Embracing technology in health and social care

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TaxPayers'
Alliance

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Foreword

I love our NHS because it's always been there for me and my family, through some of the best moments in life and some of the worst. So my number one priority is making sure it continues to always be there for every family.

It's why I care about technology in health and care. Tech transformation in the NHS directly unlocks or frees resources for just about every other improvement we want to see, from using data to help boost cancer survival rates to joining up health and care to giving clinicians back the precious gift of time. Longer-term, it's the only way we're going to bridge the gap between finite resources and the growing demand of an ageing population.

This report from the TaxPayers' Alliance is a timely and provocative intervention in this debate. Whilst we don't agree on everything, the TPA has a long history of challenging the status quo. So I welcome the challenge to think even harder about how we can use technology and innovation to save money, time and ultimately lives.

Many of the innovations that the TPA highlights depend on us first getting the technical infrastructure right, something I set out in my Tech Vision for Health and Care last year. This includes sorting out the NHS's data layer: ensuring that essential diagnostic information about you can be accessed safely and reliably from wherever you are in the system, just as you can access your emails from any device. It also means only buying or building systems that can talk to each other, designing them in a way which means we can plug in the latest innovations without breaking the technical plumbing underneath. It might not be as glamorous as robotics, genomics or AI, but it's completely essential if we want to take advantage of this new technology.

I'm glad to report that this work is already underway, and with the formation of our new tech transformation unit – NHSX – it's now set to accelerate.

But it's not just about inventing new technology. In some ways that's the easy part. The hard part is getting those ideas to spread. This is as much about people and culture as it is about open APIs and interoperability. Some of the best minds in health technology already work for our NHS. We need to make sure they get heard at the highest levels. We also need a flourishing healthtech ecosystem rather than a supplier market dominated by a few giant incumbents. Above all, every decision we make on new technology needs to be guided by real evidence about the needs of the patients and staff.

Technology has huge potential to improve productivity in health and care. Just as important it has the potential to improve the working lives of our amazing clinicians and care staff, freeing them up to do more of what they love: treating and caring for patients.

It's an exciting time for healthcare and I congratulate the TPA for putting this issue on the agenda.

Rt Hon Matt Hancock MP
Secretary of State for Health and Social Care

Introduction

This paper is the second in the TPA series investigating automation in the public sector. In our first paper we set out the benefits for taxpayers, public sector workers, and the economy of increasing the rate of automation in the public sector. These benefits include public services being delivered in a more cost effective and efficient way as productivity increases. Public sector workers will also be freed up from performing mundane and repetitive tasks and be able to undertake more rewarding and challenging work.

The previous paper looked at the potential savings in terms of staff costs. It found that introducing automation could result in annual savings of £17 billion for the public sector by 2030.[1] In this paper we focus our attention on the potential savings in terms of staff costs and other expenditure resulting from the accelerated adoption of automation in health and social care in the UK.

There are case studies interspersed throughout the paper. They contain examples of automation being used in a health and social context in the UK and around the world. These are for illustrative purposes and explain how these technologies have the potential to improve patient outcomes and also achieve significant savings.

The NHS is seldom out of the news and hardly a day goes by without newspapers and the broadcast media highlighting the challenges facing it. Indeed, the government recently announced a substantial increase in funding for the NHS.

Over the coming decades the UK will have an ageing population, which will place increased pressure on both health and social care. It is essential that this challenge is addressed, so that high quality health and social care can be provided now and into the future.

This paper will examine the potential impact of the increased use of automation in health and social care. It will consider how embracing existing and developing technology can enable the health and social care system to increase productivity, reduce costs, and result in better – world class – health and social care.

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[1] Ramanauskas, B., 'Automate the State: Better and Cheaper Public Services', *TaxPayers' Alliance*, June 2018.

Key findings

- The potential value of time released for NHS staff through improved productivity from increased automation is estimated to be **£12.5 billion** a year.

- The social care sector could similarly save **£5.9 billion annually** by improved productivity from accelerated automation.

- These combine to give potential annual savings of up to **£18.5 billion** by 2030.[2]

- The ways these annual savings could be achieved by embracing automation include:

    - **£1.1 billion** in pathology costs

    - **£75 million** on medication for insomnia, depression, and anxiety

    - Improved cardiovascular diagnosis delivering savings of **£300 million**

    - Improvements in end of life care that could yield savings of more than **£556 million**

    - The greater use of automated systems to help patients recover better after operations, thereby saving the NHS **£100 million**.

- There will be an increase from 19 per cent of the population being above the state pension age in 2016 to 23.1 per cent in 2066.

- Public spending on health as a percentage of national income is projected to increase to over 12 per cent of national income by 2067.

- The NHS is facing significant challenges, and is introducing steps to tackle them.

- There are barriers to entry into the NHS for companies offering innovative healthcare solutions. Many are being addressed and in the long term it's crucial that the NHS remains open to new ideas and innovation.

- In order to continue to provide world class care now and in the future, the NHS will have to take steps to increase its productivity. Progress is already being made in this regard, but big productivity gains are made when technology is embraced.

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[2] These figures are based on analysis conducted by IPPR on data provided by McKinsey and the NHS. Using different methods of analysis may reveal different potential savings.

