

National Health Servers

Delivering digital health for all

Nigel Keohane
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EXECUTIVE SUMMARY

This research considers how technology could be adopted quicker and more widely by the NHS to improve the care that patients receive and to drive better health outcomes.

The report's structure tracks the patient journey, from prevention and diagnosis in the community, into primary and secondary care, through into management of long-term conditions. As well as improving the care experience in primary and secondary care, the report argues that there are huge opportunities to keep patients out of the NHS: prevention of disease can reduce the likelihood of people having to enter hospital care in the first place; better digital management of long-term conditions can help avoid unnecessary readmissions into hospital. It concludes with six policy recommendations to drive improvements across the care pathway.

The potential for deploying digital technology across the patient journey

Action before the patient enters the NHS	Prevention of disease	<ul style="list-style-type: none"> Establishing a new health and safety preventative agenda for employers through more proactive monitoring of screen time and staff activity levels. Utilising wearable technologies that individuals can use on a day-to-day basis to predict and diagnose disease, for instance to detect diabetes and hypertension.
	Diagnosis in the community	<ul style="list-style-type: none"> Expanding use of App-based condition management for those with long-term conditions and for remote monitoring and testing. Making diagnosis more accessible for harder-to-reach communities, by making it available in community settings such as supermarkets.
Action in the NHS (primary and secondary care)	Primary care	<ul style="list-style-type: none"> Blending remote consultations with remote monitoring and diagnosis so that the patient can access care and advice at a place of their choosing, including their home or their care home. Positively encouraging more primary care services that specialise in different modes of delivery offering greater choice to consumers.
	Secondary care	<ul style="list-style-type: none"> Intensifying the use of artificial intelligence in diagnostics to enable radiologists to focus on more complex cases. Building on efforts to track and monitor patients using wearable devices, and track beds to promote patient safety and the flow of patients through hospital.
Action after patient is discharged	Management of long-term conditions	<ul style="list-style-type: none"> Expanding the role of wearables to gather clinical grade patient data and offer condition management facilities. Promoting the integration of health management into devices that individuals already own and use.

Evidence of slow and varied take-up of digital technology in healthcare

In describing this patient journey, the report charts some of the current shortcomings of in adopting technologies that can improve healthcare and the patient experience.

Analysis by the regulator indicates that take-up of digital services correlates with better ratings among secondary care providers. However, this report reveals that where you live, which commissioner serves you, which GP practice you live near and which hospital you use will dictate whether you receive a digitally-enabled or an outdated service. Levelling out this unwarranted variation without suffocating innovation should be a priority.

- Across Clinical Commissioning Groups (CCGs), the percentage of appointments carried out remotely by telephone video or online ranges between 4% and 30%; and the percentage of patients who report using online tools to book appointments from 4% to 27%.
- Based on the NHS's own data, digital maturity varies by more than a factor of three between the best and worst performing NHS Trusts.
- While the data shows that use of e-referral to enable choice at first routine elective referral is comprehensive in some CCGs, in some it is a minority.

The report also identifies challenges across the NHS:

- Routine NHS use of pagers for communications creates a systemic risk via reliance on the single remaining pager provider in the UK.
- There are also areas where overall digital performance is very weak across the board – for instance, only 3% of GP patients report using Electronic Patient Records.

Unlocking the potential of digital technology

The report sets out proposals for future development of technology in the NHS, which impact across the patient journey. These recommendations are based on three core foundations. First, they form part of a wider compact with the public: if patients are increasingly going to be asked to bear the burden of care through prevention and self-management, then in return, they should be entitled to better care, more convenience and a better experience. Second, whilst the NHS should make digital healthcare more accessible and more patient-centred, in many areas we see these supplementing rather than replacing existing practices. The NHS should not seek to remove face-to-face services for those who want and need them just because others would prefer a digital service. Third, we take as a starting point an emphasis on empowering NHS staff to make use of digital technology to make their jobs easier to do and enable them to spend more focusing on patient care. We acknowledge the important work done through the Topol Review and its conclusions that technology can allow 'a marked improvement in the patient-clinician relationship', owing to the 'gift of time' and that this can enable stronger 'inter-human bonds' between clinicians and patients.¹

The report recommends:

1. Enshrining **digital rights in the NHS Constitution** to make a reality of promises in the NHS *Long Term Plan* and to level out unwarranted variation in provision.
2. **Establishing clear priorities to promote access to digital healthcare** among:
 - Those who are already digitally-enabled - Recent Ofcom data shows that four in five UK consumers now own smartphones. Meanwhile, ONS data from 2018 also reveals that in

the last decade the proportion of individuals using the internet for health-related activities increased from 24% to 54%.

- Those managing long-term conditions where digital tech could have a huge impact.
- 3. Promoting digital access among individuals with long-term conditions, including through **social prescribing of digital skills** where necessary.
- 4. Addressing the risk that technology could exacerbate existing health inequalities by **prescribing devices and wearables** where there is a clear health need to individuals who cannot afford these products.
- 5. Enacting proposed reforms to **instil interoperability across digital systems** as proposed in the recent *NHS Long Term Plan*.
- 6. **Opening a public debate on Electronic Patient Records** and selling the benefits of patient data to the health of the UK population, as a first step towards winning consent for sharing and using data. This should include publishing an annual analysis of the estimated value of patient data to the public and NHS users, in terms of treatments developed and made available, health improvements and efficiencies recorded.

INTRODUCTION

Recent decades have seen multiple initiatives and programmes to expand the use of technology and digital applications in the NHS. However, the Government acknowledged in its strategy paper *The Future of Healthcare* that ‘the state of online services, basic IT and clinical tools in health care is far behind where it needs to be’.² It also perhaps says something of the antiquated nature of parts of the healthcare system that the statement that the NHS would rid itself of fax machines needed saying and indeed that this announcement made headline news. Research by the Nuffield Trust has noted a consensus that healthcare around the world is at least a decade behind other industries in its use of information technology.³

The *NHS Long Term Plan* meanwhile noted that although digital technology has been taken up much more widely in recent decades, there is a significant distance to travel. The Plan committed to more joined-up and coordinated care, more proactive services and more differentiated support to individuals. Each of these can be facilitated and enabled by technology. The Topol Review, published in February 2019, noted that within 20 years 90% of all jobs in the NHS to include some element of digital skills.⁴

In part, the failure to make more rapid progress can be explained by the nature of the debate on technology in healthcare which has too often focused on operational and efficiency improvements rather than on enhancing the quality of care and the patient experience. This has meant the discussion has frequently remained a technical one, all the while most people’s interactions with technology and digital applications in their wider lives have burgeoned, multiplied and become more central to their social, cultural and economic existence.

Focus of paper

This report seeks to answer the following questions:

- What future steps can be taken through digital technology to improve health outcomes and the patient experience in primary and secondary care?
- Which technologies could help prevent illnesses and promote good health outside of the traditional NHS services?
- How could these improvements manifest themselves across the patient journey or care pathway?

The report does not seek to be exhaustive as the scope of digital applications in the NHS is extremely widespread. Instead, we take a thematic approach across the patient journey and identify risks, challenges and opportunities.

Report structure

This report follows the outline structure of the patient journey in healthcare, before concluding with policy recommendations.

Methodology

Our analysis draws on:

- UK-based and international literature on the application of digital technology in healthcare settings.

- Analysis of data from:
 - The NHS's GP Patient Survey: NHS Digital's Appointments in General Practice.
 - NHS England's Digital Maturity Index data.
 - NHS England, CCG Improvement and Assessment Framework Data.

STAGE 1 OF THE PATIENT JOURNEY: PREVENTING DISEASES

The role of the NHS is changing from a service which intervenes when health deteriorates to one that also helps keep people healthy through prompt preventative measures. In November 2018, the Department of Health and Social Care released a report entitled *Prevention is better than cure*.⁵ This report, alongside the *NHS Long Term Plan*, highlights an emerging view that citizens should be more responsible for their own health, and identifies prevention through smoking cessation, obesity reduction and reduced air pollution as important measures to pursue.⁶ International studies have suggested that past investments in prevention have had a significant long-term social return, with around £14 of social benefit for every £1 spent across a broad range of areas.⁷

The current landscape of preventive technology

Major societal challenges need to be addressed to drive significant improvements in disease prevention; these include the prevalence of smoking, childhood obesity and alcohol consumption.⁸ The NHS is already using technology to help promote or encourage better lifestyle choices and to help prevent long term conditions or diseases.

Gamification

Heart disease is one of the biggest challenges facing the UK. Research shows that premature deaths from heart disease are completely preventable.⁹ Changes to lifestyle can prevent the occurrence of heart disease and strokes.

