

Powerful Patients, Paperless Systems

How new technology can renew the NHS

By Alan Mak MP

Foreword by the Rt Hon Jeremy Hunt MP



**NEW
GENERATION**



About Alan Mak MP

Alan Mak was elected as the Conservative Member of Parliament for Havant in May 2015, succeeding former Cabinet Minister David Willetts, and re-elected in June 2017.

He led the first ever debate on the Fourth Industrial Revolution (4IR) in Parliament in September 2016, founded the APPG on the 4IR in October 2016 and formally launched it in March 2017 with the Chancellor, Philip Hammond. Alan's main political interests are the economy, technology and social mobility. He is also Co-Chairman of the APPGs for Entrepreneurship, and for Apprenticeships; and Chairman of the 1922 Committee's International Trade Policy Sub-Committee. Alan is currently Parliamentary Private Secretary (PPS) to the Secretary of State for Business, Energy & Industrial Strategy, having previously served as a PPS in the Ministry of Justice.

Before his election, he started and ran his own business, having begun his career at Clifford Chance LLP in the City advising some of the world's largest businesses. He has invested in a number of tech start-ups. Alan was born and grew up in York, and read law at Peterhouse, Cambridge University where he won the ECS Wade Prize for Administrative Law.

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Foreword



By the Rt Hon Jeremy Hunt MP

Across the world, new technology is transforming healthcare, with medical innovations set to transform

humanity in the next 25 years in the same way as the Internet has done in the last 25. The breakthroughs, disruption and progress we have seen in other walks of life are now sweeping through healthcare, and we can ensure our NHS harnesses their benefits like no other healthcare system.

As I set out last year in a speech at the Health and Care Innovation Expo, the “master-servant” relationship between doctors and patients is being vanquished by new technology. Control will soon be at the fingertips of patients through smartphones and computers, while clinicians will be granted more freedom and assistance by the technologies at their disposal.

My ambition is to harness that potential to ensure patients can benefit from a truly digital NHS, ushering in a new era of patient power.

As Alan Mak sets out in this excellent report, by embracing the future, the NHS can continue to flourish for the next 70 years and beyond. Staff and patients are often at the sharp end of driving this change and the Government is doing its bit by providing the necessary vision, policy framework and funding. Through the Personalised Health and Care 2020 Programme we are spending £4.2 billion bringing hospital IT and online services for patients up to date.

Our plans to improve patient choice and access through technology include the new NHS app – which will enable patients to access a number of digital services through a single app including the ability to book appointments, contact the online 111 service, order repeat prescriptions, and access and add to their GP record, as well as control how their personal data is used beyond their direct care.

This report makes a clear and consistent argument that the healthcare of tomorrow will be driven by big data, AI, automation and connectivity, which is why the NHS must be a global leader in these fields. Much work is already under way, delivering the vision of the Life Sciences Industrial Strategy and Personalised Health and Care 2020.

The first Life Sciences Sector Deal was published on 6 December, and includes action related to research, the technologies of the future and the evolution of clinical trials, alongside substantial government support for direct and indirect investment to support growth. The deal will draw in substantial investment to the technology and life sciences sectors, ensuring that the next wave of breakthrough treatments, innovative medical research and technologies, and highly skilled jobs are created in Britain and harnessed by the NHS.

While ensuring that the NHS is fit for the future is a key priority, we know that improvement is a continuous process. That’s why I welcome new ideas from parliamentary colleagues – including many of the recommendations in this report – and innovative platforms such as the CPS’s “New Generation” project which help develop policies that deliver a better future for us all.



Introduction

This year, the NHS celebrates its 70th anniversary. It is a service the British people both cherish and rely on – including my family.

And it is a service the Government are determined to protect. Recently, for example, the Prime Minister committed to providing a long-term funding settlement for its future. We have already seen record levels of investment since 2010, including increases in training places for doctors and nurses and the biggest capital investment programme for over a decade.

But additional funding is not all the NHS needs. Today, we are witnessing an unprecedented fusion of new technologies that blur the traditional boundaries between the physical, digital and biological spheres – termed the Fourth Industrial Revolution (4IR). Breakthroughs in fields such as AI, the Internet of Things, drones, 3D printing, personalised medicines and nanotechnology are already transforming many aspects of our economy and society.

If we are to strengthen and renew the NHS, we need to embrace this technology to empower patients – putting them at the heart of a reformed, digital-first NHS. Patients with the latest information about their health at their fingertips – from personal test results to reviews of their local hospital – can make more informed choices and exert greater control over their treatment.

We know that the quality of care is jeopardised if the patient voice is not heard and respected – and when patients are ignored, they are most at risk. We also know that too often, the NHS has not always utilised technology as effectively as possible – and that often top-down, centralised technology projects have wasted billions.

The argument of this report is that we have an historic opportunity to strengthen the NHS, empower patients and support doctors which we must seize. As Conservatives, we must support technology to transform the NHS.

We must make the NHS paperless and wholly digital. Pagers, fax machines and paper records must be replaced by integrated digital systems that provide patients and those that care for them with the latest medical data that can be easily stored and shared between GP surgeries, hospitals and other care providers. Every system the NHS uses, whether for data storage, messaging and communication or any sort of patient care and integration should be digital – paperless systems must become the norm and not the exception. New apps and messaging services must be introduced to allow doctors and nurses to communicate more easily; the NHS must invest heavily in incubating new innovations; and NHS staff must be up-skilled to use new technologies as automation, virtual reality (VR) and personalised medicines become more commonplace.



However, we must avoid top-down “big bang” approaches such as the National Programme for IT in the NHS, launched by the Department for Health in 2002. When the Labour Government started awarding contracts in 2003, the then Secretary of State, John Reid, promised that the initiative would deliver fully integrated NHS services, including through electronic patient records which would enable different parts of the NHS to exchange information in a way that was both rapid and paperless.¹

However, it gradually became clear that neither the Department of Health nor their contractors were up to the mammoth task. A damning report by the National Audit Office in 2011 concluded that as a result of Labour’s actions “the NHS is now getting far fewer systems than planned despite the Department paying contractors almost the same amount of money”.² Two years later, the Public Accounts Committee noted that Labour’s Programme was still expected to cost the taxpayer more than £10 billion despite being largely dismantled.³

One area where IT policy has been more successful is in e-prescribing. This saw the then Department of Health drive change by ensuring GPs and pharmacies had access to multiple potential suppliers, in a phased approach that slowly introduced change. The centre was responsible for driving improvement, managing operating standards and ensuring interoperability, but not imposing a single “big bang” approach. By early 2016, e-prescriptions were running at 43% of primary care prescriptions – a take-up rate far better than other NHS IT system changes.⁴

Digitisation is a delicate balancing act. Too much from the top and the system collapses. Too little and change is not driven fast enough. Therefore, this report does not propose a single top-down project, but instead suggests that the Department should work with suppliers and NHS partners to drive a fundamental shift in behaviour through a series of linked changes, giving substance to Jeremy Hunt’s vision of a digital-first NHS.

The Department of Health and Social Care should therefore set out three key targets to be achieved by 2028:

- Move the NHS from paper-first to digital-first. The aim should be to ensure that 100 per cent of interactions within the health service are digitally driven by 2028.
- Build a flourishing ecosystem of apps and innovation within and around the NHS, to better serve patients and put them in control.
- Ensure that savings from automation and innovation are ploughed back into frontline services, and that budgets for R&D and technology training for staff rise at least in line with overall NHS spending.

1 <https://www.digitalhealth.net/2003/12/reid-announces-2-7-billion-of-nhs-it-contracts/>

2 <https://www.nao.org.uk/report/the-national-programme-for-it-in-the-nhs-an-update-on-the-delivery-of-detailed-care-records-systems/>

3 <https://www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/news/npfit-report/>

4 <https://www.politics.ox.ac.uk/materials/publications/15224/workingpaperno5ulrikedeetjen.pdf>



To maintain focus on these targets, the Department should report annually to Parliament on 10 key recommendations that drive forward these overarching goals:

1. All NHS patient records to be fully digitised
2. New digital messaging system for all NHS doctors and nurses
3. Build a new NHS app to provide patients with instant access to medical data and health services
4. An NHS Kitemark for approved apps
5. Regional data innovation hubs to cover the whole population of England
6. Bringing in a hub and spoke model of digital specialisation, so 4IR technologies become available to all
7. A technology retraining scheme for doctors and nurses – continuing professional development for the 4IR
8. Guarantee that every pound saved from back office automation is re-invested in frontline services
9. More investment in R&D and staff training as NHS budgets increase, to speed up adoption of new technologies
10. Launch NHS Worldwide – a new NHS commercial arm to replace Healthcare UK

This would focus the Department and NHS on improving digital access and take-up, without replicating past failures where a national push fails to build in sufficient flexibility and innovation.

We all want to see the NHS deliver a safe, world-class service. I hope the policy proposals in this report for empowering patients and prioritising paperless, digital systems will not only stimulate further debate within the Conservative Party, but also act as a blueprint for action.



1. The public sector and the Fourth Industrial Revolution

We are living through an age of profound technological disruption – but also extraordinary innovation.

The First Industrial Revolution was powered by steam, the Second by electricity, and the Third by computing. But as Professor Klaus Schwab, executive chairman of the World Economic Forum, has argued, we have now entered a Fourth Industrial Revolution: one shaped by AI, big data, automation and hyper-connectivity as digital, physical and biological technologies converge.

The new, disruptive technologies of the 4IR are already transforming every aspect of our lives. Advanced smartphones keep us connected to work, friends and family. At home, AI algorithms make Netflix suggestions and feed us advertising, while smart speakers such as the Amazon Echo enable us to order our shopping without lifting a finger.

Soon the family car will be replaced by self-driving vehicles ordered through an app; mortgages and loans will be approved by algorithms and bots; drones will deliver parcels; and physical offices will disappear as workers log in from anywhere in the world.