Demographic change

Due to improved health outcomes, the UK will experience a demographic change over the next 50 years as life expectancy continues to increase.[3] [4] The number of people over the state pension age will increase from 12.4 million in 2016 to 18.9 million in 2066.[5]

Chart 1: cohort life expectancy at birth (UK), 2019-2066[6]

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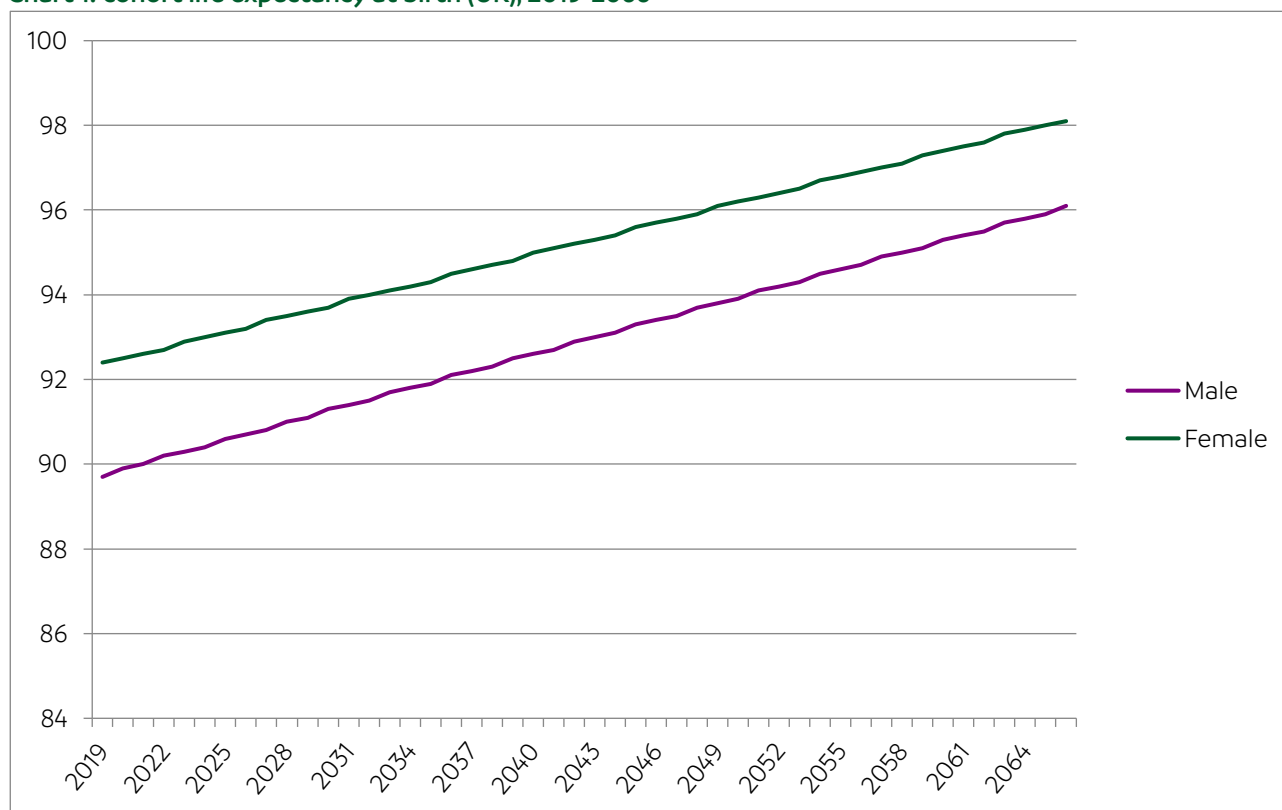
[3] OBR, *Fiscal sustainability report*, July 2018.

[4] ONS, *Life expectancy at Birth and at Age 65 by Local Areas in England and Wales: 2012-2014*, November 2015.

[5] *Ibid.*

[6] ONS, *Past and projected data from the period and cohort life tables, 2016-based, UK: 1981 to 2066*, December 2017.

Increased spending on health and social care

There will also be an increase in demand for services from the NHS driven by improvements in procedures, treatments, diagnostics, and understanding in addition to a growing population. This, coupled with an increased elderly population, will result in significantly more pressure on health and social care services in the UK.[7] Public spending on these in both real terms and as a percentage of GDP is set to grow over the next five decades.[8] [9]

Public spending on health as a percentage of national income is projected to increase over the coming years and decades to almost 14 per cent of GDP in the financial year ending 2067.[10]

Table 1: forecast spending on health and social care compared to other expenditure as a percentage of GDP, 2017-18 to 2067-68[11]

	2017-18	2022-23	2027-28	2037-38	2047-48	2057-58	2067-68
Health	7.1	7.6	8.3	9.9	11.3	12.6	13.8
Adult social care	1.2	1.3	1.4	1.6	1.8	1.9	1.9
Education	4.3	4.1	4.0	3.8	3.8	3.9	3.8
State pensions	5.1	5.0	5.0	5.9	6.3	6.6	6.9
Pensioner benefits	0.8	0.8	0.9	1.1	1.3	1.3	1.3
Public service pensions	2.0	2.1	2.1	1.8	1.6	1.6	1.5

[7] Luchinskaya, D., Simpson, P., & Stoye, G., 'UK health and social care spending', *IFS*, 2015.
[8] OBR, *Fiscal sustainability report*, July 2018.
[9] Appleby, J., 'Spending on health and social care over the next 50 years: Why think long term?', *The King's Fund*, 2013.
[10] *Ibid.*
[11] OBR, *Fiscal sustainability report*, July 2018.

