> Pandemic-related disruptions are predicted to cause an excess of up to **35,000** cancer deaths in the UK within a year

Digitally driven approaches could drastically shorten the time required to clear the NHS backlog. With 26 million fewer outpatient appointments occurring during the first year of the pandemic,[35] it is predicted that it could take up to four and a half years for the NHS to address this severe backlog.[36] But embedding digital approaches at the centre of future models of care could release capacity of 516,805 appointments per week, improving staff capacity to clear this backlog in only eight months.[36] Digitally enhanced models have already demonstrated benefits to improving many aspects of cancer and cardiovascular care, presenting clear opportunities to scale up promising solutions.[31 32 37-39]

> Embedding digital approaches could release capacity of **516,805** appointments per week

Greater adoption of digital approaches to care may also help address long-standing workforce shortages across the NHS. In cardiovascular disease (CVD), significant national shortages of cardiac physiologists and other professionals in the wider cardiology team require the adoption of a resilient new model of care.[40] Similarly, in cancer care, there are considerable shortfalls in the number of radiologists and oncologists, failing to meet demand and ultimately jeopardising patient safety.[41 42] Without reforming traditional models of care, it is anticipated that the shortage of radiologists in the UK could reach 44% by 2025.[41]

Enhancing the efficiency of NCD care

Digital health can help to optimise the use of limited resources and reduce waste. Seamless transfer of real-world data between remote monitoring tools and clinical data systems allows patients and clinicians to be well-informed ahead of in-person or virtual appointments. This can help streamline appointments by reducing preparation time and allowing clinicians to focus on areas of concern and/or things that cannot be done remotely, such as physical examinations. Digital technologies can also reduce appointment cancellations or 'no shows', freeing up appointment slots.[43] This is particularly important, as more than 15 million GP appointments (5%) are wasted every year owing to people not attending.[44]

Virtual clinics have been found to optimise workflow. These innovative models of care dynamically change the outdated outpatient model, helping to address staffing constraints and improve speed of diagnosis while challenging the assumption that clinicians can only make decisions when patients are seen in person (*Case studies 3 and 4*).[45 46] The relationship between various NCDs, such as CVD and respiratory diseases, may also benefit from health systems merging digital platforms together in the future, thus avoiding duplication between services.

Case study 3. Virtual clinics for people with respiratory symptoms[45]

In December 2018, a referral management project commissioned by West Hertfordshire Hospitals was piloted to address rising demand. The integrated service offers advice, virtual clinics, pre-clinic investigations and follow-up in the community for people living with chronic diseases such as asthma, chronic obstructive pulmonary disease and sleep apnoea. GPs refer patients to specialists for appropriate investigations. Respiratory specialists are then responsible for reviewing patient data and triaging patients without meeting them in person. This model has allowed people to be diagnosed and treated earlier, ultimately maximising outcomes from their initial visit. It has also successfully reduced clinic utilisation, waiting times and demand for specialists, while increasing the rate of discharge.

The pilot evaluated the outcomes of 3,000 patients between January and July 2019.

Findings:

- 1,877 people were triaged correctly to sub-specialty clinics in the community.
- 28.4% of people required no additional tests and were discharged following the first appointment (up from 21.6%).
- 71.6% of people needed a follow-up appointment at the hospital.
- There were 230 fewer follow-up appointments per 1,000 new referrals.
- Waiting times to first appointment significantly decreased.

Case study 4. App offering virtual GP appointments[46]

Livi, an accredited Swedish supplier to the NHS, has partnered with the NHS to deliver a digital health solution that enables remote GP consultation. To reduce the burden placed on the NHS and offer additional capacity to GPs, Livi works closely with integrated care systems, primary care networks and more than 4,000 GP surgeries. People can use the Livi app through their phone or tablet to book an appointment and see a registered GP by video seven days a week; the solution allows GPs to offer medical advice virtually if symptoms do not need physical examination. To enable accurate diagnosis, patients are also given the option to attach photos. Where required, patients may receive prescriptions or referrals for further care. Livi is the first digital healthcare provider to receive an Outstanding rating from the Care Quality Commission.

Findings:

- 95% of users received lasting assistance (asked 14 days later).
- 95% of appointments replaced in-person appointments, saving clinical and administrative time.
- Five million NHS patients from diverse backgrounds have access to the platform in various languages.
- The service achieved a 40% reduction in costs.