As each Industrial Revolution in history has progressed, it has been the countries and governments that have reacted the fastest to technological change that have stolen a march on their competitors. Like private firms, government and public services have to respond and adapt to the 4IR – the public would expect no less.

When it comes to leading the 4IR, Britain starts from a position of real strength: our world-leading universities already produce some of the brightest minds focused on developing new technologies. For instance, the world-leading developer of AI, DeepMind, is based in London, while the new wonder material graphene, many times stronger than steel yet incredibly light, was developed by researchers at Manchester University.

At the start of every Industrial Revolution, new technologies are developed by and for the private sector, but as the pace of change gathers speed and costs come down, the public sector then reacts. Think how the computer and the internet have changed access to public services, with everything from paying council tax to reporting local issues now possible online.



In fact, a whole new industry – Govtech, or digital technology to improve public services and government activity – is starting to change our relationship with the state. But the public sector still has a long way to go. For instance, PwC found that currently more than 250 million central government transactions are still completed offline every year at a cost of £14.70 per hour.⁵ So these new technologies have the potential to deliver real savings for the taxpayer in the future.

For example, businesses such as Calipsa are using AI to analyse CCTV, potentially watching hundreds of cameras simultaneously to both spot crimes and monitor traffic problems. But rather than replacing human operators, this new technology will simply flag clips for a human operator to watch, enhancing skilled humans rather than replacing them.

From paperless tax discs for cars to an online justice system for minor crimes, the UK government is already adapting to the 4IR across every department. But only by creating a truly smart state can our Government offer taxpayers best value for money – delivering high-quality, efficient public services alongside low taxes.

While physical infrastructure and geopolitical power were key to success in previous Industrial Revolutions, today it is data, knowledge and connectivity that drive the 4IR. And perhaps the area most ripe with opportunities for reform is public healthcare and the NHS.

‘As the NHS celebrates its 70th anniversary, the Government must look to the future and renew the NHS so it is ready for the Fourth Industrial Revolution’

The NHS still spends vast amounts of money on outdated paper-based systems and processes that hold back improvements in both patient care and the public finances.

As the Health Secretary Jeremy Hunt said in his keynote speech at the 2017 Health and Care Innovation Expo, the next 10 years can become the NHS’s “Patient Power Decade”.⁶ This will only be achieved if the NHS fully embraces the improvements to patient care – and wider accountability and transparency – that the new technologies of the 4IR can bring.

New technology in the NHS can and should mean less time spent on administration, better diagnostics, fewer missed appointments, and ultimately more powerful patients and digital, paperless systems.

As the NHS celebrates its 70th anniversary, the Government must look to the future and renew the NHS so it is ready for the 4IR, and so its founding principles can flourish for the next 70 years and beyond.

5 <https://www.pwc.co.uk/industries/government-public-sector/govtech.html> PwC, Gov.Tech: The power to transform public services in the UK, September 2016

6 <https://www.england.nhs.uk/expo/wp-content/uploads/sites/18/2017/10/Jeremy-Hunt-keynote.pdf> Health and Care Innovation Expo 2017, Keynote address: Jeremy Hunt, Secretary of State for Health, September 2017



2. Conservatives and the NHS

The Conservative Party has a long and proud record of supporting the NHS.

During the Second World War, it was a Conservative Health Minister, Henry Willink, who published the first blueprint for a universal, free health service. Following the 1945 General Election, won by Labour, it fell to Clement Attlee's Government to take the idea forward in Parliament. But Conservatives backed its key principles then and have supported them ever since.

Just three years after its creation in 1948, a new Conservative Government under Winston Churchill took over the then fledgling NHS and nurtured it for the next 13 years. Indeed, for over 40 of the NHS's 70 years, it has been under the care of Conservative ministers.

Yet a worrying (and incorrect) narrative has emerged in recent years, in which the Conservatives' political opponents have at times succeeded in painting the party and its supporters as uncaring about the NHS.

The Ashcroft Exit Poll following the 2017 General Election campaign questioned 17,000 voters. When asked, unprompted, what had been the most important issue in deciding how to vote, 33 per cent of Labour voters named the NHS. Amongst Tory voters, health wasn't even in the top five, scoring less than immigration and security.⁷

Ashcroft's results were reflected in a pre-election poll by Ipsos Mori, in which 61 per cent of people recognised the NHS as one of the most significant issues facing the country – 16 points higher than Brexit.⁸

In order to win the next general election, it is vital that the Conservatives are able to appeal across the political spectrum, winning new voters who see the Tories as effective managers of the economy but fear for the NHS and its ability to cope with the demands of an ageing population.

Nonetheless, current public satisfaction with the NHS remains strong, and there is overwhelming support for the founding principles of the NHS – that good healthcare should be available to all, regardless of wealth. The British Social Attitudes (BSA) Survey, which has conducted a broad survey of healthcare in the UK since 1983, shows that satisfaction in the NHS remains higher now than at any time during the first ten years of New Labour.⁹

Conservatives in government since 2010 have continued to support the NHS's growth and success. In January 2018, a new Department of Health and Social Care was created, bringing together responsibility for two key services under one Cabinet minister. In March 2018, it was announced that one million NHS staff would receive a pay rise of at least 6.5% while Prime Minister Theresa May told MPs that she wanted a long-term funding plan for the NHS.

7 <https://lordashcroftpolls.com/2017/06/result-happen-post-vote-survey/> Lord Ashcroft, Exit Poll Data, June 2017

8 <https://www.ipsos.com/ipsos-mori/en-uk/ipsos-mori-may-issues-index-sharp-rises-concern-about-nhs-and-education> Ipsos MORI pre-election poll, May 2017

9 BSA, Public satisfaction with the NHS and social care in 2017, accessed here: <https://www.kingsfund.org.uk/publications/public-satisfaction-nhs-2017>



Technology is key to the NHS's future success

This increased investment and strategic co-ordination is welcome. But while a long-term funding settlement is necessary to secure the NHS's future, rising budgets alone are not the solution to the challenges it faces in the future.

In the last ten years, NHS net expenditure has increased from £78.9 billion in 2006/07 to £120.5 billion in 2016/17. Planned expenditure for 2017/18 is £123.8bn, and for 2018/19 it is £126.3bn – without taking into account the costs of any increased pay for staff.

At the same time health expenditure – which includes medical services, health research, central and other health services – has, on a per capita basis in England, risen from £1,879 in 2011/12 to £2,106 in 2015/16.¹⁰ Despite this, when asked by the Health Foundation, half of respondents thought the NHS often wastes money.¹¹

As Jeremy Hunt has said, adopting new technologies has a key role to play in making extra money go further – and the NHS has acknowledged this by outlining plans for the growing use of innovation and technology to deliver better care, support people in managing their own health, and meet rising demand.

The Next Steps in the NHS Five Year Forward View, published in March 2017, set out plans to make it easier for patients to access urgent care online, enable 111 to resolve more problems without visiting A&E or their GP, simplify and improve online appointment booking for hospitals, make patients' medical information available to the right clinicians wherever they are, and increase the use of apps to help people manage their own health.¹²

Other initiatives include a new Innovation and Technology Tariff (ITT) to expedite the uptake and spread of innovation across the NHS, a national Clinical Entrepreneurs Programme, and an NHS Innovation Accelerator.

In addition, NHS England has also launched a Knowledge Transfer Partnership Programme, a 12-month development programme aimed at clinical leaders in healthcare science to bring innovation into the NHS. Successful applicants who secure a place will work with other leading healthcare scientists and build long-term collaborations across clinical, research and industry sectors.¹³

10 HM Treasury, Public Expenditure Statistical Analysis 2017

11 http://www.health.org.uk/sites/health/files/Polling2017__web.pdf Health Foundation, What does the public think about NHS and social care services?, May 2017

12 <https://www.england.nhs.uk/wp-content/uploads/2017/03/NEXT-STEPS-ON-THE-NHS-FIVE-YEAR-FORWARD-VIEW.pdf> NHS England, Next Steps on the NHS Five Year Forward View, March 2017

13 https://www.england.nhs.uk/2017/03/knowledge-transfer-partnership/?mc_cid=6e5f2af9db&mc_eid=de12964af8 NHS England, Knowledge Transfer Partnership, March 2017



3. Patient power and paperless systems

The creation of CCGs, Foundation Trusts and Sustainability and Transformation Plans (STPs) has yielded significant benefits in terms of simplifying and integrating NHS services at a local level.

However, there is a risk that silos are created, with new techniques and technologies developed in one part of the NHS not up-scaled and transferred across the wider NHS.

Moreover, the failure of the last Labour government to reform NHS technology has left a toxic legacy of underinvestment and outdated technology. As a result, too many NHS bodies and trusts still use paper systems for records, fax machines to send patient data, and pagers to communicate in hospitals. All these factors hold back patient data connectivity and ultimately impede patient care and reduce patient power, whilst causing costs to rise.

Some statistics illustrating Labour's technology legacy are thought-provoking:

- NHS Trusts account for over 10% of all pagers in circulation worldwide – with more than 100,000 still in use across hospitals;

- The NHS is the largest consumer of fax machines worldwide;
- Of the 1.5m connected devices across NHS England, about 70,000 are running Windows XP;¹⁴
- The average NHS trust has 160 different computer systems in operation while it is estimated that nearly half of emergency response time is wasted due to inefficient communication.¹⁵

Although Tony Blair and Gordon Brown spent billions of pounds on a digital agenda for the NHS, they failed to achieve their main objective of establishing an integrated electronic health record system across secondary care.¹⁶

The graphic overleaf, produced by the NHS itself, shows how the current system too often works.

An integrated, fully digital healthcare system, by contrast, also has the power to finally eradicate paper and reduce missed appointments. The NHS's new e-Referral service allows patients to book a hospital visit at a time that suits them, while appointments integrated onto a healthcare app such as Catina (see case study 3) will give patients notifications and little excuse for missed slots.