The NHS is already starting to use gamification through its app “Active 10” to promote lifestyle change. The app encourages participants to walk briskly for 10 consecutive minutes. It uses gamification to encourage users to hit their walking targets, features include daily goals, badges based on achievement and the ability to track your progress.¹⁰ Walking 10 brisk minutes per day reduces the risk of serious illness such as heart disease, type 2 diabetes and some cancers.¹¹ Over 600,000 people have downloaded the Active 10 app.¹²

Educational tools

Equipping individuals with the correct knowledge to make the best choices regarding their own health, and to help them fully understand the link between their actions and their health, is vital if we are to reduce the occurrence of many long-term conditions. NHS choices, Public Health England (PHE), University College London and British Heart Foundation have collaborated to create a website which gives those over the age of 30 a ‘heart age’. The heart age alerts the individual to the state of their heart health, it then gives useful tips on how to reduce your heart age and prevent to occurrence of strokes or heart disease.¹³

Wearable technology

In 2017, NHS England, PHE and Diabetes UK, collaborated with technology companies to launch a diabetes and obesity prevention pilot project. The pilot projects feed into the NHS’s Diabetes Prevention Programme that was launched in 2016. The digital stream of this project involves a range of technological tools including apps, gadgets, wearables which are available through eight pilot areas.¹⁴

One technology piloted during this programme is Buddi Nujjer. This is a form of wearable technology that monitors activity, sleep patterns and eating frequency. In addition to activity monitoring, patients referred through the pilot scheme can access educational sessions via the app, these sessions target diet, physical activity and mental resilience.¹⁵

Figure 1: Five step referral programme for NHS users of Buddi Nujjer¹⁶



Source: Nujjer

Encouraging physical activity and weight loss reduces the risk of developing type 2 diabetes. This intervention has been rolled out across 52 practices in Somerset.¹⁷ This is an early form of social prescribing; a tool that the NHS intends to utilise more.¹⁸

The future potential for disease prevention technology

The NHS has stated that it will fund a doubling of the NHS's Diabetes Prevention Programme over the next five years, including a new digital option that will widen choice and target inequality.¹⁹

We envisage huge potential to expand the use of apps to improve how the NHS interacts with patients, to 'gamify' desired health outcomes, and to use behavioural nudges to change behaviours.

Making the most of smartphones

The benefit of app-based tools is that they harness a technology that many people already own and use. Recent Ofcom data shows that four in five UK consumers now own smartphones.²⁰ Meanwhile, ONS data from 2018 also reveals that in the last decade there has been a significant increase in the proportion of individuals using the internet for health-related activities, increasing from 24% to 54%.²¹ Together, these facts suggest that the NHS should focus on widespread technologies that are widely understood.

Behavioural nudges

Persuading people to make better choices for their long-term health can be difficult. However, the NHS should learn from initiatives across a range of markets, where nudges have been shown to encourage individuals to make more optimal decisions, including:

- Encouraging people to seek out diagnosis, for instance the NHS has commissioned text nudges to encourage people to go for cervical cancer screening.

- Learning from financial services, where consumers receive nudges when their financial position becomes precarious and whether similar exchanges could take place related to someone's health.
- Healthier eating - Research in Florida has shown nudges to be effective in altering the decisions students make for their school lunches.²²
- Medicine and therapy adherence could be promoted.²³

Expanding the role of employers – a new health and safety agenda

Since the mid-nineteenth century there have been requirements on employers to prevent them causing harm to employees, but there is now a much more proactive agenda to be developed here.

The *NHS Long Term Plan* shows the NHS taking its role as an employer very seriously, including taking forward its Health and Wellbeing Framework and initiatives on availability of healthy food for its staff. The Plan also notes the role of wider business in preventing the occurrence of negative health outcomes and supporting staff effectively.

Many individuals spend a significant proportion of their lives at work, and employers are trusted intermediaries. In turn, a healthier workforce can be a more productive workforce, for instance through reductions in absenteeism and presenteeism.

Studies have shown that excessive periods sitting can be linked with obesity, diabetes and some types of cancer.²⁴ In the US, employers are increasingly encouraging their workers to become more active.²⁵

Tools could include using technology to monitor how long a member of staff has been sat at their desk or staring at a screen, if employees had been sedentary for a prolonged period they could be encouraged to move away from their desk or take a break from their screen. A delicate balance must be struck to ensure the steps employers take are not seen as intrusive.

STAGE 2 OF THE PATIENT JOURNEY: DIAGNOSIS IN THE COMMUNITY

Diagnosing conditions early can have numerous benefits for patients, such as better management of symptoms and in some cases increased chance of survival.

The Cancer Taskforce has described early diagnosis as the key to improving outcomes for cancer patients. In 2018, the government announced that by 2028 three quarters of cancers should be diagnosed at stages one and two, this was reinforced in the *NHS Long Term Plan*.²⁶ By diagnosing conditions early patients may need less complex treatment in the short and long term, which could reduce overall costs for the NHS, although the evidence base on this needs to be developed further.

The current landscape of diagnostic technology

Cutting edge diagnostic technology has been within the NHS for several years, however several innovations are starting to further revolutionise practices. Artificial Intelligence (AI) can help clinicians diagnose diseases in the community as well as in primary and secondary care.

Examples that could be built on and developed include the NHS's 'C the signs': an app-based tool that is designed to be used during a GP consultation. The app helps identify patients at risk of cancer, the type of cancer they are at risk from and the next steps for the GP. Following a successful trial of 'C the signs' in Sutton the app is now being piloted in Merton and Wandsworth.²⁷

The future potential for diagnostic technology

More opportunities to take diagnosis into the community

Technology has the potential to increase the convenience and ease with which diagnostic technology, and hence diagnoses, can be delivered to patients. This brings the opportunity to significantly increase access to diagnosis services by making them available in community settings. This may also help address unequal access to diagnosis as settings can be chosen where harder-to-reach groups can be targeted.

For example, a pilot scheme in Manchester brought lung cancer CT scans to supermarket car parks, where smokers and ex-smokers were offered free health checks and on the spot CT scans. The pilot scanned more than 2,500 people in deprived areas of Manchester and found 65 lung cancers affecting 61 patients. Cancers were diagnosed much earlier through the study: before the study 18% of lung cancers were diagnosed at stage one and 48% stage four. After the study, 68% of lung cancers were diagnosed at stage one and 11% were stage four.²⁸ The NHS has now made additional funding available to roll out this approach more widely.²⁹

Wearable technology

Utilising items that individuals use on a day-to-day basis to predict and diagnose disease could be the way of the future. In 2017, research by YouGov estimated that 17% of the population in the UK own a wearable device and a further one in six of those who don't own a device stated they were in the market for one.³⁰ Improving the health-based offering of these products could broaden the health impact. Research from a variety of studies has shown that when smart watches and AI are combined they can detect diabetes, sleep apnoea and hypertension.³¹ These systems could alert patients when to visit doctors and increase the likelihood of an earlier

diagnosis. By 2021, the NHS hopes to integrate data from wearable devices and lifestyle apps into the NHS app and have this data linked to their health record.³²

However, we also note that policymakers will have to be increasingly alert to the risks of over-diagnosis as such technologies roll out.³³

STAGE 3 OF THE PATIENT JOURNEY: DIGITAL TECH IN PRIMARY CARE

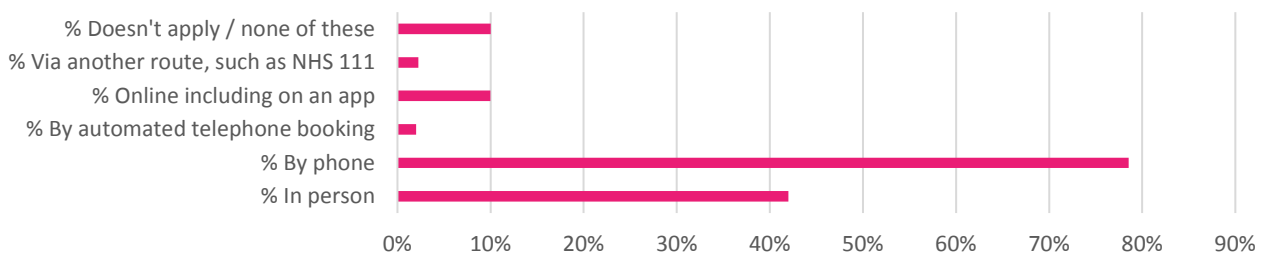
The *NHS Long Term Plan* makes commitments towards ‘digital-first primary care’, including an option for patients to choose a telephone or online appointment.³⁴ Our analysis illustrates how far off this vision remains and how technology could further improve the patient experience.

Current landscape in primary care

Making contact and making appointments

Patients’ initial contact with the health service often arises when they seek to make GP appointments. Figure 2 shows that the most common mode is by telephone, although a surprisingly large number make the appointment in person (the latter may be at least partly explained by people making repeat appointments in person). Only one in ten have made an appointment online in the last 12 months. It is unclear why this figure is so low. Processes may put some off: patients must complete an application form, and registering may include providing photographic evidence and proof of address in order to be able to make appointments online.³⁵ Awareness is also low: only two in five (41%) patients report that they are aware that online appointments are available in their GP practice.³⁶

Figure 2: In the past 12 months, have you booked general practice appointments in any of the following ways?