Reducing recurrent hospitalisations and promoting early discharge

Digital health can play an important role in reducing the risk of hospital readmission after initial treatment. This is particularly relevant in CVD care. Recurrent hospitalisations account for the greatest proportion of admissions in people with heart failure over the age of 65 years in Europe.[47] By alerting clinicians to heart failure signs and symptoms in a timely manner, remote monitoring can help prevent hospitalisations and improve people's outcomes and quality of life[48] (*Case study 5*). Furthermore, evidence suggests that, compared with usual care, remote monitoring technologies can significantly reduce blood pressure.[49] Some clinical guidelines also recommend remote monitoring in people living with atrial fibrillation.[49] As is the case in cancer care, there is evidence that remote monitoring in cardiovascular care can enable patient engagement and strengthen the relationship between patients and clinicians.[50]

Case study 5. Remote monitoring in heart failure care[37]

The Telemedical Interventional Management in Heart Failure II (TIM-HF2) was a prospective, randomised, controlled, parallel-group, unmasked and multicentre trial. A total of 1,571 people were randomised to either usual care or remote management plus usual care. Participants were followed up for a maximum of 393 days.

The remote monitoring system relied on weight, heart rate, heart rhythm, blood pressure, oxygen saturation and a self-rated health status being transmitted daily to the person's treating clinicians. Participants were also offered heart failure education, as well as monthly structured interviews by phone to review their clinical status and medications.

Findings:

- 97% of participants transferred data daily to the telemedical centre at least 70% of the time.
- There was a reduction in unplanned cardiovascular hospital admissions: 18 days were spent hospitalised in the remote monitoring arm, compared with 24 days in the usual care arm.
- There was a reduction in the rate of all-cause mortality: the rate was 7.9 per 100 person-years in the remote monitoring arm, compared with 11.3 per 100 person-years in the usual care arm.

How can we move the healthcare digitalisation agenda forward?

The NHS has seen many examples of digital health innovations in recent years – but how we can transition from pockets of innovation to widespread integration deserves careful scrutiny. Evidence suggests that adoption of new digital technologies is slow across the NHS in England compared with other health systems.[51] The reasons for this are varied and complex. Some healthcare professionals have indicated that legal, financial and organisational aspects of their work have not been adapted to allow digital innovations to add value to patient care.[52] The fear of digitally excluding patients is another barrier that hinders deployment and sustainability of service innovations.[53] Gaining public trust and protecting patients' data privacy are also vital.

Effectively scaling up digital technologies is about more than just availability of those technologies, and requires a long-term view. We must be able to see beyond pilots and create pathways that can enable upscaling in a sustainable way. This will require guaranteeing a roadmap to implementation, forged through long-term public–private partnerships involving those developing digital innovations, those implementing them and decision-makers who oversee system change. Such partnerships should be established before testing of products, thereby avoiding haphazard and opportunistic integration of digital technologies in the NHS.

For digital health to provide sustainable and tangible benefits to the NHS, we need to ensure that it is fully integrated into all aspects of the health system, with implications for the NHS, clinicians and patients. Potential approaches to achieving this are outlined in this chapter.

Creating a digital-ready health service

Ensuring a seamless integration of digital health in all relevant governance frameworks

Digital health needs to be fully embedded into NHS policies as an integral feature of healthcare services. Too often, digital health is considered an 'add-on' component of care, necessitating its own strategies and funding mechanisms. Instead, it should be seen as integral to NCD care delivery – and the health service more broadly – with leadership, policy frameworks, funding streams and models of service delivery fostering this integrated vision, as opposed to running along parallel tracks. Reconfiguration of the NHS into integrated care systems (ICSs) may help enable this integration;[18] it will also be important for different ICSs to share their experiences of digitalisation to help replicate successful models.

Governance frameworks need to ensure data are able to follow the patient through their care journey, spanning the NHS and private sector. Digital technologies challenge the status quo by offering a unique opportunity for data to follow people through the system. Despite the Acute Data Alignment Programme intending to create a single source of health data across the NHS and private healthcare,[54] we have yet to build frictionless data-flow networks that allow people to use digital innovations regardless of where they receive care.