14 <https://deepmind.com/blog/independent-reviewers-annual-report-2017/> DeepMind Health Independent Review Panel, Annual Report 2017, July 2017

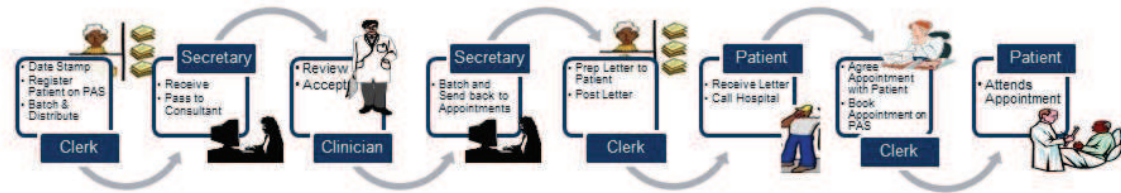
15 <https://www.common-time.com/wp-content/uploads/2017/07/Report-Paging-in-the-NHS.pdf> CommonTime, Pagers in the NHS - The Cost of Ageing Comms Channels in Healthcare, July 2017

16 https://www.kingsfund.org.uk/sites/default/files/field/field_publication_file/A_digital_NHS_Kings_Fund_Sep_2016.pdf Kings Fund, A Digital NHS, September 2016



Paper Vs Electronic Hi level comparison

Paper Process – *partial booking*



Electronic Process – *directly bookable service*



- **Paper**
 - *full booking*
 - *partial booking*
- **NHS e-Referral Service**
 - *Directly Bookable (online review)*
 - *Directly Bookable (paper review)*
 - *Indirectly Bookable (online review)*
 - *Indirectly Bookable (paper review)*

[Click here if you wish to understand more about the paper and electronic processes](#)



Last year it was estimated that almost £1bn is being wasted annually by patients missing 8 million appointments.¹⁷ The money wasted could fund 1 million more cataract operations or 250,000 hip replacements.

More generally, the estimated annual cost of paper storage is between £500,000 and £1 million for each Trust – money which could be spent instead on more doctors and nurses.

The NHS estimates that up £200 million a year is spent just on printing for the 120 million outpatient appointments that take place, a figure which does not even include the cost of postage.¹⁸ Nor does it account for therapy, diagnostics, primary care and mental health appointments or patients that receive multiple letters.

There are around 200 NHS Trusts, which means that the NHS is spending up to £200 million a year on paper storage – that’s without the costs incurred by 7,500 GP practices that operate around the country.¹⁹ As the example of St Helens and Knowsley NHS Trust shows (see case study 1), going paperless could result in significant savings.

17 <https://www.theguardian.com/society/2018/jan/02/patients-missing-their-appointments-cost-the-nhs-1bn-last-year> NHS Digital, January 2018
 18 Department of Health, March 2018
 19 <https://www.england.nhs.uk/2015/09/cutting-reliance-on-paper/> NHS England, Cutting reliance on paper, September 2015



Case study 1: St Helens and Knowsley Teaching Hospitals NHS Trust

St Helens and Knowsley Teaching Hospitals NHS Trust, which employs 4,500 staff across two sites, has identified technology as central to its development and improvement.

They are leading the way in the North West with their paperless Health Informatics Service.

In 2013 St Helens and Knowsley was one of the first NHS trusts to move all patient records online. Since then they have been at the forefront of technological innovation in the NHS, winning numerous awards including being shortlisted for a Health Service Journal Award that “recognises, celebrates and promotes the highest achievements in the NHS”.

The Trust has scanned more than 100 million pages into an electronic document management system (EDMS), with staff accessing an average of 500,000 documents every day. The project itself cost £1.2 million, and the hospital says EDMS had produced cost-savings of £1.4 million every year since its implementation.

More recently St Helens and Knowsley went live with Patientrack, replacing a previously paper-based system. It records vital signs, bedside, using a tablet. The automation of the previous paper system has increased efficiency but most importantly improved patient safety.

The introduction of the Patientrack e-observation solution in January 2016 has reduced the amount of time nurses spend doing patient observations by a third – the equivalent of around 8,000 working hours.

The system is also able to monitor patients’ vital signs and then alert medical staff if they reach a certain tipping point, meaning clinicians spend less time having to physically check in on patients.

As this example shows, going paperless is not just about saving money – it is about transforming patient care, and putting power in the hands of patients.

Jeremy Hunt has announced that by the end of 2018 patients should be able to access online all their health and care interactions. In addition, doctors and nurses will be able to access the most up-to-date lifesaving information across GP surgeries, ambulance services and A&E departments, no matter where a patient is in England.

As the NHS e-Referral appointment system is rolled out this year it will combine electronic booking with a choice of place, date and time for first hospital or clinic appointments. Patients can choose their initial hospital or clinic appointment and then book it in the GP surgery at the point of referral, or later at home on the phone or online.²⁰

The NHS Standard Contract for 2018/19 requires the full use of the NHS e-Referral Service for all consultant-led first outpatient appointments, and from 1 October 2018 providers will only be paid for activity resulting from referrals made through NHS e-Referral.

20 <https://digital.nhs.uk/e-Referral-Service> NHS Digital, NHS e-Referral Service



This should be the first step in a wider transformation. In Sweden, they are aiming by 2020 to give all their citizens electronic access to their medical records. Already a third of Swedes have set up accounts and studies show that with access to records, patients have a better understanding of their illnesses, leading to more successful treatment.²¹

Moving electronic records online can also transform treatments. In the future, data-driven computers using AI will be at the heart of healthcare – and with its wealth of health data the NHS is in a uniquely strong position to benefit, in comparison with other countries which have not adopted universal healthcare systems.

In particular, the last few years have seen the successful implementation of Electronic Healthcare Records in primary care, with GPs and surgeries having enrolled all patients digitally. However, the secondary care system still relies heavily on paper – as highlighted in the Wachter Review.²² This stifles communication, reduces patient power and hampers the NHS's ability to harness the power of AI to improve healthcare.

As the Chair of the Independent Review Panel for DeepMind Health told the House of Lords Artificial Intelligence Committee for a report published this year, there are “real problems with data storage, availability and flow throughout the NHS at pretty much every level. It is very much in silos at the moment.”²³

Recommendation 1 **All NHS patient records to be fully digitised**

All levels of NHS healthcare – primary, secondary and tertiary – need to ensure that medical records are fully digitised and portable so that they can be easily shared between GPs, hospitals, NHS Trusts and other care providers.

In the long run, the Government should consider both financial incentives and sanctions for those organisations that fail to go paperless. Internal communication should have digital as the norm and not the exception.

Patients should still be able to opt out of digitisation, but the success of the Electronic Healthcare Records initiative needs to be replicated across the whole NHS – especially in hospitals. Records should be kept in a fully transferable format, which can be shared at the request of the patient between other GP surgeries, hospitals or care facilities.

21 <https://www.economist.com/news/leaders/21736138-welcome-doctor-you-revolution-health-care-coming> The Economist, A revolution in health care is coming, February 2018

22 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/550866/Wachter_Review_Accessible.pdf Robert M. Wachter, Making IT Work: Harnessing the Power of Health Information Technology to Improve Care in England, August 2016

23 <https://publications.parliament.uk/pa/ld201719/ldselect/ldai/100/10002.htm> House of Lords Artificial Intelligence Committee, AI in the UK: ready, willing and able?, April 2018



Case study 2: By Dr Felix Jackson, Founder of medCrowd

I developed medCrowd, the essential messenger for health and care, because I have seen first-hand how poor communication prevents health and care workers giving the best care both here in the NHS and globally in places like South Africa and China.

Getting access to help, support and advice from peers and senior colleagues is crucial in every area. But in health and care, it can have a life-changing impact on patients.

You could be a junior doctor in your first week in a hospital having to make decisions on your own because colleagues are on a course or on holiday, or you could be an experienced doctor in a primary care clinic in Zambia who needs to perform specialist surgery for the first time on a patient who is in a critical condition. Now, thanks to digital technology, none of those people have to go forward relying on just their own knowledge. They can use medCrowd to access support and advice instantly.

Doctors have, of course, been quick to realise this and have begun to use commercial apps such as WhatsApp. Unfortunately this is often illegal as they do not protect patient information to the required standards – and we have seen in the recent news coverage of Facebook how data can end up in unexpected hands.

Not only does medCrowd protect confidential information to the required standards, it is specifically designed to suit the needs of everyone in health and care – workers, patients and carers – so everyone can focus on getting the best outcomes.

For instance, teams using medCrowd can have separate conversations about each patient or topic, to ensure information is kept in the right place. We are currently trialling the use of medCrowd with an NHS community provider, who intends to include chronically ill patients in conversations so they can instantly communicate with their entire health team. And this information can be synced with the patient's electronic health record so that crucial details about treatments or decisions are accessible for future reference.

medCrowd is poised to help everyone provide and receive the best care, while hugely improving efficiency in the NHS and globally, and we are another step closer to getting a better outcome for everyone involved!

For many doctors and nurses, the current NHS technology lag has led them to find ways of working around the challenges, including using popular mobile messaging apps such as WhatsApp or Snapchat that can potentially put patient data at risk.

A study of 2,107 doctors by the British Medical Journal across five hospital sites found that 98.9% own a smartphone, and just over a third use web-based messaging apps to send clinical information.²⁴

24 <http://innovations.bmj.com/content/bmjinnov/early/2015/10/08/bmjinnov-2015-000062.full.pdf> Mohammad H Mobasheri, Dominic King, Maximilian Johnston, Sanjay Gautama, Sanjay Purkayastha, Ara Darzi, British Medical Journal, The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study, August 2015



The same report also showed, worryingly, that 65 per cent of doctors had texted patient data from their smartphones, 46 per cent had sent pictures (e.g. of wounds or X-rays) to a colleague, and around a third had used an app such as WhatsApp to share confidential information.