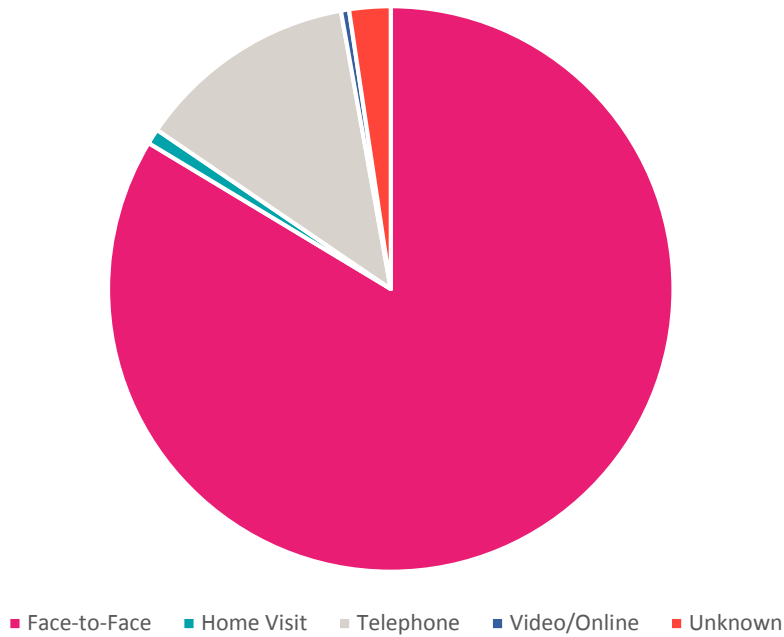


Source: NHS, *The GP Patient Survey: CCG report (August 2018 publication)*

Remote appointments

Remote consultations are no-longer exceptional. Figure 3 shows that while the overwhelming majority (84%) of appointments are still face-to-face, one in eight (13%) appointments are completed by phone, whilst fewer than 1% are done by video or online.

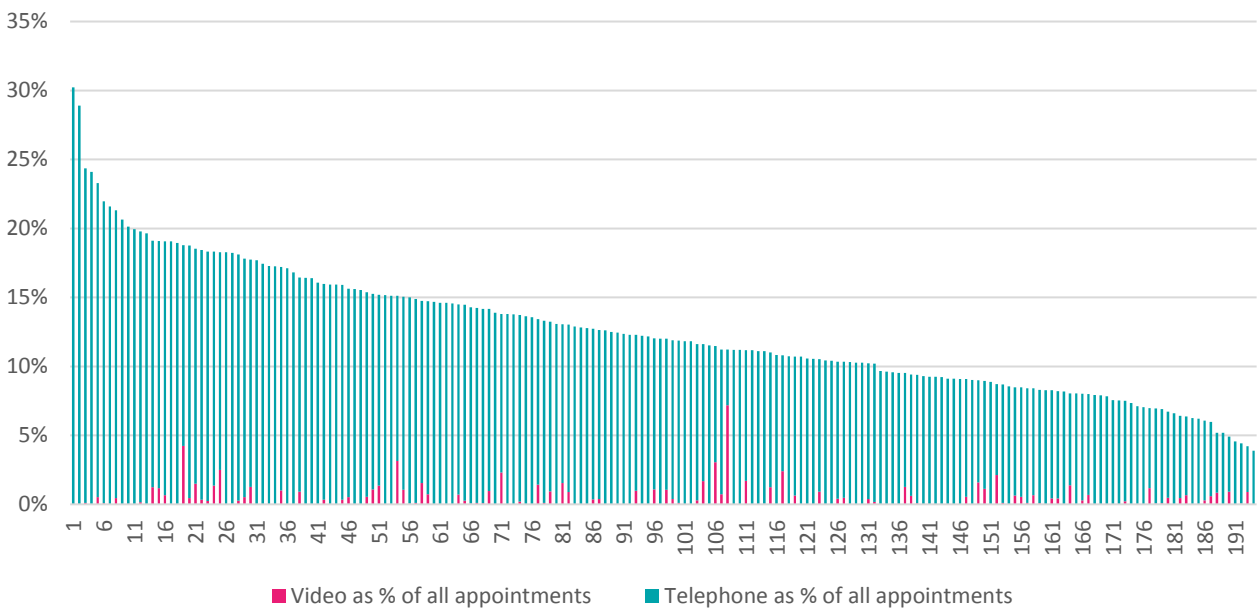
Figure 3: Mode of GP consultation in England



Source: NHS Digital Data: Appointments in General Practice, October 2018; <https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/oct-2018>

However, Figure 4 shows a staggering level of variation in use of remote appointments (including telephone, video and online).³⁷ Almost half of CCGs record no video consultations and others carrying out a significant share of consultations via this method. Some CCGs report doing nearly one in three appointments remotely, whilst others as few as one in twenty-five.

Figure 4: Percentage of appointments in general practice carried out by video / online and by telephone (by CCG)



Source: NHS Digital Data: Appointments in General Practice, October 2018; <https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/oct-2018>

Remote prescribing

Only four in ten (38%) primary care patients in England report that they can order repeat prescriptions online. As described below, there is also very significant variation in the reported availability of online prescribing.

What explains variation in primary care

The latest survey of GP patients shows huge variation across CCGs.

- Patients who report that repeat prescriptions are available online: Lowest 22% and Highest 55%.
- Patients who report that accessing medical records online available: Lowest 6% and Highest 22%.
- Patients who report using online tools to book appointments: Lowest 4% and Highest 27%.
- Patients who report that booking appointments online is available: Lowest 24% and Highest 57%.

We might expect some variation in use of digital technology driven for instance by the demographics of the population in different CCGs. We observe that those CCGs where a lower proportion of responses are from older patients have on average a lower percentage using online appointments and a higher proportion ordering repeat prescriptions online (potentially because there are simply more people likely to need repeat prescriptions). However, significant variation remains even when controlling for the age of patients.

Use of electronic patient records

A 2013 study suggested that the UK did well by international standards in terms of doctors having access to electronic patient records (EPRs) and that a large share of these were multifunctional.³⁸ Research by the King's Fund suggested that 96% of GP practices have digital clinical record systems.³⁹

However, the use of EPRs by patients is nearly non-existent. The 2018 GP Survey 2018 survey of primary care which had 753,000 responses found that only 13% reported that this service was available. Even more alarmingly, only 3% of respondents had accessed their medical record online. In this regard, though there is variation, even the highest performing CCG has only 7% of GP patients reporting accessing medical records online.⁴⁰ This is a system-wide failure.

The future potential in primary care

Blending remote consultations with remote monitoring

Remote consultations have been possible for a long time. However, more reliable and secure technology, changing patient preferences and complementary interventions considerably increase their potential. Evidence generally indicates that video appointments are reasonable substitutes for physical visits but are likely to be cheaper.⁴¹

Complementing telephone or video consultations with remote patient diagnosis and testing could enhance patient convenience and help make most efficient use of GP time. For instance, it is likely that heart monitoring, weighing, blood tests and urine test could increasingly be

undertaken remotely and, if necessary, communicated automatically.⁴² Salford Royal NHS Foundation Trust is introducing home testing of urine via a smartphone that incorporates a mobile phone camera and computer vision technology.⁴³ Such technologies are likely to be made available initially to those managing long-term conditions, and could play a significant role in reducing repeat appointments to primary or secondary care. They may also improve health outcomes. An evidence review shows that home-based telemonitoring of blood pressure can improve blood pressure control, with the results particularly pronounced when complemented with other support.⁴⁴

These services could be especially beneficial in more rural areas, for patient groups that find it expensive or harder to travel to their local GP practice and for those who need to be tested frequently.

Blurring the boundary between primary and secondary care

Better flow of information and advice between primary and secondary care could mean preventing avoidable referrals to secondary care, delivering convenience to the patient and more efficient use of consultants' time. This revolves around quicker and less-time consuming communication between GPs and consultants; sharing of patient information, diagnostic images and advice.⁴⁵ There is also increasing scope for virtual consultations between GPs and consultants. The Topol Review notes that such an approach could also work in social care settings, with advice provided via video-link to care home staff and residents.⁴⁶

Encouraging and adapting to more specialist primary care services

We are starting to see the evolution of greater specialism in delivery mode of GP services. This is a trend that has already evolved in many consumer markets. For example, in banking services, some providers have blended their offer between 'bricks' and 'clicks', some providers have specialised as online or telephone only. Specialisation may allow greater investment and more choice for patients.