Challenges facing the NHS

Public spending on health and social care is projected to increase significantly over the next five decades. However, it is important to note that current projections for spending are based on numerous assumptions, including that productivity in the NHS will increase in the coming years.[12] This is important because, although the NHS has witnessed some increase in productivity growth over recent years, historically it has been low and still lags considerably behind the rest of the UK economy. However, since 2007 productivity growth in healthcare has outstripped productivity growth in the rest of the economy.[13] This trend will need to continue if it is to match the productivity growth assumed in the OBR's projection.

Chart 2: cumulative productivity growth in health care & in the whole economy[14]
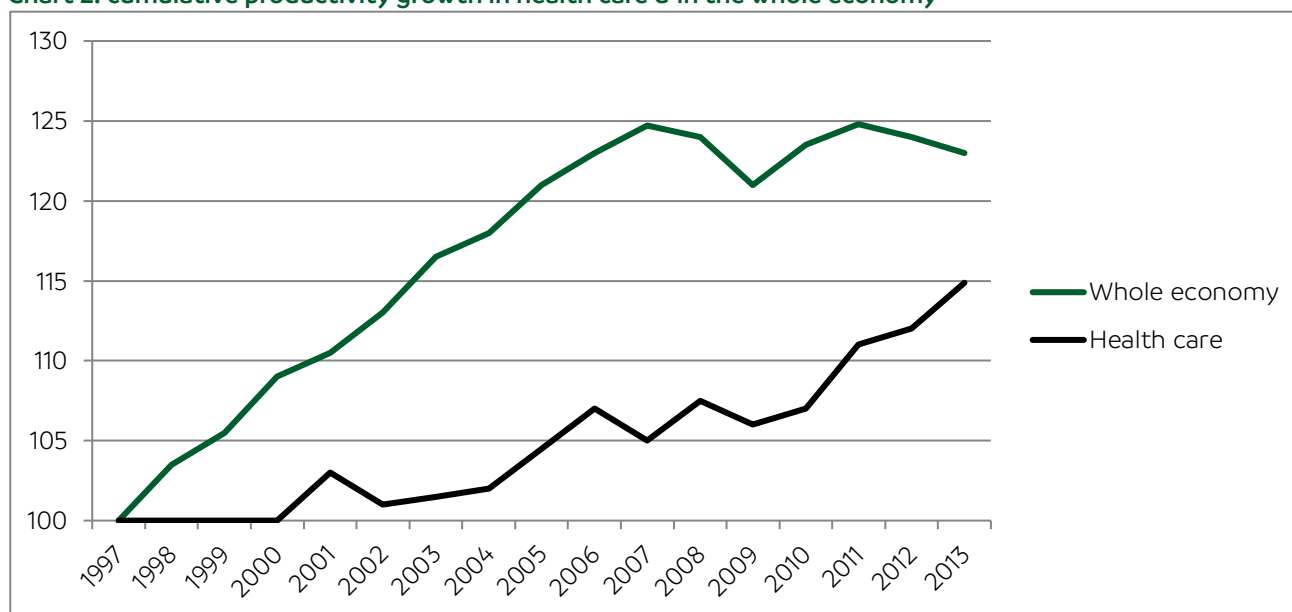
Research conducted by the Commonwealth Fund ranks the NHS as the number one healthcare system out of 11 highly developed countries. It ranks particularly highly in regard to care process and equity. It also performs well in terms of access and administrative efficiency.[15]

The NHS has been striving to improve efficiency in recent years. There are case studies interspersed throughout this paper, highlighting examples of best practice in individual NHS Trusts and in other countries. There are also numerous examples of the NHS improving systems and processes across the board in order to provide a more efficient service for patients.

For example, the NHS has introduced the 'Getting It Right First Time' (GIRFT) programme. The aim has been to improve clinical quality and efficiency in all main surgical and medical specialities. It does this through the use of datasets which help to equip clinicians and management to focus on boosting quality and productivity.

The GIRFT pilot saved the NHS over £50 million in one speciality over one year. It also helped to improve the outcomes of thousands of patients.[16]

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12 *Ibid.*
13 ONS, *Public service productivity estimates, healthcare: 2015*, January 2016.
14 *Ibid.*
15 Commonwealth Fund, *Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care*, July 2017.
16 Marlow, J., 'Taking on the productivity challenge', *NHS Confederation*, 14 February 2017.

The NHS is also investing £3.5 billion on mobile medical teams. These will comprise of GPs and pharmacists who will be sent to care homes in order to reduce the number of unnecessary hospital admissions and lower hospital waiting times as a result.[17]

Further efficiency savings have been achieved through electronic prescribing at GP surgeries and pharmacies. This has resulted in patients spending less time in pharmacies and GP surgeries and removed the risk of prescriptions being lost. The Health and Social Care Secretary, Rt Hon Matt Hancock MP has called for this to be expanded across the NHS and is projected to bring savings of £300 million by 2021. As the he remarked:

"We need to harness technology across the NHS to improve care, save time for patients, and make the lives of hardworking staff easier. In an NHS where thousands of GP surgeries already enjoy the benefits of electronic prescriptions, it can't be right that there are occasions when archaic paper prescriptions still have to be used.