The continued use of outdated technology has led to what has been described as a “Wild West” in digital communication,²⁵ as doctors look to circumvent the rules to improve patient care, despite the risk of fines for data breaches. This needs to end. Conservatives must fix the problems caused by the last Labour government. There must be a far better roll-out of compliant digital messaging devices by NHS trusts. One such provider is medCrowd (see case study 2), an encrypted messaging service that combines a WhatsApp style messaging service with protection for personal patient data.

Care.data, the last Government initiative to collate information securely from GP practices, hospitals and care homes into a central database, was discontinued after public concerns surrounding the sharing of personal health records without explicit consent. This left the NHS unable to truly capitalise on its strength of patient records and is holding back crucial medical research that could deliver new treatments or cures.

Recommendation 2 **New digital messaging system for all NHS doctors and nurses**

Labour’s technology legacy has left the NHS as the world’s biggest consumer of fax machines and pagers, inhibiting the ability of GP surgeries and hospitals to effectively communicate digitally.

GPs and doctors use thousands of different computer systems between them, making joint working challenging and time-consuming.

One system should be in place to allow effective and secure digital communication, not only between primary healthcare and hospitals, but between doctors and nurses treating patients.

A disturbing number of cases of health workers using apps such as WhatsApp and Snapchat have been reported, which has put in danger patient confidentiality. Apps such as medCrowd, which allow compliant messaging for health and care teams, are being developed, but NHS England should ensure that every NHS Trust and CCG implements a data compliant healthcare messaging service which can be accessed by phone or tablet.

Fax machines, pagers and paper records in the NHS must become a thing of the past.

25 <http://www.bbc.co.uk/news/technology-40507440> BBC News, Use of WhatsApp in NHS ‘widespread’, say doctors, July 2017



4. Building an ecosystem of innovation

In recent months, a GP surgery in South West London has quickly established itself as one of the UK's fastest growing clinics, jumping from 2,500 registered patients in April 2017 to nearly 25,000 in March 2018 – growing on average by 4,000 a month.²⁶

The Lillie Road Health Centre in Fulham is one of the clinics offering Babylon's *GP at Hand Service* – a smartphone app that allows patients to be connected to doctors virtually.

Exploiting a change in the rules by the Coalition Government, which allows patients to enrol at any GP practice, this new online doctor service represents one of the biggest disruptions to general practice in years.

There has been some controversy over the service, with some patients complaining that they did not realise that signing up meant they would no longer have access to their existing GP.

But the popularity of a convenient service that promises a video consultation within two hours and a GP appointment which doesn't require taking time off work should be a wake-up call to others.

It was notable that nearly 80% of the patients using the service were aged 20-39 and only 1% are over 80.

For the first time, technology is starting to bring competition to primary care, offering a new range of convenient patient-focused products. This trend is set to continue, and the Government should support it.

The ultimate goal is a digital-only, paperless health system which provides patients with instant information and access to the NHS at their fingertips. Every system the NHS uses, whether for data storage, messaging and communication or any sort of patient care and integration should be digital – paperless systems must become the norm not the exception.

While Babylon is giving patients access to GPs anytime and anywhere, others are bringing together different parts of the NHS to create a more integrated system. Mobile apps such as Catina allow patients to store all their medical records in one place, from GP interactions and hospital consultations to private appointments (see case study 3).

In future, it's vital that the NHS can implement an integrated system that gives patients control of their own healthcare, both by offering additional flexibility between the private and public systems and making it easier to track progress between primary and secondary healthcare.

²⁶ <https://www.digitalhealth.net/2018/03/hammersmith-fulham-ccg-additional-costs-gp-at-hand/> Digital Health, CCG could face £10.6m additional costs to continue funding GP at Hand, March 2018



As Nick Woodruff from Catina envisions (see case study 3, below), in the not-too-distant future we will be able to track our healthcare progress in the same way we can track an Amazon delivery.

To achieve Jeremy Hunt's stated aim of creating a decade of patient power, the Government must bring together the many excellent digital services offered by the NHS – and combine them with the best of the private sector to create an integrated platform.

In a speech last year on creating a digital-led NHS, Jeremy Hunt promised that a new NHS app would be rolled out nationally which allowed people to access their own medical records, book GP appointments and repeat prescriptions, or consult the NHS 111 service.

As Babylon's *GP at Hand* service shows, demand for a smartphone health service exists, and it's vital that the NHS responds to both patient needs and new emerging technologies. As Hunt says, patients must be given easy access to all their healthcare interactions and data, including test results, prescriptions, letters from doctors, and health records.

Case study 3: by Nick Woodruff, developer of Catina

We purpose-built Catina to sit as a layer on top of the NHS Spine offering a unified platform providing Identity and Access Management capabilities for web and mobile app developers across the NHS.

In our roadmap we will be able to allow patients to track their healthcare pathway enabling empowerment in the process. We will be able to show the pathway in a similar clear way to an Amazon order or DPD delivery.

Long-term plans are to provide a birth till death record of healthcare personally held and managed. The benefits remain that the data is stored by the patient with full knowledge at any time about who has access to any part of that data.

The app will allow translation of data so when travelling the medical history will be relayed to a shared professional in the correct language of that professional to assist in accurate healthcare management.

We have had discussions and are making plans to roll this patient-held record system out in Ghana and have interest from Zimbabwe. This would allow us to offer those less fortunate the ability to control their own health record. We envisage doctors worldwide may decide to make themselves available to manage virtual consultations and assist with healthcare in developing countries.



Apps and wearables can create a new, patient-focused NHS

Healthcare has to be seen as something that is offered cradle to grave by the NHS, and that includes not just a system where good health is created reactively by doctors fixing ailments, but instead integrated into healthy lifestyles.

With obesity rates the highest in western Europe, there is a golden opportunity in Britain to use health and lifestyle apps to reduce the pressure on the NHS and improve the service provided to patients.

The NHS needs to invest not only in the latest virtual reality headsets to improve surgery survival rates and AI diagnostic equipment to ensure fewer misdiagnoses, but also needs to support healthy lifestyle apps and wearable devices such as Fitbit that can fully integrate with NHS services.

For instance, a new device called the Watch BP (a heart rhythm detector) was introduced recently as a stroke prevention measure. Statistics show that over 42,000 people in England have undiagnosed irregular heart rhythm which could cause a stroke if not diagnosed and treated early enough.

The aim of this device is to identify at least 130,000 cases of irregular heart rhythms and prevent 3,650 strokes and potentially prevent 900 deaths. But equally important, the project is also estimated to save the NHS £81 million every year.²⁷

One of the quirkiest apps offered on the NHS' own Digital Apps Library is Brush DJ, which plays two minutes of music to make the mundane task of brushing teeth for the correct length of time more enjoyable for children. The treatment of dental disease costs the NHS £3.4 billion per year while in England, 26,000 children aged between five and nine undergo a traumatic and expensive general anaesthetic to remove decayed teeth each year.²⁸

Creating an environment where more apps and wearables can flourish in the NHS will not only benefit patients but in the long run save the NHS money.

While the political pressure is always to increase budgets to plug shortfalls, strategic planning should be about an efficient NHS. Efficiency means better treatment, more choice and a faster service.

But the only way to become more efficient is improving productivity, and to do that new technology and innovation has to be at the heart of the NHS's future decision-making. As Simon Stevens, Chief Executive of NHS England, rightly acknowledges, "the NHS is a hotbed of innovation but clearly as we think over the next three to five years, we need to go further, faster and accelerate what that looks like".²⁹

27 <https://www.digitalhealth.net/2018/02/nhs-stroke-innovation-tech-81m/> Digital Health, NHS could save £81m a year though new tech designed to prevent strokes, February 2018

28 <http://www.ahsnnetwork.com/wp-content/uploads/2018/02/Introducing-the-NHS-Innovation-Accelerator.pdf> AHSN, Introducing the NHS Innovation Accelerator, February 2018

29 <https://www.england.nhs.uk/expo/wp-content/uploads/sites/18/2017/10/Simon-stevens-keynote.pdf> NHS England, Simon Stevens Keynote Speech at the NHS Health and Care Innovation Expo 2017, September 2017



Recommendation 3

Build on the new NHS app to provide patients with instant access to medical data & health services

The NHS is introducing a range of welcome digital systems for patients, but they need to be brought together.

The NHS e-Referral Service, Citizen Identity, Patient Online and NHS 111 Online are just some of the digital services that are either being rolled out or in the process of development. This plethora of different options, which in some cases offer overlapping services, may be confusing for some patients to understand or use.

This fragmentation is exacerbated by different NHS Trusts across the country offering different apps, services and products varying between primary and secondary healthcare.

The NHS needs a simple, overarching portal and app that patients can access via their smartphones. A new app has been mooted by Jeremy Hunt, and is currently in the process of development. This app – let us call it “NHS NOW” – should be a “one stop shop” allowing patients across England to book an appointment, see their progress through the system, order repeat medications, control access to data, or seek advice on medical problems through NHS Direct. By logging on to the NHS NOW app, the patient would have access to all their healthcare data at their fingertips.

This new system of electronic patient records would facilitate better communication between all levels of primary, secondary and social care, helping the NHS deliver real patient power. Patients being able to access data at their convenience allows information and power to flow from hospitals, GP surgeries, and papers held in filing cabinets, back to the patients' fingertips.

Doctors and nurses could also use the app to track patients, ensure that medication is being correctly administered, meet waiting time targets, and facilitate the upgrade towards a smart hospital system. The long-term vision should be smart systems delivering personalised medication, treatments and advice.

Not only would this digital, app-based system offer patients and doctors an integrated platform in which they can simplify care, but substantial amounts of money can be saved by eliminating postage and paper.

Many hospital appointments are also cancelled or postponed at short notice when additional information is required prior to an appointment – often due to a document that needs to be faxed from a GP. This process means wasted consultant fees, extra appointments and longer waiting lists.