There is already a well-known specialised service: Babylon's 'GP at hand' service provides virtual appointments with GPs via video which is available 24/7, and the service can also prescribe medicines. The app is available to anyone who works or lives within 40 minutes of Babylon's 5 London clinics.⁴⁷ It has recently been given approval to expand to Birmingham.⁴⁸ Online consultations may reduce the need for face to face appointments for some individuals. Video appointments may be more suitable than telephone appointments where visual clues are important.⁴⁹ People can also pay for private online appointments for instance via Push Dr (£30 per consultation).⁵⁰

Some fear that such apps and services will undermine the financial position of bricks and mortar GP practices. The logic is that GP practices receive their funding on a per patient basis (weighted based on the health of the population). However, as patients are unable to register with both Babylon and a local GP practice there is a concern that healthy, digitally-engaged individuals will self-select into Babylon practices and move away from standard GP practices. In this situation, practices will not be able to cross-subsidise from healthy patients with a low cost base to those with higher levels of need. However, this problem arises because - as the NHS Plan notes - GP funding does not effectively reflect the health needs of the patient population. There is an ongoing review being conducted by Ipsos Mori commissioned by London NHS leaders into the impact of 'GP at Hand' on the sustainability of general practice.⁵¹

Risks that easier access will lead to increased demand

Some also cite concern that making the NHS easier to access and more agile may increase demand and usage of NHS services. In contrast to most other sectors of the economy, technology (including medicines and devices) often pushes up NHS costs because the productivity-enhancing improvements that they trigger in healthcare delivery are less significant than the opportunities they create for additional spending (through new treatments, heightened expectations among consumers, expansion of treatments and more accessible services).⁵² The Wachter Review into IT in 2016 concluded that digitisation can drive efficiencies and cost savings but that the return on investment is more likely to materialise through improvements in safety and quality, at least in the short term.⁵³

However, two fundamental qualifications must be made here. First, digital technology may be able to substitute for labour and drive efficiencies. Second, technologies also can improve patient care, access and life expectancy, and in turn promote a healthier more productive workforce.

In short, increasing demand must be a risk worth taking. To put it bluntly, NHS resources and services should be rationed on the basis of need and cost-effectiveness rather than simply by making them inconvenient and awkward to access. Using outdated methods of communication and interaction with patients to restrict resource-use will not allocate resources efficiently and may unwittingly skew resource use towards those patients with the ability to avoid the obstacles placed in their way, while excluding those without such wherewithal. If so, better use of technology could have socially progressive consequences.

STAGE 4 OF THE PATIENT JOURNEY: DIGITAL TECH IN SECONDARY CARE

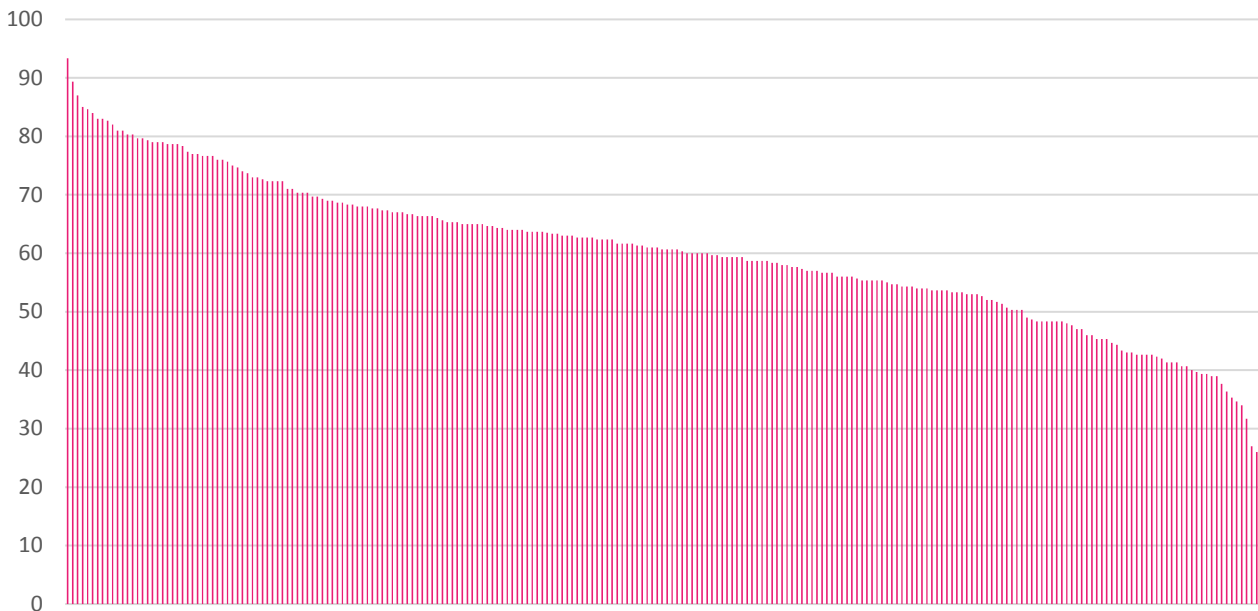
Multiple reviews and policy initiatives have sought to promote the wider use of digital technology in secondary care to improve care outcomes, improve the patient experience, and drive efficiencies which can free up resources for better care in other areas. These range from using e-rostering of staff, more advanced use of data analytics, use of AI in diagnosis, electronic data sharing, and bed trackers to enable occupancy to be maximised. The Carter Review revealed the huge level of unwarranted variation in operational efficiency across NHS Trusts.⁵⁴

Current landscape in secondary care

Overall digital maturity

Analysis of published data on digital maturity in NHS Trusts illustrates a patchy picture. NHS England’s Digital Maturity Index (DMI) scored Trusts on three core metrics: capability, infrastructure and readiness. Figure 5 shows that scores varied by more than a factor of three between the best and the worst performers.

Figure 5: Distribution of scores for Digital Maturity Index by NHS Trust (average across three dimensions)



Source: SMF analysis of NHS England DMI data

Across all categories, scores for digital performance were lowest on average in ‘Medicines Management’, ‘Remote and Assistive Care’ and ‘Decision Support’. This is concerning given that these approaches have huge potential both in care delivery and prevention strategies.

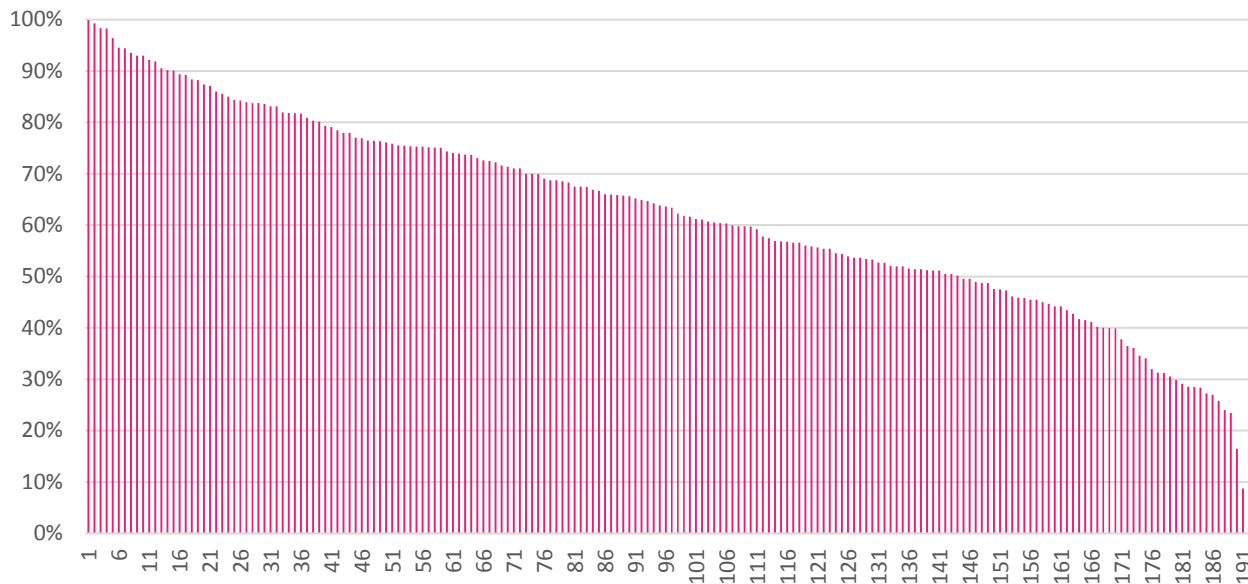
Our analysis suggests that variation between Trusts is not driven by scores on subjective measures on digital maturity but also by actual take-up and use of technology. Indeed, it is worrying that average scores are lower on objective measures (such as usage of digital systems). A recent study into use of digital services in maternity services revealed that even in this particular aspect of NHS there is huge variation, with scores varying on some measures from 0 to 100.⁵⁵

Given that all Trusts and CCGs operate under the same performance and incentives regime it is unclear why this level of variation occurs. Analysis suggests that while some Sustainability and Transformation Partnership (STP) areas out-perform others on digital maturity, all STPs contain some weaker Trusts.⁵⁶ A similar picture emerges for local maternity services (LMS) digital maturity: all LMS areas with a low score share a boundary with a LMS with a high score.⁵⁷ However, past analysis on adoption of health innovations in GP practices has suggested that clustering can play a part with shared learning, coordination and training.⁵⁸ Therefore, although they are not clear cut, there are likely to be some regional factors at play. Research has suggested that size may also influence adoption: larger providers are more likely to be early adopters than smaller providers.⁵⁹ This may be due to expertise and capacity, access to capital, and economies of scale in adopting new technologies.