As part of our long-term plan, I want the NHS to become the most advanced healthcare system in the world. Electronic prescribing both saves GPs' time and helps to give patients a better, more seamless experience and ensures every pound of taxpayers' money is spent effectively".[18]

This commitment to continuing to improve productivity and efficiency is both welcome and necessary. This is because, despite the skill and dedication of healthcare professionals in the UK, the NHS lags behind other healthcare systems in a number of ways.

For example, in terms of the rate of avoidable deaths, the NHS does not always compare favourably to other healthcare systems.[19] However, over the last decade the UK saw a larger decline in mortality amenable to healthcare than in other highly developed countries.[20]

Chart 3: amenable mortality (avoidable deaths), standardised rates per 100,000 inhabitants, 2015[21]

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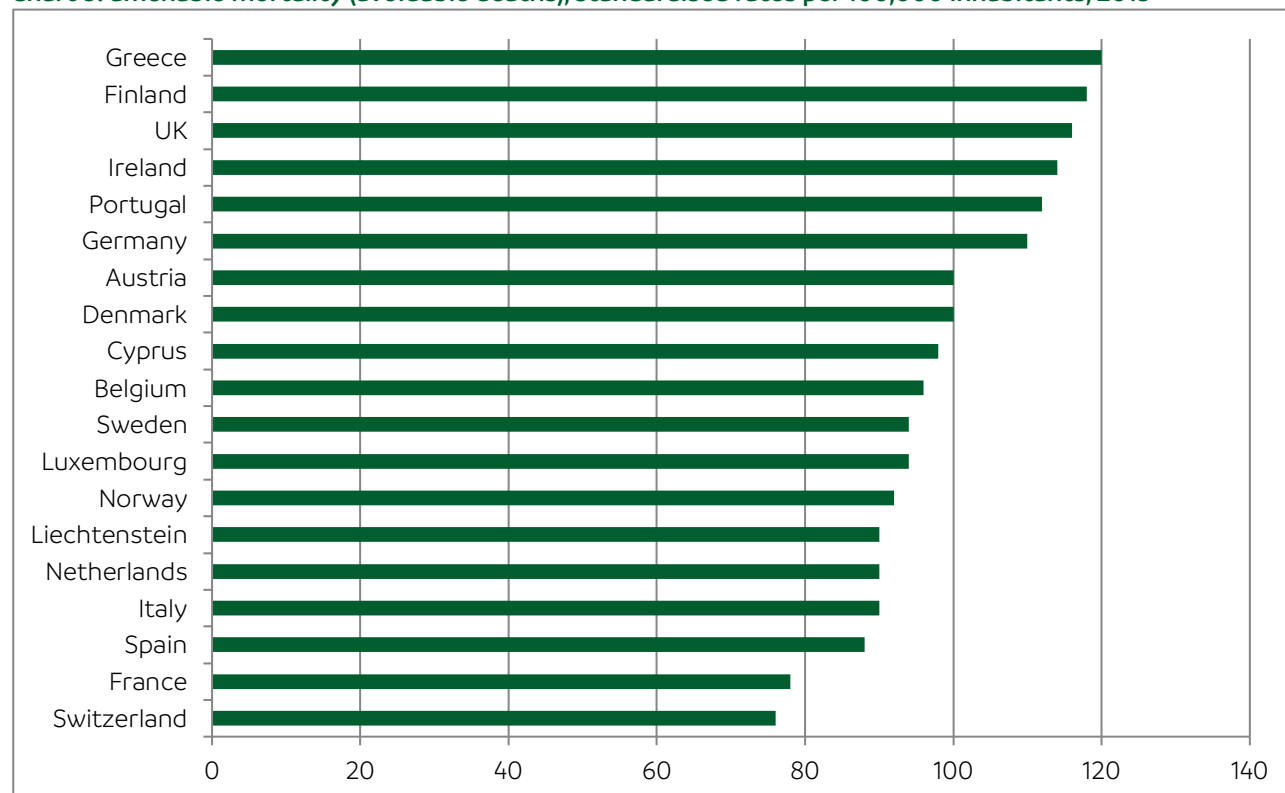
[17] Gault, B., 'GPs to be assigned to care homes to provide tailored treatment and support', *Pulse*, 21 November 2018.
[18] Department of Health and Social Care, *Expansion of electronic prescribing at GPs and pharmacies*, 26 August 2018.
[19] Jarcuska, P., Janicko, M., Bartak, M., Gavurova, B., & Vagasova, T., *Central European Journal of Public Health*, December 2017.
[20] Commonwealth Fund, *Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care*, July 2017.
[21] Niemietz, K., 'Towards a Patient-Centred Health System', *Institute of Economic Affairs*, 2016.

For cancer survival, the NHS again does not compare favourably with healthcare systems in other countries.[22]   Take the most common type of cancer diagnosed each year in the UK: breast cancer. The UK's 5 year survival rate for breast cancer is 81.1 per cent. This rate is approximately eight percentage points below Sweden's, which translates into over 4,200 excess deaths per year.[23]

Case study 1: breast cancer care

OWise is the first personalised care app for patients with breast cancer. It allows patients to record, in real time, their side effects and overall quality of life, and collates fully anonymised patient-reported data with a view to improving clinical outcomes for cancer. It therefore allows clinicians to tailor care for their patients.[24]

Breast cancer is the most common cancer in the UK, with one person being diagnosed every 10 minutes. It claims the lives of 11,400 people every year in the UK.[25] Incidence rates have increased by a fifth since the 1990's and are projected to rise by two per cent by 2035.[26]

Automation has the potential to help improve health outcomes for one of the most common forms of cancer in the UK.