NHS NOW would have an open source API to allow private sector developers to enhance the service – and to build their own versions, in particular to customise the service for patients with particular needs. For instance, as Jeremy Hunt suggests, it could integrate with Fitbit data showing calorie counts or allow heartbeat monitors to instantly notify doctors of irregular patterns.



Whilst bringing together key services in one NHS app is essential, in a rapidly expanding healthcare tech market, patients also need to retain confidence in apps and technology in the private marketplace.

On the NHS's own App Library there are 45 different apps.³⁰ These products include myCOPD, which helps people with Chronic Obstructive Pulmonary Disease (COPD) to better manage their condition; Cove, which allows people to express through music what they might struggle to say with words; Chill Panda, an app to manage stress; and Active 10 walking tracker, which aims to get people into the habit of walking briskly for 10 minutes every day.

However, these apps represent just a small proportion of the global market for health-related apps, with more than 325,000 available on the main app stores worldwide, and an estimated 3.7 billion downloads in 2017.³¹ This multi-billion-pound industry is rapidly expanding, with apps that monitor blood pressure, calculate insulin doses and diagnose conditions to name but a few.

While many of these apps undoubtedly offer benefits like keeping track of a heart condition, many operate in an ungoverned space. Any health-related app developer should have the opportunity to prove that their product is NHS-approved, especially those that can better manage conditions or promote healthier living.

Recommendation 4 is, therefore, that an NHS Kitemark is offered to those apps which receive health service approval – but also that the developers of such apps can be part of the wider NHS app ecosystem via the use of APIs and open standards.

Healthcare by app will revolutionise how we receive care, giving patients power to decide when, where and how they receive treatment. An app-based health system will also mean a natural end to paper in surgeries and hospitals, consigning the fax machine and the letter to NHS history.

Recommendation 4 **An NHS Kitemark for approved apps**

When faced with a vast array of healthcare related apps, patients need to know whether an app is safe to use or is NHS approved.

While the NHS does currently have an app library, realistically most patients will always download health-related apps straight from either the Android Play Store or the Apple App Store.

The best way to quickly and effectively ensure that all patients know if an app is NHS-backed would be to place an NHS Kitemark logo on approved apps. App developers offering services that can manage conditions, deliver personalised medicine or encourage healthier life choices should all be encouraged to apply for NHS certification – as would those built out using the framework and APIs from the core NHS NOW app.

The NHS Kitemark would help small app developers in particular, allowing them to quickly and credibly market their products to the wider NHS market, ensuring the market place is not just open to larger developers with established brand names. Patients would also be given a wider choice than currently available on the NHS app library.

30 <https://apps.beta.nhs.uk/> NHS App Library

31 <https://research2guidance.com/wp-content/uploads/2017/11/R2G-mHealth-Developer-Economics-2017-Status-And-Trends.pdf> Research 2 Guidance. mHealth App Economics 2017

5. Shared data saves lives

Throughout the history of the NHS, data has always driven medical breakthroughs.

British scientist Sir Richard Doll, for instance, in 1954 studied lung cancer patients in 20 London hospitals and found smokers were far more likely than non-smokers to die of lung cancer. That ground-breaking medical research more than 60 years ago has saved countless lives.

Today, as mentioned above, there is even more potential for using medical data to save lives. Researchers with access to anonymised NHS patient data can explore in unprecedented detail whether certain people are more vulnerable to certain conditions, or determine the key interventions that might be made decades beforehand in order to prevent people from developing certain illnesses.

Increasingly, this work of correlation will be done not via human researchers but through AI.

As the House of Lords AI Committee concluded, the development of AI systems in healthcare should be seen as a collaborative effort benefiting both developers and patients.

“The data held by the NHS could be considered a unique source of value for the nation. It should not be shared lightly, but when it is, it should be done in a manner which allows for that value to be recouped,” the peers wrote.³²

Yet an independent review commissioned by the Government, aimed at growing the AI industry in the UK, described organisations being left with an “unfathomable task” of trying to gain access to data.³³ “I strongly believe that the levelling and opening of the access to such vital data is fundamental for the creation and development of ground-breaking AI services in the healthcare sector,” said Matteo Berlucchi, an AI healthcare developer quoted in the report.

The first step to capitalise on the benefits of AI is ensuring that all records in the NHS are fully digitised (see Recommendation 1). Fortunately, the NHS is already in a strong position, with 64% of UK adults saying they trust the NHS and other health service providers with their personal medical data.³⁴ But once the infrastructure is in place, the benefits of shared data have to be fully conveyed to the public.

32 <https://publications.parliament.uk/pa/ld201719/ldselect/ldai/100/10002.htm> House of Lords Artificial Intelligence Committee, AI in the UK: ready, willing and able?, April 2018

33 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/652097/Growing_the_artificial_intelligence_industry_in_the_UK.pdf Professor Dame Wendy Hall and Jérôme Pesenti, Growing the Artificial Intelligence Industry in the UK, October 2017

34 <https://theodi.org/blog/odi-survey-reveals-british-consumer-attitudes-to-sharing-personal-data> Open Data Institute, ODI survey reveals British consumer attitudes to sharing personal data, February 2018



As the Caldicott Review on data security made clear: “The case for data sharing still needs to be made to the public, and all health, social care, research and public organisations should share responsibility for making that case.”³⁵

There is, in fact, strong support for the sharing of medical records. Four in five people say they would be happy to share their medical records for research purposes if they were anonymised.³⁶ Another recent survey showed that 47% of respondents are willing to share their personal data if it improved drugs and medical treatments.³⁷

But as the care.data initiative showed, the argument has to be made that shared data saves lives, and patients need to buy into the reality that for the NHS to work long into the future they have to be willing to share data.

This will become easier with time, as age plays a role in the decision to share personal data. Overall young people are more willing to share data compared to their parents’ generation. At the same time older people are also willing to share but only when it directly involves their personal care.

While some patients will never feel comfortable about their medical data being used for research, we need to appeal to a new generation that routinely share information online with each other every single day.

The Government has recognised the need for a return to a centralised data centre for medical research and the Life Sciences Industrial Strategy proposed the creation of two to five regional data innovation hubs. These would each cover three to five million people and contain “comprehensive and secure data in primary, secondary and tertiary care as well as social care and community data”. Any such hub would need to assure the public that they operate within data standards and requirements for security, privacy and ethical approval, and that national opt-outs are respected as per the recommendations of the National Data Guardian.

While the Life Sciences Industrial Strategy only envisioned two to five of these centres covering 3-5 million people each, the Government should go further and commit to ensuring they cover the whole population of England within 10 years. For this to work the Government needs to win the argument about why sharing data can be beneficial, and importantly how it can save lives.

The NHS must be frank with patients too: data breaches can happen and no single IT system is entirely safe, but that should not deter the NHS from creating centralised data centres. In fact, the NHS should strive to become a world leader in data safety, considering how innovations such as blockchain could help secure data. That includes full implementation of the Caldicott Review recommendation to consider stronger sanctions to protect anonymised data, which include criminal penalties for deliberate and negligent re-identification of individuals.

35 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/535024/data-security-review.PDF National Data Guardian for Health and Care, Review of Data Security, Consent and Opt-Outs, June 2016

36 <https://wellcome.ac.uk/what-we-do/our-work/our-policy-work-using-patient-data-research> Wellcome Trust, Patient data in research, March 2016

37 <https://theodi.org/blog/odi-survey-reveals-british-consumer-attitudes-to-sharing-personal-data-online> Open Data Institute, ODI survey reveals British consumer attitudes to sharing personal data, February 2018



Recommendation 5 Regional data innovation hubs to cover the whole population of England

The Government needs to implement fully Professor Sir John Bell's plan in the Life Sciences Industrial Strategy for new regional data innovation hubs. Such hubs should cover the whole population of England within 10 years.

We need to argue that machine learning is best with big data sets. Shared data saves lives, and an opt-out system similar to that for organ donations should be implemented. Artificial intelligence will not only save lives, but make the NHS more efficient, so it's in everyone's best interests to allow data to be shared.

This argument needs to be front and centre as the new data centres are created, and this message needs to be relayed to GPs, who effectively blocked the implementation of care data by opting out entire surgeries.

We will only unlock the immense value of patient data if we have open and honest discussions about how and why data can be used for care and research, and how personal information is safeguarded.

Ultimately control must be given to the patient to decide how they want their data to be used. This new paperless system can be loosely based on the opt-out system for organ donations, which will come into force in England this year. Under the new rules of presumed consent, patients are considered to be on the organ donation register unless they explicitly opt out. In Wales, where the system has operated since 2015, just 6% of patients have opted out of the scheme.³⁸

Rules for data sharing should be similar, with patients deemed to have given consent for their medical records to be shared anonymously for research, unless they explicitly opt out. To make this work, patients need to have easier access to their medical records. The simplest way would be to link the system to Summary Care Records (electronic health records containing essential information about a patient) and give patients the same level of access to this information as doctors and nurses.

In light of the care.data initiative, Government must re-state the case for shared medical records.

We should empower the patient to choose, and in this new era of data sharing they should have full control over privacy settings. At that point it's the scientists, doctors, nurses and politicians who all have the responsibility to make the argument for how shared data can save lives.

The remaining chapters of this report will set out what the healthcare of tomorrow is beginning to look like, and make recommendations about how the rate of innovation in the NHS can be accelerated, preparing our health service for the 4IR, and placing patients at the heart of it.

38 <https://www.theguardian.com/society/2017/dec/12/jeremy-hunt-launches-opt-out-organ-donation-plans-in-england-and-wales> – The Guardian, Jeremy Hunt launches opt-out organ donation plans in England, December 2017



6. Tomorrow's Healthcare: the NHS in the Fourth Industrial Revolution

Until recently, retinitis pigmentosa (RP) was a condition for which no cure or approved medical treatment existed. Those suffering from the worst effects of the disease could see nothing more than the difference between daylight and darkness.