Research by the CQC found that trusts with good and outstanding ratings had better digital systems in place.⁶⁰ Trusts with 'Outstanding' ratings had average DMI scores of 89% compared to 74% for Trusts rated 'Requires Improvement' and 72% for those rated 'Inadequate'.

Part of the problem is at the interface between primary and secondary care. The Topol Review highlighted the importance of health IT infrastructure especially with respect to interoperability across secondary, primary and social care. Again, here the performance picture is very mixed. Research by the SMF has previously shown that the use of digital interactions between primary and secondary care varies between CCGs by a factor of two.⁶¹ Figure 6 shows that utilisation of e-referrals differs hugely between CCGs.

Figure 6: Utilisation of the NHS e-referral service to enable choice at first routine elective referral by CCG, (12-month average, August 2017 to July 2018)



Source: SMF analysis of CCG IAF Data Extract, Average Aug 2017 to July 2018, <https://www.england.nhs.uk/publication/ccg-iaf-data-extract/>⁶²

Pagers: a warning from Japan

According to a CommonTime assessment based on FOI disclosures, the NHS in England uses around 130,000 pagers at an annual cost of £6.6 million.⁶³ The use of pagers has been the focus of much political debate, with the devices often held up as a sign of the service's slow uptake of new technology. Advocates of pagers argue that they are a robust communications system offering greater reliability than mobile phones.

The debate about pagers has largely overlooked a central and troubling fact about the market for paging services in the UK: it is a monopoly. Since the closure of Vodafone's pager business in 2018, the UK has had only one significant pager provider, PageOne, which is part of the Capita Group.

Monopoly supply creates many problems, not least the risk of customers paying excessive prices. But more important in this context is continuity of provision. Here, the NHS should urgently consider a warning from Japan.

In December 2018, Tokyo Telemessage announced it was ending its pager services.⁶⁴ The company had been the last provider of pagers in Japan. The decision left its 1,500 remaining customers without a pager service. Among those customers were hospitals and other healthcare services.

The Japanese experience has gone largely unnoticed in the British healthcare debate, but it suggests that, whatever operational advantage NHS bodies and professionals see in the use of pagers, it would be prudent to ensure that the service has proper contingency plans in place for operating without those pagers. Relying on a single supplier for what is said to be vital technology exposes the NHS, and thus patients, to significant risk.

The future potential in secondary careTechnologies that drive up patient safety and free up resources

There are a number of quicker wins where technologies could deliver improved safety, better health outcomes and lower costs. For instance, research by the LSE has suggested that the use of automated timekeeping systems offer significant safety gains in ensuring effective staff on wards as well as at least £31m.⁶⁵ Selling this to professionals is important because it may otherwise be perceived as a staff surveillance technique.

Wearable devices and tracking patients

Teletracking of patients can make sure that patients are put in a bed appropriate to their needs, as well as better managing the availability of beds so that patients are seen within the required time periods.⁶⁶ University College Hospitals London NHS Foundation Trust has recently introduced a scheme to better track patients. By giving patients wristbands, the hospital is able to track when beds become empty and available and when a bed needs cleaning following a patient's discharge from hospital, as well as monitoring where patients are in their treatment stage.⁶⁷

Remote monitoring and analysis

Electronic monitoring systems that allow experts to remotely observe the progression of patients' health and responses to interventions have been introduced in hospitals in the USA and at St Thomas' NHS Foundation Trust. These can have multiple potential benefits – enabling

remote oversight by specialists, as well as building up large reservoirs of data on diseases and interventions, that can in turn inform AI and machine learning and new treatments.⁶⁸

Expanding the role of AI in diagnosis

Artificial Intelligence (AI) is already being used within the NHS to improve the early diagnosis of heart disease and lung cancer.⁶⁹ Following a scan for cancer it can take a significant amount of time for a radiologist to review the images. Artificial intelligence can be used to review these images and improve diagnose cases of cancer sooner.

There is likely to be huge further potential. Academics at Stanford University have developed a radiology model which can predict the probability of abnormality by using images. It achieved performance comparable to that of radiologists.⁷⁰ Such developments could mean quicker diagnoses, with radiologists able to focus on more complex cases.

The partnership between Moorfields Eye Hospital NHS Foundation Trust and DeepMind Health has been testing how accurately an AI system can give referral decisions for over 50 eye diseases. In 2018, the initiative reported that decisions can be made with 94% accuracy, matching world-leading eye experts. Using such technology could enable professionals to identify conditions earlier and prioritise patients with the most serious eye diseases before irreversible damage occurs.⁷¹

STAGE 5 OF THE PATIENT JOURNEY: MANAGING LONG-TERM CONDITIONS

At present, £7 out of every £10 spent on the health and social care budget is attributed to caring for people with long-term conditions. People with long-term conditions account for 50% of all GP appointments, 64% of all hospital outpatient's appointments, 70% of all inpatient bed days.⁷² Allowing patients with long term conditions to remotely monitor and manage their own conditions could have considerable time and cost savings for the NHS and for patients. The Topol Review suggests that in the future many aspects of care will shift closer to the home.⁷³

The current landscape of technology in the management of long-term conditions

Remote monitoring

Individuals can use technology to regularly monitor their blood pressure and blood glucose levels, an important task for those with diabetes. The NHS announced in November 2018 it would end the current level of variation in the availability of Freestyle Libre for those with Diabetes in some parts of the country.⁷⁴ Freestyle Libre is a wearable sensor that does away with the need of finger prick blood tests by relaying glucose levels to a smart phone or e-reader. From April 2019, eligible patients will be able to receive the product on prescription. It is estimated that at present only around 3% to 5% of patients with Type 1 diabetes have access to this technology, however if the CCGs follow the NHS guidance correctly, this should increase to at least 20 to 25%.⁷⁵

App based condition management

The Innovation and Technology Payment (ITP) was introduced to incentivise the adoption and spread of transformational innovation in the NHS, including the use of the MyCOPD app.⁷⁶ The app allows patients to manage their Chronic Obstructive Pulmonary Disease (COPD), and it includes functions such as advice on suggested inhaler techniques and the ability to track medication.⁷⁷ The ITP reimburses CCGs that prescribe the MyCOPD to patients with COPD. This condition costs the NHS more than £1bn a year, treatment is complex and compliance with treatment is often extremely low, leading to poor outcomes and potentially wasteful prescribing. As a result, helping patients to self-manage their COPD is a priority for the NHS.

The NHS now has its own app known as 'The NHS App', to be rolled out publicly in early 2019.⁷⁸ At present, the app focuses on booking appointments, ordering repeat prescriptions and the checking of symptoms. The *NHS Long Term Plan* states that "digital-first primary care will become a new option for every patient".⁷⁹ There is potential for this app to have video consultation and to harness other innovative technologies.

Such approaches could be particularly beneficial to those with long-term conditions, because these conditions may impact an individual's ability to regularly attend GP surgeries. For these individuals video consultation could be a way to better manage their symptoms and have more regular interaction with their GP, leading to improved health outcomes for this group. However, the NHS will need to keep up with technological change within the healthcare sector if it is to engage patients at scale. Patients will not want to engage with outdated and clunky systems when most of their online interactions are easy and frictionless.

Mental health management

The NHS app library contains a range of offerings focused on managing depression and anxiety. Many of these tools offer cognitive behavioural therapy (CBT) through alternative means. Some of these apps need to be purchased or offer in-app purchases and others are available for free depending upon the location of the individual. Digital tools can be used to improve access to therapy for those who do not wish to take up face-to-face options. This form of online interaction will not be appropriate for everyone or for certain types of mental health conditions. The use of digital technology appears likely to be an important area of future development and worthy of further detailed analysis.

The future potential for condition management

The pace of technological development suggests that wearables have potential to play a much larger role in future management of long-term conditions. At present, many devices tend to focus on heart rate tracking and step monitoring enabling individuals to better monitor and take ownership of small segments of their overall health. The next generation of wearables could be designed to gather clinical grade patient data and offer condition management facilities. If the next generation of wearable technology included facilities to help manage, as well as prevent, diabetes, uptake could be significant. In this case the NHS may find that for certain individuals there would be a preference to manage their diabetes through a device with additional features, or that they already own, rather than the specific diabetes monitor that is currently being rolled out across England.

Integrating health management into devices individuals already own or want to own could take the burden off the NHS to provide this type of technology to consumers. However, we note the risk that this could impact the quality of care for individuals who cannot afford these items. This may lead to differential outcomes for patients with differing levels of income or wealth, adding further to existing health inequalities.

POLICY PROPOSALS: UNLOCKING THE POTENTIAL OF DIGITAL TECHNOLOGY FOR BETTER HEALTHCARE

Below we set out six policy proposals. Many of these are cross-cutting reforms that could improve the care experience across the patient journey.