Case study 2: breast cancer diagnosis

A 2009 study conducted in the United States found that one in four breast cancer patients was affected by the process of care failure such as inadequate physical examinations and incomplete diagnostic tests.[27] Furthermore, a study from 2017 found that pathologists miss small metastases on individual slides as frequently as 62 per cent of the time when under time constraints.[28]

Google is developing a new AI system called the Lymph Node Assistant (Lyna). A December 2018 study found that it has achieved an area under the receiver operating characteristic – a measure of detection accuracy – of 99 per cent.

Further developments and research will need to be conducted in order to increase its accuracy. However, it does demonstrate the potential of the technology. For example, the model used in the study halved the amount of time it took for a six-person team of board-certified pathologists to detect metastases in lymph nodes.

As the authors of the paper stated: "[Lyna] achieves higher tumor-level sensitivity than, and comparable slide-level performance to, pathologists. These techniques may improve the pathologist's productivity and reduce the number of false negatives associated with morphologic detection of tumor cells".[29]

[22] Joumard, I., Andre, C., & Nicq, C., 'Health Care Systems: Efficiency and Institutions, *OECD*, June 2010.
[23] Niemietz, K., 'Towards a Patient-Centred Health System', *Institute of Economic Affairs*, 2016.
[24] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[25] Breast Cancer Care, *Facts and Statistics 2018*, January 2018.
[26] Cancer Research UK, *Breast cancer statistics*, 2018.
[27] Weingart, S., Saadeh, M., Simchowitz, B., Gandhi, T., Nekhlyudov, L., Studdert, D., Puopolo, A., Shulan, L., 'Process of Care Failures in Breast Cancer Diagnosis', *Journal of General Internal Medicine*, June 2009.
[28] Bejnordi, B., Veta, M., van Diest, P., Ginneken, B., Karssemeijer, N., Litjens, G., van der Laak, J., 'Diagnostic Assessment of Deep Learning Algorithms for Detection of Lymph Node Metastases in Women With Breast Cancer', *The Journal of the American Medical Association*, December 2017.
[29] Stenier, D., MacDonald, R., Liu, Y., Truszkowski, P., Hipp, J., Gammage, C., Thng, F., Peng, L., Stumpe, M., 'Impact of Deep Learning Assistance on the Histopathologic Review of Lymph Nodes for Metastatic Breast Cancer', *The American Journal of Surgical Pathology*, December 2018.

Many healthcare systems around the world are classed as more innovation friendly in relation to pharmaceuticals than the NHS.[30]   Also, in terms of overall quality, the NHS again lags behind healthcare systems in other countries as classified by the Commonwealth Fund, which judges healthcare systems on their health outcomes. This is defined as the "change in the health of an individual, group of people or population which is attributable to an intervention or a series of interventions". It includes a healthcare system's record for infant mortality, life expectancy, survival rates for strokes and illnesses such as cancer.[31] [32]

Case study 3: AI in pathology and radiology

Google DeepMind has started using AI to analyse CT and MRI scans from cancer patients in order to devise an algorithm that can instantly distinguish between healthy and cancerous tissue. The technology can provide a quick and accurate diagnosis of cancers of the head and neck, reducing the time in clinics from three hours to just 30 minutes.[33] If the NHS introduced technology such as DeepMind, cancer survival rates could potentially increase in the UK.

There is also the potential for huge savings to be made in pathology with the use of automation. For example, Professor Sir John Bell, the Regius Professor of Medicine at Oxford University and author of the government's report on life sciences and industrial strategy, has claimed that the widespread use of automation in pathology could save the NHS £1.1 billion every year. He stated: "There is about £2.2 billion spent on pathology services in the NHS. You may be able to reduce that by 50 per cent. AI might be the thing that saves the NHS".[34]

Table 2: international health outcome rankings[35]

Country	Rank
France	1
Sweden	2
Switzerland	3
Australia	4
Netherlands	5
Norway	6
Germany	7
Canada	8
New Zealand	9
UK	10
US	11

However, it should be noted that there are numerous factors which contribute to health outcomes. These can include diet, lifestyle, the social and economic environment and also the physical environment.[36] These, of course, differ from country to country.

As for the social care systems in the UK, it is estimated that there are now approximately 1.2 million elderly people in the UK who do not receive the help they need with essential daily living activities, an

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[30] Nolte, E., & Corbett, J., 'International variation in drug usage', *Rand Europe*, 2014.

[31] Edwards, R., 'Introduction to health outcomes', *Healthcare Costing For Value Institute*, October 2016.

[32] Dayan, M., Ward, D., Gardner, T., & Kelly, E., 'How good is the NHS?', *Nuffield Trust*, 2018.

[33] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.

[34] Telegraph Reporters, 'Artificial intelligence to diagnose heart disease', *Telegraph*, 3 January 2018.

[35] Commonwealth Fund, *Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care*, July 2017.

[36] World Health Organisation, *Health Impact Assessment*, 2013.

increase of 48 per cent since 2010.[37] Moreover, almost one in eight elderly people in the UK now live with some level of unmet care need.[38]

Getting medical help when required is also an issue in the UK. Compared to other highly developed countries, it is usually not possible for a patient to obtain a same-day appointment with a GP in England.[39] The NHS in England also performs poorly compared to other countries in terms of patient waiting times at A&E departments.[40]

Case study 4: population health intelligence

ArtemusICS is a data-driven population health intelligence platform, which supports community teams to identify and keep patients out of hospital through earlier detection and intervention. It also enables commissioners to assess the needs of their local populations better.