Promoting interoperability and system redesign

Data standardisation is needed to overcome long-standing issues regarding interoperability. The majority of existing medical data across the NHS – hidden in incompatible and isolated systems – lack interoperability; this hinders data exchange, analysis and interpretation. The Local Health and Care Record Exemplar programme, launched in 2018 in England, is a step in the right direction to encourage linking of health and care data through interoperability.[55] However, we need stronger, harmonised data governance legislation that enables data linkages while ensuring that patients' privacy and dignity, autonomy and confidentiality rights remain protected. Data standardisation and interoperability initiatives will also need to be upscaled further.[56]

We need to reconfigure services to make the most of digital technologies. For example, the creation of digital healthcare hubs, with dedicated teams that continuously monitor patients and escalate care either in person or virtually, may increase patient access to timely care while reducing the burden on clinicians.

Ensuring clinical buy-in and professional training

Providing clinicians with appropriate information

Digital approaches should relieve – not amplify – the burden on clinicians. Limited acceptance among front-line staff has been one of the main barriers to the adoption of digital technologies. With the need for change being a recognised characteristic of the NHS, some healthcare professionals have described working in an evolving environment as 'overwhelming', and feeling 'bombarded' by new initiatives.[57]

Co-creation
of digital solutions with healthcare professionals can address unmet needs

Aligning the expectations of front-line staff regarding digital technologies can improve buy-in. Some clinicians may be uncertain about which patients to target and the goals to be achieved.[57] To this end, balanced information about different technologies' risks, benefits, potential uses and expected impact on patients and workflow should be presented to healthcare professionals in an appropriate manner, with adequate support and training opportunities.[52 57] Similarly, data collected should be fed back to clinicians in a way that allows rapid assessment and interpretation, optimising their integration into clinical decision-making – for example, through intuitive dashboards.[56] Healthcare professionals are essential in identifying unmet needs; co-creation of digital solutions with healthcare professionals can therefore ensure these needs are met.

Empowering clinicians to adopt digital technologies to support their local needs should be considered, thereby promoting confident clinical decision-making. Some have suggested incentivising local organisations within the health system (such as NHS trusts) that adopt and utilise new technologies appropriately by giving them more freedom to implement changes in line with national guidelines.[53] Similarly, decision-making may be transferred to front-line services, delegating responsibility for service improvement to providers themselves,[51] thereby ensuring they play a key role in service transformation.

Developing a digital-ready workforce

We need to prepare the current and future clinical workforce for greater integration of digital health. There remains a clear need – often cited by healthcare professionals themselves – to upskill the workforce and facilitate a conducive digital culture.[52] This requires both embedding digital health as a core subject of education and professional training for future healthcare professionals, and offering upskilling opportunities to existing professionals in a flexible and supportive manner.[52] Several initiatives have been set up across the NHS to address this need. The National Information Board and Health Education England have developed a partnership to enhance the digital capabilities of the healthcare

workforce.[58] Meanwhile, NHS Digital Academy, a virtual organisation launched by Health Education England, provides training to hundreds of digital leaders, thereby improving knowledge and preparation within the NHS.[59]

Professional training should stress the importance of communication with patients regarding the use of digitally collected data. Asking patients to provide data such as PROMs may lead to expectations on their part that these data will be taken into consideration to guide their care. Clinicians should be encouraged and guided on how to assess results and communicate with patients about how they intend to integrate these data (or not) into their clinical assessments.[60]

Securing public trust and patient involvement

Gaining and maintaining public trust

Awareness campaigns will be important to enhance public trust in digital approaches. Efforts to build digital and health literacy can help the public gain a deeper understanding of how rapidly evolving digital technologies can enhance their experience of care.[56] Gaining public trust is crucial, as many digital technologies rely on people's willingness to share highly sensitive personal data, which could raise concerns about privacy and how these data might be used by recipients or third parties (e.g. insurers). Engaging with the public to overcome concerns about manipulation and nefarious use of data is also important in light of previous cyberattacks on the NHS.[56 61]

> Regular adaptation of legislation on patients' rights can ensure that people remain the 'gatekeepers' of their own **health data**

People should be made aware of who owns their health data and how they can manage their consent. Historically, patient information has generally been owned by the organisations responsible for data generation and storage, rendering some people reluctant to share their data.[62] People should have the option to opt out of their health data being used for reasons that go beyond direct care, unless use is overridden by public interest or legal requirements.[63] Legislation surrounding patients' rights should also be adapted regularly to ensure that people remain the 'gatekeepers' of their own health data.

Involving patients in the design of new technologies

People living with NCDs should be involved in the design of remote monitoring services, as they are more likely to trust technologies that are person-centred. Digital technologies need to be tailored to the end user to have a real impact.[64] Some people may prefer traditional face-to-face interactions or view computers as 'dehumanising',[65] and using their perspectives to co-design digital tools may help increase uptake.