Putting ‘digital’ into the NHS constitution

Given the huge variation across the country on many measures and the sluggish use of electronic patient records, ‘digital’ should be written into the NHS Constitution, which enshrines legal rights that patients have recourse to. The last major iteration of the NHS Constitution took place in 2015. It is due to be renewed every decade. However, there is a strong case to set out new constitutional changes alongside the *NHS Long Term Plan*. Currently, digital and technology are notable by their absence in the NHS Constitution⁸⁰ – in terms of how patients receive information, services and make appointments. It should be a basic right that NHS services are available in a digital form where wanted.

We also believe that progress measures should be charted to set out how key digital objectives will be achieved over the next ten years and enshrined in the constitution. This would put providers’ and commissioners’ feet to the fire.

Recommendation

Digital rights should be enshrined in the NHS Constitution. These should build on commitments in the *NHS Long Term Plan* and go further. For instance, patients should have the right to a digital patient pathway if appropriate – from booking appointment and e-Prescriptions, to remote consultation, to secure messaging and e-support from consultants and specialists, through to immunization records and updates, data entry and smart links to smartphone technology allowing uploading of measurements.

Opening a public debate on Electronic Patient Records

There are multiple reasons why digital records and data have the potential to drive a revolution in healthcare: it should be much easier for providers to assess their performance relative to others; data on treatment outcomes can be measured and understood, enabling better development and targeting of treatments based on patient’s specific conditions and underlying characteristics; patients will be able to manage their care pathways digitally and access their records and take appropriate action; and population patient management can help effective targeting of at-risk groups.⁸¹ As such electronic records properly updated and shared underpin many of the improvements described in this report. Some NHS Trusts, including so-called Global Digital Exemplars, are pointing the way to exciting initiatives.⁸²

There would be huge benefit if patients were able to pursue a digital journey through their whole care journey. This could include making appointments, viewing their care record and care plan and requesting e-Prescriptions. Beyond this, it could include immunization records and updates; organ donation preferences; secure messaging with health professionals; data entry and smart links to smartphone technology allowing uploading of measurements (i.e. blood sugar levels, weight). A 2012 public poll cited in Nuffield Trust research showed that 80% of patients would like to view their medical records online.⁸³

As discussed earlier, take-up of EPRs by patients is minimal, although much of the underlying technology infrastructure appears to be in place.

The *NHS Long Term Plan* commits to enable all mothers to access their maternity record digitally by 2023 and that all patients with a long-term condition be able to access their health record via the NHS App by 2020.⁸⁴

There is scope to be much bolder, although this will include the NHS taking the public with it.

Past studies have suggested that a wide range of factors can affect individuals' take-up and use of EPR portals, including privacy concerns, views on the motives of the provider, security concerns and practical issues.⁸⁵

However, there are also reasons to be optimistic. First, part of the problem is caused by misinformation and incomplete information. A review found that there is a widespread misconception about the difference between anonymised data and its use, versus the role of personal care records.⁸⁶ Second, work on public attitudes suggests that the concept of 'public benefit' is central to public acceptance of data sharing. In such cases a large majority of the public report being in favour of using patient data. Indeed, the public become more positive as they become more informed through deliberative processes. Separately, we know that public trust in the NHS, doctors and nurses is extremely high.⁸⁷

Third, there are reasonable misgivings about the NHS's ability to safeguard patient data, which can affect public attitudes to data. In 2017, the WannaCry ransomware affected around one in three NHS Trusts and 595 GP practices. Thousands of operations and appointments were cancelled.⁸⁸ High profile events may damage trust. Recent research suggested that one in five individuals (20%) are not confident in the ability of the NHS to protect their patient data.⁸⁹

However, many still favour a national system of EPR. A survey of the public found that half (53%) said their confidence in the ability of the NHS to handle data was negatively affected by the Wannacry incident, but three quarters (77%) reported confidence in the ability of the NHS to protect their patient data. One study found that while 71% shared doubts that the NHS can guarantee security of EPRs, over half (54%) of these respondents would still favour development of national EPR.⁹⁰ In part this appears to be because the public generally trust the motivations of the NHS. As the Topol Review argues, robust ethical and security frameworks and measures must underpin EPRs.

These factors all indicate significant potential to win public consent and take-up. They also highlight a wider failure to openly debate the role of information in healthcare and to sell the benefits to the public. This issue should also be seen in wider social context. The last decade has seen a dramatic change in public habits around technology and personal data. Smartphones that routinely share user data with third parties are a staple of many lives and despite some concerns about personal privacy, user-numbers and the volumes of data that people share continue to increase. In other areas of policy, especially economic regulation, this has sparked a lively debate about personal ownership of data and the advantages it could bring (see, for instance, the March 2019 Furman Review for HM Treasury⁹¹.) The debate on personal health data should catch up with those trends, and Government could play a useful role in driving that conversation forwards.

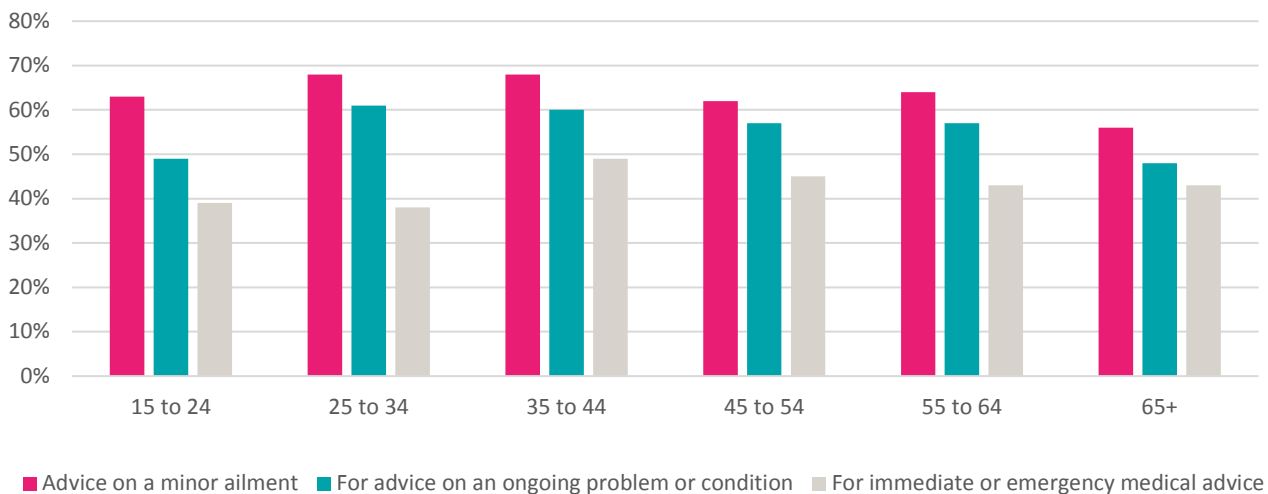
Recommendation

- **The Government should initiate an honest public debate on electronic patient records and how information is used for the patient and the wider healthcare system. As part of this:**
 - **The Government should explain the value of patients sharing their personal information. This could include publishing an annual analysis of the estimated value of patient data to the public and NHS users, in terms of treatments developed and made available, health improvements and efficiencies recorded.**
 - **Ensure that opting out is straightforward and easy. The ‘National Opt-out’ is an important policy and operates on the basis that patient records and data belong to the patient and that consent is required if that data is to be shared and used more widely.⁹² As of December 2018, more than 1.6 million NHS patients in England have opted out of having their data shared for research purposes.⁹³**

Establishing clear target patient groups for digital technology

Research commissioned by the Health Foundation found that there is a willingness from the public to participate in video consultations with their GP and there was little variation between the age groups, 63% of 15–24 year olds being willing to consult with their GP via video for a minor ailment compared to 56% of over 65s.⁹⁴

Figure 7: Public willingness to use video consultations with own GP



Source: Ipsos MORI polling commissioned by The Health Foundation (2018) Base: 2,083 adults 15+ in the UK

Research also reveals some differences in willingness to engage with technology by household income, with those on higher incomes more willing to engage with video consultations.⁹⁵ At the same time, there is a link between socio-economic status and the likelihood of developing certain conditions. For instance, technology is already being used to help manage conditions such as heart disease and COPD where there is a link to age and socio-economic status. If those who would benefit the most are unwilling to engage with technology the benefits of technological innovation within the NHS are unlikely to be felt universally or equally. The trend towards digital engagement is particularly strong in some health service areas, such as maternity services, where nine in ten users report that they would use digital technology to access information and access their maternity records.⁹⁶

Based on our analysis, we propose that priorities for the NHS should include making a digital offer available to patients who already have the digital tools and devices to engage, as well as where digital can have the most impact, such as for those with long-term conditions.