One sufferer was Keith Hayman, a 68-year-old grandfather of five, who was diagnosed with RP in his 20s, becoming registered blind in 1981. Now, following pioneering surgery at Manchester Royal Eye Hospital, he is able to see again using a bionic eye. The Argus II, which employs a camera mounted in a pair of glasses and a tiny computer to relay signals directly to the nerves controlling sight, has for the first time given RP patients their ability to see the world.³⁹

There are an estimated 16,000 people with RP in the UK, all suffering from differing levels of sight loss, and although currently each bionic eye costs around £150,000 for surgery, follow-up, equipment and rehabilitation, the boost it gives to quality of life is immeasurable.

Pioneering treatments such as the ones developed by Second Sight to cure RP are just the first wave of a new generation of technology that will fundamentally alter healthcare. Now, instead of simply operating to heal broken bones, we can replace entire limbs or potentially reverse paralysis. As Yuval Noah Harari explores in his bestselling book, *Sapiens: A Brief History of Humankind*, while currently bionic body parts are poor replacements for the original, they have unlimited potential.

Similarly, advances in AI are rapidly transforming healthcare, with London-based DeepMind Health recently signing a five-year deal with the Royal Free Hospital to use an app to alert clinicians to acute kidney injury in patients. According to the Royal Free, acute kidney injuries are linked to 40,000 deaths a year and £1 billion is spent on treating the condition.

Known as the *Streams* app, it allows acute kidney injuries or sepsis to be detected in a matter of hours as opposed to next-day routine blood checks. It means rather than sorting through the patient's electronic record, the information is delivered into the clinician's hand.⁴⁰

39 <http://www.secondsight.com/> SecondSight website

40 <https://deepmind.com/applied/deepmind-health/working-partners/how-were-helping-today/> DeepMind Health, Streams in NHS hospitals



Not only does this app make care easier for doctors and nurses, it also empowers patients. Through graphs and trend lines, patients can clearly see if certain markers of kidney health are spiking or falling, and by how much, making the progress of their condition easier to grasp.

These kinds of AI have huge potential, yet it's also important that data ethics and informed consent are put at the forefront of any advancement in technology. A year-long investigation by the Information Commissioner's Office found that the 1.6 million patients whose data was used in testing weren't sufficiently informed that their information was being used in the pilot. The project is continuing, but as AI becomes more commonplace it's important that the concept of informed consent is not put at risk, and that the patient's voice is kept at the heart of all treatment.

Virtual reality and augmented reality

While AI can rapidly improve diagnostics, virtual reality (VR) and augmented reality (AR) headsets have the power to change how surgeons operate. For instance, surgeons at St Mary's Hospital in London have used Microsoft HoloLens to overlay images of CT scans onto patients' legs during reconstructive lower limb surgery.⁴¹

The HoloLens AR headset allows surgeons to see the positions of the bones and key blood vessels through the limb during surgery. HoloLens is a powerful tool in the operating theatre and this approach is less

time-consuming and more reliable than the current method of ultrasound used to locate blood vessels. This new technology can't replace the experience and skills of a clinical team, but it could help to reduce the time that a patient spends under anaesthetic and provide support for the operating surgeon.

Such changes shouldn't be seen as robots replacing doctors – though increasingly, there will be procedures that can be performed with more precision and safety by robots, and we should not deny patients the benefits of such innovation. But many of these medical advances can empower health professionals, or help them carry out more operations, more safely in a given time period, while allowing patients to better understand their treatment.

AI, VR and AR have the power to democratise healthcare like no other previous medical advancement. For the first time the balance of power will be shifted from the consultant back to the patient, who will have far more control over their treatment.

Not only will AI be able to explain healthcare decisions to patients in a way that's easy to understand, VR and AR will allow them to feel what it's like to undergo procedures like radiology. As Jeremy Hunt said last year: "the changes in medical innovation are likely to transform humanity by as much in the next 25 years as the internet has in the last 25 years."⁴²

41 <https://eurradiolexp.springeropen.com/articles/10.1186/s41747-017-0033-2> Philip Pratt, Matthew Ives, Graham Lawton, Jonathan Simmons, Nasko Radev, Liana Spyropoulou and Dimitri Amiras, Through the HoloLens™ looking glass: augmented reality for extremity reconstruction surgery using 3D vascular models with perforating vessels, January 2018

42 <https://www.england.nhs.uk/expo/wp-content/uploads/sites/18/2017/10/Jeremy-Hunt-keynote.pdf> NHS England, Jeremy Hunt speech at the NHS Health and Care Innovation Expo 2017, October 2017



Hospitals of the future

While previous chapters have already set out how data can empower patients, it's important to consider the hospital of the future too and how it might care for patients.

In England, the stereotype of a traditional small local hospital hasn't changed much in the last 70 years.

Some countries have already started addressing this with the "hub and spoke" model, a move towards centralised larger specialist hub hospitals for acute care with in-patient facilities, supported by smaller spoke community facilities. This model offers better care at similar cost.

Denmark enacted reforms in 2007 reducing its acute hospitals from about 40 to 21. But while they reduced the number of hospitals that offered surgical procedures, they also reduced the incidence of complications, with post-operative mortality rates after two years improving by 62%. Since the reforms, hospital productivity has increased by more than 2 per cent per year and costs have been stable.⁴³

Britain has long been moving towards a hub and spoke model, in which specialist procedures, or the toughest emergency cases, are concentrated in big acute hospitals. In Wiltshire, instead of having three community hospitals at Chippenham, Trowbridge and Melksham, they have launched a plan for one community hub hospital, one community spoke, three urgent treatment centres and extra space for primary care.

Likewise, an £80 million specialist emergency care hospital recently opened at Cramlington, Northumberland – the first of its kind in the UK – and deals only with urgent and emergency cases, such as heart attacks, car crashes, industrial injuries and falls. Meanwhile, fewer people have died of strokes in London since it merged 32 specialist sites into eight.⁴⁴

Reforms like these will always encounter criticism from people disappointed at the loss of service from a local hospital. But as a King's Fund report this year noted: "It has been clear for some time that simply working our current hospital-based model of care harder to meet rising demand is not the answer."⁴⁵

This hub and spoke model is also a natural model for technology deployment (see Recommendation 6), enabling our biggest and busiest hospitals to become centres of digital innovation, with the benefits radiating outwards.

Upskilling doctors and nurses for 4IR technology

While hospitals, GP surgeries and NHS bodies need to be ready for the healthcare revolution, doctors and nurses need to be too. There has to be a recognition that clinicians need to be retrained to be able to operate new machinery, understand AI, AR and VR, and deliver personalised medicine.

43 https://www.sdu.dk/-/media/files/om_sdu/centre/cohere/.../wp-cohere_07-2017.pdf Terkel Christiansen, Karsten Vrangbæk, Hospital centralization and performance in Denmark – ten years on, July 2017

44 <https://www.theguardian.com/healthcare-network/2012/jul/03/stroke-care-success-london-nhs> The Guardian, Stroke Care Success London NHS, July 2012

45 <https://www.kingsfund.org.uk/publications/making-sense-integrated-care-systems> Kings Fund, Making sense of integrated care systems, integrated care partnerships and accountable care organisations in the NHS in England, February 2018

Recommendation 6

A hub and spoke model of digital specialisation – so 4IR technologies become available to all

As treatment becomes more specialised, the NHS must enable hospitals and trusts to become world class in a smaller number of fields, using the latest technologies to assist them – a digital hub and spoke model.

Specialised acute care is better at scale, and indeed other countries around the world have already achieved dramatic improvements by moving towards a system of fewer acute hospitals providing higher quality treatment. All CCGs, Foundation Trusts and STPs should evaluate how such a hub and spoke model could improve patient outcomes and save money in their area.

The importance of this model will be felt further in the next decade. At first, new 4IR technology for surgery and personalised medicine will likely be very expensive, meaning that only a few hubs around the country will be able to afford them. By ensuring that different hospital hubs specialise, the NHS can maximise coverage around the country. And in the long term, improvements in connectivity and transport links should mean that patients are less opposed to travelling further for acute treatment.

As Dr Sobia Raza, Head of Science at the PHG Foundation, a health think tank that's affiliated with the University of Cambridge, told the House of Lords AI Committee, "there is an important need for healthcare professionals to have knowledge about the technology, to be aware of what it is capable of and to understand its limitations and gauge an awareness of how it might change or influence clinical practice in years to come".

We shouldn't necessarily expect a professional clinician to immediately be able to pick up new technology. Indeed, highly specialised technology could take years to fully master. For the next generation of doctors and nurses these technologies will become second nature, and the nurse of the future could well become a higher-level delegator. Overseeing patient care and managing technology to ensure care is delivered appropriately will become a key element of future nursing roles.

In the meantime, the NHS must prioritise the upskilling of current staff to be ready to use new technology – a goal supported by the House of Commons Health and Social Care Select Committee.⁴⁶

In particular, further investment must be made into continuing professional development (CPD) for NHS professionals (see Recommendation 7).

Automation & AI must deliver benefits for patients on the NHS's front line

At the same time as investing in staff, Conservatives must act to alleviate fears that robots will entirely replace humans in the NHS. As every patient knows, what remains central to the success of the NHS is the personal service provided by doctors and nurses on the front line.

46 <https://publications.parliament.uk/pa/cm201719/cmselect/cmhealth/353/35302.htm> House of Commons Health Select Committee, The nursing workforce report, January 2018



Recommendation 7

Technology retraining scheme for doctors and nurses – Continuing professional development for the 4IR

As NHS budgets are increased in the coming years, money should be set aside for continuing professional development and a special technological retraining scheme for doctors and nurses.

Just as the 2017 Conservative Party Manifesto pledged a National Retraining Scheme for workers in jobs threatened by technological change, the NHS should put in place a similar scheme for doctors and nurses who will be tasked with managing and using new, advanced 4IR technologies in the future, including AI, VR and AR. This scheme could be funded via the savings from automation (see Recommendation 8).

The scheme would have two objectives: firstly, help clinicians whose specialist work is being replaced by automation, and secondly, enable doctors and nurses to develop the technical skills to use the medical technologies of the future.