It has resulted in a reduction of hospital admissions for patients in care homes in Sussex by up to 75 per cent. Furthermore, 999 calls have reduced by between 65 and 70 per cent for care home patients, and GP and nurse visits have also decreased by between 40 and 50 per cent.[41] [42] [43]

£13.7 billion is spent each year on admitting patients to hospital,[44] £1.9 billion is spent each year on ambulance services,[45] and £14 billion is spent on GP appointments.[46] A significant proportion of patients using these services are care home residents.[47] Technology such as this could bring vast savings for the NHS.

Case study 5: pregnancy care

Ask the Midwife is an online advice platform run by midwives for pregnant women and their families. The service provides fast and accurate advice from UK registered midwives. As a result, pregnant women and their families are reassured, and there are fewer trips to the GP and A&E.[48]

Although patients might wait longer for an appointment with their GP or to see a doctor in A&E, the NHS does rank highly in relation to access and equity when compared to other healthcare systems. This means that there are relatively small differences between lower and higher income adults on measures related to timeliness, financial barriers to care, and patient-centred care. The UK compares favourably to the United States, France, and Canada where there are larger disparities between lower and higher income adults. These are especially large on measures related to financial barriers such as skipping needed doctor visits or dental care, forgoing treatments or tests, and not using prescriptions because of the cost.[49]

[37] Age UK, *Later Life in the United Kingdom*, January 2018.
[38] *Ibid.*
[39] Niemietz, K., 'The UK Health System: An International Comparison of Health Outcomes', *UK 2020*, 2016.
[40] *Ibid.*
[41] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[42] Docobo, *Use of low intensity Telehealth in Adult Social Care to prevent avoidable admissions*, 2017.
[43] Docobo, *Use of Telehealth to Shift the Balance of Care From Acute to Primary Care: Inverclyde Community Health Partnership*, 2017.
[44] National Audit Office, 'Reducing emergency admissions', *Department of Health & Social Care NHS England*, March 2018.
[45] National Audit Office, 'NHS Ambulance Services', *NHS England*, January 2017.
[46] NHS Digital, *GP and GP practice related data*, August 2018.
[47] Smith, P., Sherlaw-Johnson, C., Ariti, C., & Bardsely, M., Focus on: 'Hospital admissions from care homes', *Quality Watch*, January 2015.
[48] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[49] Commonwealth Fund, *Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care*, July 2017.

Further increasing efficiency and productivity in the healthcare system can result in an increase in health outcomes at a higher rate than in other highly developed countries.[50]

The health and social care services in the UK also face staff shortages.[51] Many roles in health and social care are low paid and often involve working in difficult and unpleasant situations. As a result, there can be a high turnover in these roles or NHS trusts and local authorities struggle to fill these posts at all.[52] This can lead to situations where staff members and resources are overstretched, resulting in poor outcomes for patients.

There are also issues concerning patient data and internet security. The computers used by the NHS often have outdated operating systems which place the NHS at risk of cyber-attacks and again imperils doctor patient confidentiality.[53] Between 2011 and 2014 there were 7,000 breaches of data, equivalent to six data breaches every day.[54]

A large scale data attack on the NHS could have a devastating impact on the ability of the NHS to provide care for the public. One only has to look back to 2017's WannaCry cyber-attack on the NHS to understand its vulnerability. The attack resulted in at least 6,900 appointments being cancelled, including at least 139 people potentially with cancer who had urgent referrals cancelled. An assessment of 88 NHS trusts by NHS Digital found that none passed the required cyber security standards.[55] The NHS has recognised this, and has spent a large amount of money to prevent this from happening again. £150 million will be spent on cyber security over the next three years and a multi-million Microsoft security package will ensure all health and care organisations can use the most up-to-date software with the latest security settings.[56]

As already discussed, the NHS is taking serious steps to improve efficiency and productivity in every trust in the country. What is more, several trusts have introduced new schemes in order to improve their efficiency and productivity. The following should be considered as examples of best practice.

Many trusts are exploring options for moving care into the community. Lancashire Care NHS Foundation considered its use of Out of Area Placements. They achieved savings of £8.9 million and, most importantly, improved patient care.[57]

Leeds Teaching Hospital NHS Trust has embraced the use of eProcurement. This has allowed them to improve both safety and efficiency in theatres. It has also achieved significant savings.[58]

These are just two examples of where trusts have improved the efficiency of their systems. The result in both cases has been an improvement in patient outcomes. Individual trusts and the NHS as a whole should continue to build on the work which they have already done in order to continue to improve efficiency and productivity.

[50] Niemietz, K., 'The UK Health System: An International Comparison of Health Outcomes', *UK 2020*, 2016.
[51] Finlayson, B., Dixon, J., Meadows, S., & Blair, G., 'Mind the gap: the extent of the NHS nursing shortage', *BMJ*, 2002.
[52] *Ibid*.
[53] *Ibid*.
[54] Imison, C., Castle-Clarke, S., Watson, R., & Edwards, N., 'Delivering the benefits of digital health care', *Nuffield Trust*, February 2016.
[55] BBC, *NHS 'could have prevented' WannaCry ransomware attack*, 27 October 2017.
[56] NHS Digital, *Boost to NHS cyber security as new security measures announced*, 30 April 2018.
[57] HFMA, *Modelling the need for mental health beds*, 2018.
[58] HFMA, *Scanning for efficiency and safety*, 2018.