Recommendation

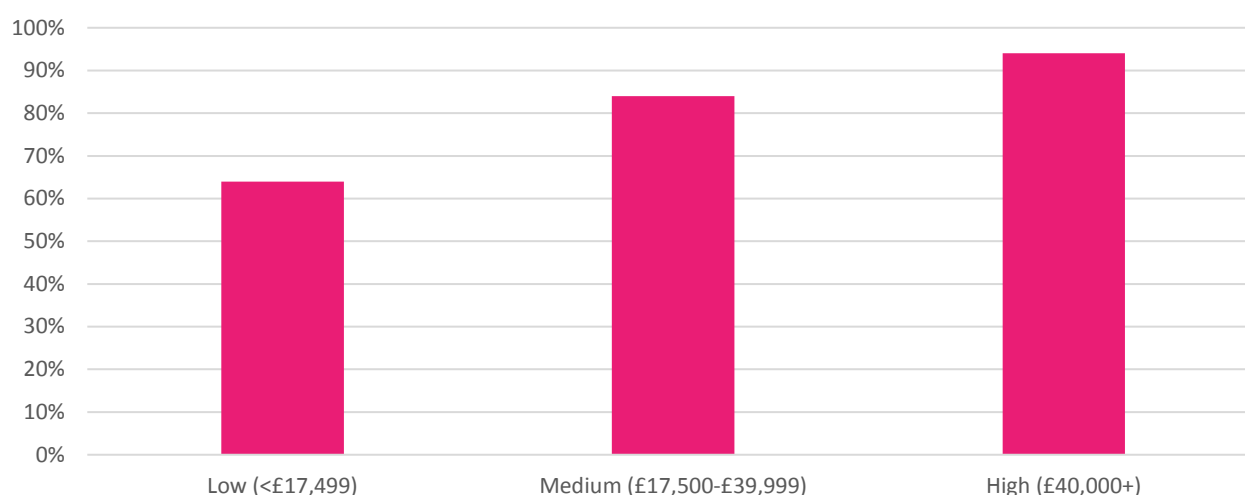
The NHS should establish clear priorities for digital and technology services including promoting access among the digitally-enabled and promoting digital access among individuals with long-term conditions.

Prescribing digital skills for health management

There is a risk that many of those who have the most to gain from condition self-management technology do not have the digital skills to benefit. There is potential to use the Government's ambition to increase the use of social prescribing to help address this issue.

Putting patients in charge of managing their conditions through technology means patients must be able to navigate the technology and use it correctly to benefit fully. In 2018, 90% of households in the UK had internet access and 89% of adults used the internet at least weekly in 2018, up from 51% to 2006.⁹⁷ However, one fifth of adults in the UK (21%) do not have all five basic digital skills, with 16% not able to fill out an online application form. In addition, 25% of those with a registered disability are offline.⁹⁸ Those with the lowest household incomes are the least likely to have basic digital skills. Separately, we know that those on the lowest incomes are more likely to have several comorbidities and they are also the group least likely to have strong digital skills.

Figure 8: Basic Digital Skills, by household income (2018)



Source: Lloyds Bank (2018)

Research by Lloyds has shown that for one in three of those aged over 60 digital skills could help them improve their health and to feel less alone. Lessons can be learnt from the NHS's widening digital participation agenda and the current pilots which are ongoing as part of the second phase of this project.⁹⁹ However, engagement is only part of the issue and the NHS should focus on the core skills needed, particularly as technology becomes more complex and necessary within healthcare.

Recommendation

The NHS should prescribe digital skill classes to those who struggle to keep up with advances in technology or for whom increased digital skills would lead to improved health and wellbeing outcomes.

Equalising access to health-improving devices

Access to improved health outcomes should not be limited by a person's ability to pay for innovative technology. The range of smart home devices on the market, and in development, that have health related tools on offer is growing fast, such as, smart scales that allow health providers to monitor changes in the weight of patient's post-surgery allowing individuals to be discharged from hospital sooner. If personal technologies, such as wearables or smart home devices become a primary delivery channel for improving health outcomes, there is a significant risk that only those who can afford the latest devices are able to benefit. The Topol Review stresses that whilst technology has the potential to reduce health inequalities, there is a significant risk that it could also exacerbate them. The review states that consideration must be given to how health technologies impact equity and equality of access, two of the founding principles of the NHS.¹⁰⁰

This raises the question of how technology may influence the ability of the NHS to continue to offer a universal service accessible to all, if those from the most affluent backgrounds have better access to cutting edge health technology.

The NHS is piloting schemes that allow CCGs to offer fitness trackers to individuals. While it is too early to know whether this intervention is good value for money, the principle should be considered more widely. In addition, the NHS should consider the equality of access to different technologies when it makes decisions on its digital offer.

Recommendation

The NHS should prescribe personal technology where needed to individuals who would be unable to purchase these items themselves to ensure equal outcomes for all patients regardless of income.

Instilling IT interoperability

Despite progress, the *NHS Long Term Plan* acknowledged that 'the NHS is made up of hundreds of separate but linked organisations, and the burden of managing complex interactions and data flows between trusts, systems and individuals too often falls on patients and clinicians'.¹⁰¹

Establishing a more joined-up digital system requires greater emphasis on interoperability of data and systems. Public and political concern about previous NHS IT projects led to paralysis for many years. Policymakers have also wrestled with the inherent conundrum of how far to allow local discretion and innovation and how far to ensure systems are interoperable. Poor interoperability leads to higher costs (because of loss of economies of scale), and it worsens the care journey because patients must wait for longer for information to be shared properly. Recent comments

from the NHS are reassuring. These set out commitments to prioritise interoperability, and to establish modular systems that can function together but that can also be open to competition and innovation from outside.¹⁰²

As the research has shown above, many hospitals and GPs – let alone the wider social care system – are unable to share records digitally and consistently.¹⁰³ Recent policy announcements indicate that the NHS recognises the importance of systems that are open to innovations from outside but also able to speak to each other.¹⁰⁴

Recommendation

The NHS should pursue its policy of interoperability as a priority project.

ENDNOTES

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- ¹ NHS, *The Topol Review: Preparing the healthcare workforce to deliver the digital future - An independent report on behalf of the Secretary of State for Health and Social Care* (2019)
- ² NHS, *Policy paper: The future of healthcare: our vision for digital, data and technology in health and care* (2016)
- ³ Candace Imison, Sophie Castle-Clarke, Robert Watson and Nigel Edwards, *Delivering the benefits of digital health care* (2016)
- ⁴ *Preparing the healthcare workforce to deliver the digital future: The Topol Review - An independent report on behalf of the Secretary of State for Health and Social Care* (NHS, 2019)
- ⁵ <https://www.gov.uk/government/publications/prevention-is-better-than-cure-our-vision-to-help-you-live-well-for-longer>
- ⁶ NHS, *The NHS Long-term Plan* (2019)
- ⁷ Masters et al., 'Return on investment of public health interventions: a systematic review', *BMJ*, 2017 - the return on investment estimate is a median of a review of published interventions worldwide (and not just limited to health interventions), and is total social return and is therefore not only healthcare savings. As seen in *Prevention is better than cure* (2018)
- ⁸ <https://www.gov.uk/government/publications/prevention-is-better-than-cure-our-vision-to-help-you-live-well-for-longer>
- ⁹ <https://www.nhs.uk/live-well/healthy-body/top-5-causes-of-premature-death/>
- ¹⁰ <https://www.nhs.uk/oneyou/active10/home>
- ¹¹ Ibid.
- ¹² Ibid.
- ¹³ <https://www.nhs.uk/conditions/nhs-health-check/check-your-heart-age-tool/>
- ¹⁴ <https://www.england.nhs.uk/2017/11/thousands-of-people-set-to-access-diabetes-and-obesity-prevention-services-through-the-touch-of-a-button/>
- ¹⁵ <https://www.england.nhs.uk/2017/11/thousands-of-people-set-to-access-diabetes-and-obesity-prevention-services-through-the-touch-of-a-button/>
- ¹⁶ <http://nuijer.com/>
- ¹⁷ <http://nuijer.com/>
- ¹⁸ NHS, *The NHS Long-term Plan* (2019)
- ¹⁹ NHS, *The NHS Long-term Plan* (2019)
- ²⁰ Ofcom, *Communications market report* (2018)
- ²¹ <https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2018>
- ²² <https://www.sciencedaily.com/releases/2016/08/160830091817.htm>
- ²³ NHS England, *TECS evidence base review: Findings and recommendations* (2017)
- ²⁴ <https://www.nhs.uk/live-well/exercise/why-sitting-too-much-is-bad-for-us/>
- ²⁵ <https://www.theguardian.com/lifeandstyle/us-money-blog/2015/may/01/employers-tracking-health-fitbit-apple-watch-big-brother>
- ²⁶ <https://www.gov.uk/government/news/government-announces-plans-for-earlier-diagnosis-for-cancer-patients>
- ²⁷ <https://www.england.nhs.uk/cancer/case-studies/c-the-signs-how-artificial-intelligence-ai-is-supporting-referrals/>
- ²⁸ <https://www.england.nhs.uk/2019/02/lung-trucks/>
- ²⁹ <https://www.england.nhs.uk/2019/02/lung-trucks/>
- ³⁰ <https://yougov.co.uk/topics/politics/articles-reports/2017/04/24/what-does-future-hold-wearables>
- ³¹ <https://www.wired.com/story/with-ai-your-apple-watch-could-flag-signs-of-diabetes/>
- ³² NHS, *Topol Review* (2019)
- ³³ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5504539/>; <https://ebm.bmj.com/content/23/1/1>
- ³⁴ NHS, *The NHS Long-term Plan* (2019)
- ³⁵ <https://beta.nhs.uk/book-a-gp-appointment/>
- ³⁶ NHS England data, CCG report (August 2018 publication), Contains data collected from Jan - April 2018
- ³⁷ <https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/oct-2018>
- ³⁸ Porter (2013) Adoption of Electronic Health Records in the United States cited in https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/444921/RAN_D_final.pdf
- ³⁹ Candace Imison, Sophie Castle-Clarke, Robert Watson and Nigel Edwards, *Delivering the benefits of digital health care* (2016)
- ⁴⁰ The GP Patient Survey: CCG report (August 2018 publication)
- ⁴¹ NHS England, *TECS evidence base review: Findings and recommendations* (2017)
- ⁴² <https://www.digitalhealth.net/2018/06/salford-royal-introduces-first-of-kind-smartphone-urine-test-for-renal-patients/>
- ⁴³ <https://www.digitalhealth.net/2018/06/salford-royal-introduces-first-of-kind-smartphone-urine-test-for-renal-patients/>