Figures published by the Department of Health and Social Care show the number of full-time equivalent nurses and health visitors has increased by around 5,700 since October 2010, while there are 11,700 more doctors working in NHS hospitals and community health services in England in May 2017 compared to May 2010 when the Conservatives originally came into office – a 12% increase.⁴⁷

Some commentators have suggested medical AI could save the NHS from a forthcoming deficit of £20 billion, while Jeremy Hunt said extra investment in technology could enable the NHS to save around £22 billion through a reduction in waste, rising productivity and improved efficiency.⁴⁸

A study by the University of Birmingham stated that the use of technology to treat liver conditions is highly effective and can stop patients from undergoing unnecessary biopsies.

It is estimated that it could potentially save the NHS about £150,000 per 1,000 patients.³ Equally, researchers at a hospital in Oxford recently developed AI that can diagnose scans for lung cancer and heart diseases that could potentially save the NHS billions of pounds. Currently about £2.2 billion is spent on pathology services in the NHS which the new system could potentially reduce by a half.⁴⁹

However, as pointed out by Martin Burns, from Bruin Biometrics (see case study 4), to achieve these savings across the NHS, as much focus needs to be placed on prevention as on treatment.

His product, an SEM Scanner, has the potential to spot pressure ulcers before they develop – a condition the NHS spends £175 million per month treating. Yet as he points out, one of the big hurdles he faces are Trusts that are unwilling to make an upfront investment for preventative treatment, despite the ultimate savings that could be made.

47 NHS Digital, NHS Workforce Statistics, May 2017

48 <http://www.dailymail.co.uk/wires/pa/article-3435545/4-2-billion-investment-bring-NHS-digital-age.html> MailOnline, £4.2 billion investment to bring the NHS into digital age, February 2016

49 <https://www.openaccessgovernment.org/new-technology-could-halve-the-number-of-liver-biopsies-needed-in-the-nhs/42823/> University of Birmingham, Digital liver scanning technology could halve the number of liver biopsies needed in the NHS, February 2018

50 <http://www.bbc.co.uk/news/health-42357257> BBC News, AI early diagnosis could save heart and cancer patients, January 2018



Case study 4: by Martin Burns, CEO, Bruin Biometrics LLC

Every person in the country knows someone who has experienced a bed sore. Bed sores or pressure ulcers are the highest reported patient harm in the NHS: nearly 200,000 new cases are reported every year, of which some 1,000 patients die as a direct result. NHS England spends more than £175 million per month on treatment costs alone. They are painful, odorous and embarrassing. More than 80% are avoidable.

Early Detection is Vital

Starting at the invisible, cellular level, pressure damage works its way from inside out. Incipient damage is invisible until it manifests at the skin's surface. Healthcare practitioners have to wait until damage manifests at the skin's surface until specific treatments are applied.

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A pressure ulcer (PU) is a wound. All wounds inflame in their early stages. Think about the last time you hit your hand with a hammer: a swollen hand was the immediate result. PUs are no different, albeit the inflammation is microscopic, but detectable by the scanner. The sub-epidermal moisture (SEM) scanner, a seven-time innovation and patient safety award winner, uses physics to change the way this condition is identified and prevented through earlier treatment. The SEM Scanner works by measuring changes in moisture under the skin when placed on areas where damage is most likely to occur, such as the heels and lower back. Nurses gain on average a five-day detection advantage.

Rollout is Substantially Cost-Saving to the NHS

When prevention is realised, ward nurses spend less time treating, beds are freed up, community nursing burden is reduced, the NHS spends less and fewer patients suffer unnecessarily. Incidence reduction outcomes have already been demonstrated, at scale, within the NHS by BBI and our nursing collaborators when using our SEM Scanner in a prevention-focused protocol (the "Act Before Red" protocol). This programme has been demonstrated at nine sites across the UK and beyond.

BBI's own health economics model and real-world experience shows that when a 50% reduction of PUs grades II-IV is achieved in an average 300-bed facility with a prevailing 1.6% incidence rate, five cascading benefits result in one year:

1. £350,000 in material cost savings (mattresses/dressings etc). This literally means, "do not spend the materials budget".
2. 37,000 fewer treatment hours. This is the equivalent of 22 full-time nurses who can be dedicated to other activities.
3. 508 released bed days. This is the equivalent of 91 additional admissions per year.
4. £28,000 in litigation savings.
5. A negative Incremental Cost Effectiveness Ratio (ICER) per Quality of Life Year (QALY), meaning an overall cost saving and concurrent improvement in patients' quality of life.

Facilities using our SEM Scanner in a prevention-focused protocol have managed to reduce their incidence to zero or near zero and keep it there.

With technology and collective, systemic action, this is a disease state whose persistent incidence is tantalizingly close to becoming a "never event".



For the NHS to fully realise the potential of new technology and services, it needs to be bold, forward-thinking and willing to invest in transformative treatments that have the potential to make huge savings.

In particular, automation and AI have the power to liberate staff from labour-intensive, low-value tasks such as storing paper records, sending letters, transcribing notes, booking appointments, or transferring patient records (see Recommendation 8).

As the use of automation and AI in the NHS rises, we must be willing to redistribute money saved from back office tasks towards the front line, giving a solid political commitment that automation and AI can have a positive impact on the quality of healthcare for patients, and a positive financial impact too.

Recommendation 8 **Guarantee that every pound saved from back office automation is re-invested in frontline services**

Technology should not be viewed as a silver bullet for solving all the challenges faced by the NHS. However, by using automation & AI to save money on back office tasks, funds can be released for front-line health service priorities.

McKinsey have estimated that automation alone could save the NHS £4.5 billion in wages,⁵¹ with potentially more than 100,000 jobs being automated. NHS England estimate that a fully implemented digital service could in the long-run save up to £13.7 billion a year. In total, the NHS spends about £40 billion a year on front-line staff.

Automation has the power to liberate NHS staff from labour-intensive back office tasks and help those performing on the front-line. For example, more efficient surgery techniques assisted by automation should translate into more surgeon hours and shorter waiting list times, whilst AI-assisted diagnostics should mean quicker turnaround times for results. New technology will supplement and improve the quality of service in the NHS.

To ensure that happens, Conservatives should pledge that every pound saved through automation and AI is ploughed back into front line services such as doctors and nurses.

⁵¹ <https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-the-future-of-work-will-mean-for-jobs-skills-and-wages> McKinsey Global Institute, What the future of work will mean for jobs, skills, and wages, November 2017



7. Nurturing cutting-edge technology for the NHS

Throughout the NHS's 70-year history, British scientists and doctors have been at the forefront of medical innovation.

In 1972, CT scanners produced three-dimensional images from a large series of two-dimensional X-rays for the first time, revolutionising the way doctors examine the body, following the Nobel Prize-winning work of English electrical engineer Godfrey Newbold Hounsfield.

Six years later, Louise Brown became the first baby born as a result of IVF after work by Dr Patrick Steptoe, a gynaecologist at Oldham General Hospital, and Dr Robert Edwards, a physiologist at Cambridge University, to develop a new technique to fertilise an egg outside a woman's body before replacing it in the womb. More than a million children worldwide have been conceived in this way, making the dream of a family possible.

In 1987, Professor Sir Roy Calne and Professor John Wallwork carried out the world's first liver, heart and lung transplant at Papworth Hospital in Cambridge, offering hope to people with failing organs.

We should rightly be proud of the part that has been played by British clinicians in making the world a healthier place. But as the NHS celebrates an historic milestone, it's important to look to the future and ensure that the NHS continues to be a hotbed of innovation, taking advantage of our world-class universities, hospitals and scientific institutions to continue advancing medicine.

Political energy and public finances are often directed towards day-to-day health priorities. But it's important not to lose focus on the benefits that longer-term innovation can bring to the NHS. The Academic Health Science Networks (AHSNs) are at the centre of the Government's efforts to develop more innovation within the NHS. AHSNs are a network of 15 different regional organisations that support improvements around common themes such as patient safety, and success stories are already emerging.

For instance, home monitoring of hypertension in pregnancy (HaMpton), developed by the maternal foetal medicine team at St George's Hospital, London, is just one example of the dozens of innovations being supported by AHSNs. If scaled-up across the NHS, it could save £50 million a year while producing a 53% reduction in the number of appointments for hypertension monitoring.

As of January 2018, scale-up money has been used to support 37 projects across the NHS, delivering products to 964 additional sites and helping 13 innovations sell internationally.⁵² But more needs to be done, and the NHS has to continue to incubate more of these success stories, as well as encouraging an innovation environment within hospitals.

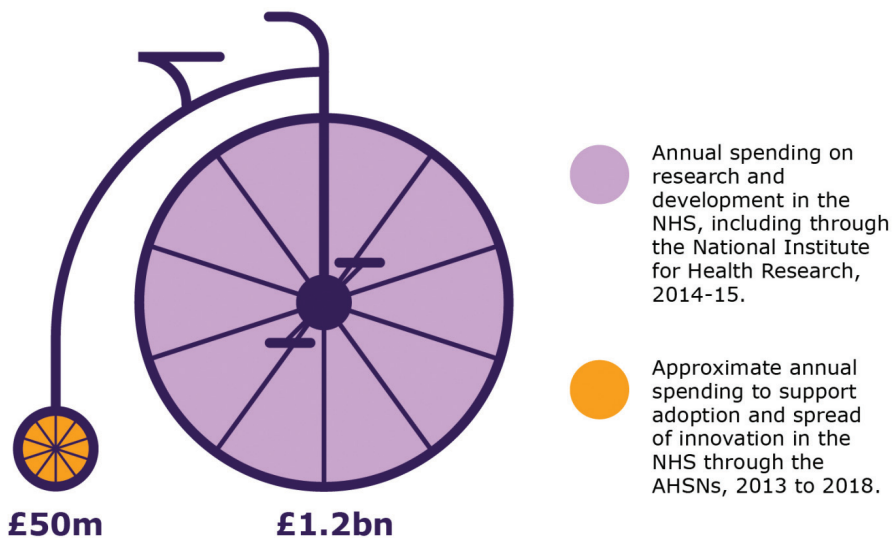
More money and focus needs to be put into AHSNs, which have the potential to develop new technology across the NHS for the benefit of patients. These organisations need to keep growing fledgling innovative ideas and spreading best practice across the NHS.