Case study 6: patient waiting times

WaitLess is an app that reduces pressure on A&E by providing patients with real time information on local services and waiting times. It currently has 125,000 users and has resulted in an 11 per cent reduction in minor injuries activity in A&E.[59]

As discussed earlier in this paper, the NHS performs poorly when compared to other countries for patient waiting times in A&E. It is an issue which often makes the headlines, with an average of 65,420 people attending A&E in England every day. Rising demand on the health service has led to an increase in long waits for patients to be seen by a healthcare professional or to be admitted. There were, for example, four times as many long waits for admission in 2017-18 than in 2012-13. A long wait is defined as when a patient has to wait more than four hours to be admitted to a hospital bed after a decision to admit to hospital has been made.[60]

An increase in the number of people using technology such as WaitLess could, therefore, help to reduce the pressures placed on front line services and bring substantial savings to the NHS. For example, 280,808 people attended A&E in 2016 for muscle and tendon injuries and 710,763 attended for sprains and ligament injuries.[61]

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[59] *Ibid.*

[60] Baker, C., 'NHS Key Statistics: England, May 2018', *House of Commons Library*, 21 May 2018.

[61] *Ibid.*

Potential benefits of automation

Increased automation has the potential to increase productivity and efficiency, improve quality, and cut costs. It also has the potential to increase both patient and employee satisfaction. It can also help address the staff shortage issue, as it frees healthcare professionals from more repetitive tasks and allows them to focus on patient care.

Case study 7: Plymouth's open e-prescribing platform

University Hospitals Plymouth NHS Trust is the first in England to implement the paperless prescribing and medications administration (ePMA) system OPENeP. It will replace time-consuming manual prescription and medication processes, which can often lead to duplication and waste.[62]

There are numerous benefits to e-prescriptions such as efficiency gains for prescribers and dispensers, savings arising from transparency, fraud reduction, and reduced printing costs; health benefits such as reduced medication errors, better accessibility of medicines, increased monitoring of adherence to physician recommendations, and aggregate analysis of health data; and social benefits around patient satisfaction with the health system, financial relief for society, and social care for the elderly.[63]

Where the Electronic Prescription Service (EPS) has been used in various trusts in the UK, there have been significant savings. Prescribers have made savings of £327 million over three years and dispensers have made £60 million in savings during the same time period.[64]

The table below illustrates the potential productivity gains for the healthcare sector in the UK resulting from accelerated automation.

Table 3: potential time freed up by automation and resulting productivity improvement (healthcare)[65] [66]

Job role	Potential time freed up for care and value added activities (%)	Value of time released (£m)
Support to clinical staff	57	3,433
Nurses & health visitors	29	2,605
NHS infrastructure support	30	1,567
Hospital and community health services doctors	23	1,563
Scientific, therapeutics, & technical staff	25	1,193
GPs	31	962
GP support including patient care and non-clinical	53	880
Ambulance staff	35	196
Midwives	11	80
Total		**12,479**

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[62] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.

[63] Deetjen, U., 'European E-Prescriptions: Benefits and Success Factors', *University of Oxford*, June 2016.

[64] NHS Digital, 'Electronic Prescription Service saves NHS £130 million over three years', 9 October 2017.

[65] McKinsey, *A Future that Works: Automation, Employment, and Productivity*, January 2017.

[66] IPPR, *Better Health and Care for All: A 10-Point Plan for the 2020's*, June 2018.

The same is true for social care. The table below highlights the potential productivity improvements for social care resulting from automation.

Table 4: potential time freed up by automation and resulting productivity improvement (social care)[67]

Job role	Potential time freed up for care and value added activities (%)	Value of time released (£m)
Care worker	24	3,425
Managerial	36	1,322
Registered nurse	29	397
Senior care worker	24	377
Support and outreach	24	252
Other direct care	24	96
Social worker	11	62
Occupational therapist	25	21
Other regulated profession	21	13
Total		**5,969**

Case study 8: cardiovascular diagnosis

Ultromics is a cardiovascular diagnostics company that has combined machine learning and one of the world's largest cardiac imaging datasets to automatically diagnose heart disease from echocardiograms with an accuracy rate of 90 per cent.

Echocardiograms contain vast amounts of data, most of which is not currently analysed by cardiographers when making diagnoses. The technology developed by Ultromics analyses over 80,000 data points for every echocardiogram scan to provide the world's most accurate diagnostics system.[68]

Approximately 42,000 people die prematurely each year as a result of cardiovascular disease. It is responsible for 38 per cent of male and 37 per cent of female deaths before the age of 75.[69] It also costs the NHS approximately £12.3 billion each year.[70]

£600 million is spent each year by the NHS as a result of the inaccurate diagnosis of cardiovascular diseases. Research by the University of Oxford has found that introducing this technology to the NHS could bring annual savings of £300 million.[71]

Case study 9: orthopaedic care

MyRecovery is an app designed for orthopaedic patients. It contains information created or approved by surgeons to optimize treatment and recovery. It acts as a guide, providing patients with important information while tracking and monitoring progress.