- ⁴⁴ Y Duan, Z Xie, F Dong, Z Wu, Z Lin, N Sun & J Xu, 'Effectiveness of home blood pressure telemonitoring: a systematic review and meta-analysis of randomised controlled studies', *Journal of Human Hypertension* volume, 31, pages 427–437
- ⁴⁵ Sophie Castle-Clarke, *What will new technology mean for the NHS and its patients? Four big technological trends* (Health Foundation et al, 2018)
- ⁴⁶ *Preparing the healthcare workforce to deliver the digital future: The Topol Review - An independent report on behalf of the Secretary of State for Health and Social Care* (NHS, 2019)
- ⁴⁷ <https://www.gpathand.nhs.uk/>
- ⁴⁸ <http://www.pulsetoday.co.uk/news/gp-topics/it/babylon-gp-at-hand-given-green-light-to-expand-nhs-services-to-birmingham/20038252.article>
- ⁴⁹ <https://blogs.bmj.com/bmj/2018/08/07/technology-enabled-remote-consulting-save-time-add-value-primary-care/>
- ⁵⁰ <https://www.pushdoctor.co.uk/pricing>
- ⁵¹ <https://www.gponline.com/gps-raise-alarm-cqc-failure-report-fast-growing-gp-hand/article/1578691>
- ⁵² OBR, *Fiscal sustainability and public spending on health* (September 2016)
- ⁵³ *Making IT Work: Harnessing the Power of Health Information Technology to Improve Care in England - Report of the National Advisory Group on Health Information Technology in England* (2016)
- ⁵⁴ Lord Carter, *Operational productivity and performance in English NHS acute hospitals: unwarranted variations* (2016)
- ⁵⁵ <https://www.england.nhs.uk/wp-content/uploads/2018/11/national-maternity-dma-report.pdf>
- ⁵⁶ 'Assessing the digital maturity of the English NHS', *HSJ*, 23 June 2017
- ⁵⁷ <https://www.england.nhs.uk/wp-content/uploads/2018/11/national-maternity-dma-report.pdf>
- ⁵⁸ *Which doctors take up promising ideas?* (Nesta, 2014)
- ⁵⁹ *Which doctors take up promising ideas?* (Nesta, 2014)
- ⁶⁰ https://www.cqc.org.uk/sites/default/files/20170302b_stateofhospitals_web.pdf
- ⁶¹ Nigel Keohane, *The NHS, innovation and productivity* (SMF, 2018)
- ⁶² Note, we excluded four Trusts which had scores of over 100%.
- ⁶³ <https://www.commonstime.com/uploads/webpage-documents/d4d76400-aa13-43a9-8974-2ec520de52a1.pdf>
- ⁶⁴ <https://english.kyodonews.net/news/2018/12/efd26c33c80b-pager-services-to-end-in-japan-after-50-years.html>
- ⁶⁵ *NHS Safe Staffing: not just a number* (2014)
- ⁶⁶ <https://improvement.nhs.uk/news-alerts/pilot-trusts-using-real-time-technology-increase-bed-capacity/>
- ⁶⁷ <https://www.uclh.nhs.uk/News/Pages/Newsystemlaunchestoimprovepatientmovementthroughhospitalandreduceelays.aspx>
- ⁶⁸ [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6132188/;](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6132188/)
- ⁶⁹ <https://www.gov.uk/government/news/new-guidance-to-help-nhs-patients-benefit-from-digital-technology>
- ⁷⁰ Pranav Rajpurkar, 'MURA Dataset: Towards Radiologist-Level Abnormality Detection in Musculoskeletal Radiographs', <https://arxiv.org/pdf/1712.06957.pdf>.
- ⁷¹ <https://www.moorfields.nhs.uk/content/breakthrough-ai-technology-improve-care-patients>
- ⁷² Department of Health, *Long term conditions compendium of information: third edition* (2012)
- ⁷³ NHS, *Topol Review* (2019)
- ⁷⁴ <https://www.england.nhs.uk/2018/11/nhs-to-provide-life-changing-glucose-monitors-for-type-1-diabetes-patients/>
- ⁷⁵ <https://www.england.nhs.uk/2018/11/nhs-to-provide-life-changing-glucose-monitors-for-type-1-diabetes-patients/>
- ⁷⁶ NHS England, *The NHS England Innovation and Technology Tariff 2017 to 2019 Technical notes* (2017). Previously called the Innovation and Technology Tariff.
- ⁷⁷ <https://apps.beta.nhs.uk/mycopd/>
- ⁷⁸ <https://www.longtermplan.nhs.uk/blog/transforming-healthcare-in-the-digital-age/>
- ⁷⁹ NHS, *The NHS long term plan* (2019)
- ⁸⁰ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/480482/NHS_Constitution_WEB.pdf
- ⁸¹ Sophie Castle-Clarke, *What will new technology mean for the NHS and its patients? Four big technological trends* (Health Foundation et al, 2018)
- ⁸² <http://www.srft.nhs.uk/media-centre/latest-news/news-archive/news-2017/salford-royal-partners-with-validic-on-new-integrated-care-model-with-personal-health-data/>
- ⁸³ <https://www.nuffieldtrust.org.uk/files/2017-01/delivering-the-benefits-of-digital-technology-web-final.pdf>
- ⁸⁴ NHS, *The NHS Long-term Plan* (2019)
- ⁸⁵ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5499062/>
- ⁸⁶ http://understandingpatientdata.org.uk/sites/default/files/2018-08/Public%20attitudes%20key%20themes_0.pdf
- ⁸⁷ https://www.ipsos.com/sites/default/files/ct/news/documents/2018-11/veracity_index_2018_v1_161118_public.pdf

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- ⁸⁸ <https://www.nao.org.uk/wp-content/uploads/2017/10/Investigation-WannaCry-cyber-attack-and-the-NHS.pdf>
- ⁸⁹ https://www.comresglobal.com/wp-content/uploads/2018/05/J303743_Healthwatch_Patient-Data-Survey_Tables_March-18.pdf
- ⁹⁰ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4607170/>; <https://wellcomeopenresearch.org/articles/3-6/v1#ref-36>
- ⁹² <https://digital.nhs.uk/about-nhs-digital/our-work/keeping-patient-data-safe/how-we-look-after-your-health-and-care-information/your-information-choices/opting-out-of-sharing-your-confidential-patient-information>; <https://www.nhs.uk/your-nhs-data-matters/>
- ⁹³ NHS Digital, *National data opt-out: December 2018* (2018)
- ⁹⁴ Ipsos MORI polling commissioned by The Health Foundation.
- ⁹⁵ Ipsos MORI polling commissioned by The Health Foundation.
- ⁹⁶ <https://www.england.nhs.uk/wp-content/uploads/2018/11/national-maternity-dma-report.pdf>
- ⁹⁷ ONS, *Internet access – household and individuals: Great Britain: 2018* (2018)
- ⁹⁸ Lloyds Bank, *UK consumer digital index 2018* (2018)
- ⁹⁹ <https://digital-health-lab.org/>; Good Things Foundation, *Socially prescribing digital skills Evaluation* (2018)
- ¹⁰⁰ NHS, *Topol Review* (2019)
- ¹⁰¹ NHS, *The NHS Long-term Plan* (2019)
- ¹⁰² NHS, *Policy paper: The future of healthcare: our vision for digital, data and technology in health and care* (2016)
- ¹⁰³ *Making IT Work: Harnessing the Power of Health Information Technology to Improve Care in England – Report of the National Advisory Group on Health Information Technology in England* (2016)
- ¹⁰⁴ <https://www.england.nhs.uk/digitaltechnology/connecteddigitalsystems/interoperability/>