But equally, as highlighted in a report by the NHS Confederation, in isolation small-scale technology projects will not bring about the “fundamental shift” envisioned in the NHS Five Year Forward View. Put simply, the NHS must think bigger.⁵³

That starts with more NHS investment into R&D, which is a catalyst for success in all areas of the 4IR. Nationally this has long been a weakness for the UK, which has lagged behind our OECD competitors when R&D expenditure is calculated as a percentage of GDP. Outside of healthcare it’s vital that the Government works with business and industry to develop a road map for increasing national R&D investment to three per cent of GDP by 2030.

The same picture is reflected within the NHS. A report by the King’s Fund this year found that only £1.2 billion was spent by the NHS on R&D, less than one per cent of its overall budget. Just £50 million is being spent on helping the spread of new technologies.⁵⁴ That’s in comparison to private healthcare providers that can spend up to 25% of their budgets promoting innovation.

Money spent on the spread of new technology – King’s Fund



52 <http://www.ahsnnetwork.com/wp-content/uploads/2018/02/Introducing-the-NHS-Innovation-Accelerator.pdf> AHSN, Introducing the NHS Innovation Accelerator, February 2018

53 <http://www.nhsconfed.org/resources/2017/09/new-care-models-harnessing-technology> - NHS Confederation, New care models: Harnessing technology, September 2017

54 <https://www.kingsfund.org.uk/publications/innovation-nhs> Kings Fund, Adoption and spread of innovation in the NHS, January 2018



As the King's Fund report into the adoption and spread of innovation in the NHS concludes: "As long as the NHS sets aside less than 0.1 per cent of available resources for the adoption and spread of innovation, a small fraction of the funds available for innovation itself, the NHS's operating units will struggle to adopt large numbers of innovations and rapidly improve productivity."

While there needs to be more investment into new technology, equally as important is the need to create a better innovation culture within the NHS. As former Health Minister Nicola Blackwood wrote in her recent report: "There is no other way to put this: the NHS is digitally risk-averse. That is not to say that NHS staff are technophobes, and there are some outstanding examples of good practice across the country. But taken as a whole, there is a collective failure of the organisation to provide the requisite opportunities to scale new technologies."⁵⁵

As Martin Burns from Bruin Biometrics describes it, "don't call it innovation, call it leadership".⁵⁶ For him, to shed its risk-averse decision-making process, the NHS needs a different approach, one that ultimately accepts that not all innovations will succeed.

As the NHS heads into its next 70 years, a renewed focus needs to be placed on both how to nurture an innovation culture within the NHS and on increasing investment into new technology. That means strategic focus needs to be directed towards how spending on R&D and innovation can be increased as budgets increase (see Recommendation 9). Importantly that means considering how capital budgets are funded, ensuring trusts stop redirecting capital funds to pay for day-to-day spending revenue budgets, and ensuring spending on innovation always increases by at least the same percentage as the overall NHS budget.

Recommendation 9 More investment into R&D as NHS budgets increase – to speed up adoption of new technologies

While the focus of NHS spending is often immediate spending commitments, in the long term the NHS needs investment on R&D too.

Therefore, as the overall NHS budget increases, the amount of money earmarked for R&D and helping the spread of new technology should increase by at least the same percentage point level as the overall budget.

Equally, capital budgets for innovation and new technology must be ringfenced to stop NHS trusts from moving those funds into day-to-day revenue budgets.

With more money set aside for developing innovation, the AHSNs will have more resources to spot the best examples of innovation, fast-tracking and upscaling them to a national level.

More focus on R&D has the potential to create a pro-innovation culture within all levels of the NHS.

55 <http://www.public.io/wp-content/uploads/2018/04/PUBLIC-The-Promise-of-HealthTech.pdf> Nicola Blackwood, The Promise of HealthTech, April 2018

56 Evidence given by Martin Burns, CEO, Bruin Biometrics LLC



8. NHS Worldwide

While more needs to be done to boost innovation within the NHS, once a treatment or new technology has proven effective at a national level, it should be exported and made an international success with British origins.

As one of the leading health organisations in the world, the NHS benefits from a brand that is recognised and respected globally. With its wealth of data and leading minds, the potential is vast for the NHS to develop and export new treatments to generate funds for the NHS in Britain. This isn't a case of selling data or taking funding away from the NHS's core services. In fact, there is no reason why after nurturing the best of British innovation, those new treatments shouldn't be sold around the world, with proceeds returning to the NHS to strengthen the NHS.

Precedents already exist. For example, Moorfields in London, the oldest specialist eye hospital in the world, now has centres of excellence in Dubai and Abu Dhabi.

Going forward, there needs to be a concerted focus on translating British healthcare innovation into global exports that raise revenue to be spent on the NHS in Britain.

Responsibility for promoting the NHS abroad is currently with Healthcare UK, a joint initiative of the Department for International Trade, the Department of Health and NHS England. Healthcare UK helps healthcare providers do more business overseas by promoting the UK healthcare sector to overseas markets.⁵⁷

However, this service only joins together British healthcare organisations and export markets. What's needed is a fully fledged commercial arm of the NHS that operates in a similar way to BBC Worldwide (see Recommendation 10).

This same approach has already been successfully implemented by a number of Fire and Rescue Services across Britain, which since 2004 have been able to trade with both the public and private sectors for profit. They are legally allowed to form "arm's length" companies, with 100% of all profits being returned to the Fire and Rescue Service to boost frontline services. One such example is 3SFire, a wholly-owned subsidiary of Hampshire Fire and Rescue Service, which has a turnover of £1 million producing a dividend worth £130,000 last year.

57 <https://www.gov.uk/government/organisations/healthcare-uk/> Healthcare UK – About Us



Recommendation 10

Launch NHS Worldwide – a new NHS commercial arm to replace Healthcare UK

The NHS brand is recognised and respected around the world, and therefore the Government's current healthcare export arm should be brought into the NHS family. This mirrors the successful rebranding of the Health and Social Care Information Centre to become "NHS Digital" following a recommendation in the Caldicott Review.

Using the prestigious NHS brand, Healthcare UK would become NHS Worldwide, a new global arm to sell and promote British excellence in healthcare for the benefit of the taxpayer. The newly formed organisation would have the power to invest in new technology and would operate as a commercial body in a similar way to BBC Worldwide. Wholly owned by the taxpayer, all profits would go back into the NHS to benefit patients. NHS Worldwide would be fully self-funded in the long-term and would sell healthcare techniques, smartphone apps, robotic surgery or medicines around the world.

As well as promoting and investing into British technology abroad, NHS Worldwide could deploy money from the Department for International Development to spread British healthcare innovation into developing countries.

NHS Worldwide would be solely for selling products developed by the NHS into international markets – and the case needs to be made to the public that this is not a privatisation of the health service in any way, but rather an innovative way to raise additional revenue for the NHS to spent in Britain.

In addition, currently the Department for International Development spends around 11% of its budget or £851.7 million on health, including £111.4 million on medical research.⁵⁸ The Government should invest more of this money into British technology projects that spread healthcare innovation into developing countries.

Innovation and new technology offer a rare and tantalising opportunity for the NHS. The modern-day accessibility of technology makes it far easier to both develop and up-scale innovation. That's especially true in healthcare where something as simple as a smartphone app has the potential to improve care. Likewise, AI has high up-front costs but quickly and cheaply scales-up.

As NHS England Chief Executive Simon Stevens has said, the NHS is a "hotbed" of innovation. It's now vital to maximise that opportunity to benefit the NHS itself by thinking globally.

58 <https://www.gov.uk/government/organisations/healthcare-uk/> Healthcare UK – About Us



Conclusion

As the 4IR accelerates, there is no other sector or policy area where new technology has such unqualified transformative potential as in healthcare.

Smartphone apps, video consultancy, AI, VR, AR, personalised medicine and robotics will all fundamentally redefine the relationship between doctor and patient – and transform the way the NHS works.

As this report makes clear, there are several recommended steps that the NHS must take to benefit from the 4IR, but with its wealth of data, history of innovation and committed staff, it is well placed to do so. Shedding outdated technology such as fax machines and pagers must be a priority, and the introduction of an integrated app such as NHS NOW can put data, and therefore power, back into the hands of patients.

Delivering Jeremy Hunt's ambition for a "decade of patient power" is tantalisingly within reach, but to realise that ambition, the patient must be put at the heart of every decision taken to improve the NHS in the coming years. Patients should have control over their health and wellbeing, be involved in every stage of their treatment, and have the facts and figures they need to make informed choices. After all, this is already the case in every other aspect of their lives as consumers and citizens.

Equally, a fully digital NHS will finally eliminate paper, saving the taxpayer billions of pounds a year through improved connectivity within the Health Service, resulting in better efficiency, care and health outcomes. As the Government develops a long-term funding deal for the NHS, it should place innovation and patient power at the heart of its plans. Only by doing so can we renew the NHS for the years ahead, and strengthen the Conservatives' position as the party that voters trust as stewards of the Health Service.

If you are interested in the Fourth Industrial Revolution, please contact me to see how you could get involved in the 4IR APPG, for example as a Parliamentary supporter, industry sponsor, or as a representative of the media, business, academia, or investor community. We welcome interest from all sectors. As I have consistently said throughout this report – and in my wider work on this topic over the last two years – ensuring Britain leads the 4IR is the greatest political and economic opportunity of our generation. If we seize those opportunities, both in the NHS and beyond, we can build a country that is not just fit for the future, but one that gets to the future first.