Addressing patient retention in the design of digital technologies is crucial. Dementia is one area where assistive technologies, including wearables and sensors, have reinvented care.[66] These include devices used *by* people with dementia that act as reminders, devices used *with* people with dementia to promote communication, and devices used *on* people with dementia to monitor their movements, falls and location.[67] However, despite the benefits of these technologies, people often give up using them.[3] Including assessment of patient experiences in evaluation of proposed technologies can ensure these data are built into future design to maximise benefits for users.[68]

Avoiding digital exclusion and exacerbation of existing inequalities

Any policies to increase digitalisation of NCD pathways must consider the risk of digital exclusion. Evidence suggests that people who already face socioeconomic deprivation are most likely to be digitally excluded,[69] and that insufficient digital skills and reduced access to digital technologies contribute to poorer health outcomes.[70] Fewer than one in five people aged 65 years and over owns a smartphone,[71] which is an important concern when thinking of digital solutions for chronic diseases, which are most prevalent in older populations. Many older people feel that it is too late to improve their digital skills.[72] Moreover, the average literacy age in the UK is nine years, and nine million adults across the UK are considered functionally illiterate, hindering their ability to manage daily living and work-related tasks.[73 74] Inclusion, as a key component of digitalisation, should be prioritised through adequate funding.[69]

> Fewer than **1 in 5** people aged 65 years and over owns a smartphone

Health systems must play a role in supporting people who are digitally excluded. The introduction of 'digital health champions' in healthcare settings, along with targeted digital training programmes, can help people use and engage with digital tools (*Box 2*).[70] Inclusive models that offer culturally sensitive patient information in a range of languages are important,[75] as is collaborating with local community organisations and charities that target deprived communities and people who face language barriers. In the UK, digital inclusion is further challenged by the need to access and navigate digital platforms in the English language; 52% of Bangladeshi populations in the UK, for example, have a first language other than English.[76]

Box 2. The NHS Widening Digital Participation Programme

Over three years, nearly 222,000 people considered 'digitally excluded' were trained to use digital health resources and tools; this markedly improved use of online health information among 59% of participants.[70 77] As a result, 65% felt better informed about their health, 51% used the internet to find ways to improve their wellbeing and 21% reduced their GP appointments.[70] The programme generated returns of £6.40 for every £1 spent on digital inclusion interventions.[70]

It is also important to mitigate against innovations that may inadvertently increase the digital divide. The further widening of inequalities can be prevented by ensuring that new technologies meet the needs of disadvantaged groups and are evaluated during their development to explore potential inequalities in access and barriers to use.[8 70] The nature of digital exclusion is dynamic, changing with the evolving nature of technology, so more research is needed on digital exclusion and health inequalities.[69]

It is essential that digital technologies benefit diverse populations. They need to be designed and tested on different populations to ensure there is no inherent racial, gender or other bias in their design that affects their applicability to diverse populations. For example, there has been a lot of controversy about pulse oximeters that measure oxygen saturation, as several studies have suggested that they are much more likely to miss low oxygen levels in Black people compared with White people.[78] These and other devices need to be clinically validated in individuals from a variety of backgrounds, thereby mitigating risks and addressing digital health inequalities. It is also important to acknowledge that the evidence on the accuracy of different technologies in different populations is constantly evolving, and clinical practice and regulations must evolve as a consequence.[79]

Conclusion

NCDs remain the world's main cause of death, threatening human health, health system sustainability and economic growth. With NCDs poised to become more prevalent in years to come, we need to ensure full integration of digital advances – across prevention, management, treatment and follow-up – for people living with NCDs. This will require adaptation across multiple facets of the health system, to ensure it is fully ready to accommodate digital technologies and allow them to become a mainstay of health delivery going forward.

Despite disruptions caused by the COVID-19 pandemic, we are at a promising juncture where we can help enhance the future sustainability of healthcare through effective implementation of digital technologies. As we take this unique opportunity to reset our health system for the post-pandemic era, efforts are required to leverage the huge strides we have already made and ensure everyone is able to benefit from digitally enhanced models of care.

Change of this scale can only happen with appropriate leadership from the top and concerted action from all stakeholders. We need a strategic, policy-led, whole-system approach, with all stakeholders – healthcare managers, clinicians, patients, industry and policymakers – closely aligned to achieve this. We simply cannot afford to let the unique position we are in turn into a missed opportunity.

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We welcome any questions or comments about the issues raised in this think piece.
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