It is integrated with electronic health systems, registry programmes, and digital wearables. It has resulted in a 40 per cent reduction in post-op phone calls from patients who communicate through the app to improve understanding of their care pathway.[72]

[67] *Ibid*.
[68] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[69] Heart UK, *Key facts & figures*, 2018.
[70] British Heart Foundation, *Cardiovascular Disease Statistics 2017*, December 2017.
[71] Radcliffe Department of Medicine, 'Artificial Intelligence added to cardiologists toolbox', *University of Oxford*, January 2018.
[72] *My Recovery*, https://www.myrecovery.ai/professional/

The use of robotics within medicine has been widespread for a number of years. For example, the Neuromate robot has been used to assist in stereotactic surgery.[73] The Da Vinci robot has been used to provide visualisation and enhanced dexterity to surgeons during laparoscopic surgery.[74] Also robots such as the hybrid assistive limb (HAL) and the Lokomat have been used in the rehabilitation of patients.[75]

Research now focuses on technology supporting 'softer' human-robot interaction tasks. A growing number of studies are looking at experiences related to the use of robotics for health and social care. For example, Frennert *et al* have studied elderly people's perception of a telehealthcare system with a robot component, recording overall positive attitudes.[76]

Robotics can be utilised in numerous ways in health and social care environments. For example, the Bestic feeding robot has been used to assist with the feeding of patients.[77] Robots such as the HelpMate and the Aethon TUG platform are used to provide autonomous transport of materials and supplies. They bring essential equipment to patients when a healthcare professional requires them. This means that they do not have to leave the room of the patient or wait for another member of staff to bring them.[78]

These technologies have the potential to free up health and social care workers from more routine work and allow them to focus on patient care.[79] The end result will be patients who are better cared for, more engaged health and social care workers, and a reduction in costs.

Case study 10: AI in emergency calls

A Danish AI software company has tested its deep-learning programme by having a computer listen in while human dispatchers took emergency calls. The algorithm analysed what the caller says, the tone of voice, and background noise. It detected cardiac arrests with a 93 per cent success rate compared to 73 per cent for humans. What is more, the software made its determination in an average of 48 seconds, more than 30 seconds faster than humans.

This rapid diagnosis allows dispatchers to quickly give instructions to the caller on what to do. This can mean the difference between life and death as studies have found that a patient's 30-day survival rate triples when a dispatcher recognises cardiac arrest during an emergency call.[80]

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[73] Shah, J., Vyas, A., & Vyas, D., *The History of Robotics in Surgical Specialities*, 2014.
[74] *Ibid*.
[75] *Ibid*.
[76] Frennert, S., Forsberg, A., & Ostlund, B., *Elderly People's Perceptions of a Telehealthcare System: Relative Advantage, Compatibility, Complexity and Observability*, August 2013.
[77] Dahl, T., & Boulos, M., *Robots in Health and Social Care: A Complementary Technology to Home Care and Telehealthcare?*, December 2013.
[78] *Ibid*.
[79] Dahl, T., & Boulos, M., *Robots in Health and Social Care: A Complementary Technology to Home Care and Telehealthcare?*, December 2013.
[80] Kahn, J., 'The AI That Spots a Stopped Heart', *Bloomberg Businessweek*, 20 June 2018.

Case study 11: surgical complications

More than 200,000 major elective surgical procedures are performed in England and Wales each year which carry a post-op pulmonary complication (PPC) risk of up to 30 per cent. This can lead to an increase in the length of time spent in hospital and reduced life expectancy.

ERAS+ reduces the risk of PPC by better equipping patients and families in their preparation for, and recovery from, major surgery. It provides advice and structure for training on exercise, nutrition, lifestyle, and oral healthcare information to help patients to play a more active role in preventing PPC.

It has successfully reduced PPC by over 50 per cent for more than 1000 patients during trials in Manchester. It has also reduced post-operative hospital length of stay by three days. It is estimated that if this was rolled out across the country, then it could save the NHS up to £100 million each year.[81]

Given the very obvious benefits, the government should spend more in readily available technology. Although this would represent expenditure for the Department of Health and Social Care, it would also result in savings within a few years due to the increases in efficiency, productivity, and cost effectiveness. Moreover, it will ensure that there are firm foundations in place to sustain the health and care system for future generations.

In addition, there is also huge potential to automate further aspects of health and social care in the future as a result of technology developments in progress. For example, by 2025 technology should be advanced enough to provide help with a wider range of physical tasks including dressing, eating, and toileting. Within this same timeframe, technology should be able to understand user preferences, intentions, and emotions. It should be able to plan more complex tasks, and provide more personalised care.

The evidence suggests that by 2035, technology will be advanced enough for robots to provide safe, dexterous close physical interaction for care and support. Within this same timeframe, experts expect social care provided by human-robot teams with human carers will be able to prioritise the interpersonal aspects of care.[82]

The many potential benefits of automation and the use of new technology have been recognised by the Health and Social Care Secretary, Rt Hon Matt Hancock MP: "The tech revolution is coming to the NHS. These robust standards will ensure that every part of the NHS can use the best technology to improve patients' safety, reduce delays, and speed up appointments".[83]

The increased use of automation and new technology has the potential to revolutionise health and social care. It will allow the Tech Vision for the NHS to be realised as patients receive world class care, system wide issues addresses, improvements in individual trusts, and a thriving health-tech economy created.

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[81] Moore, J., Conway, D., Thomas, N., Cummings, D., & Atkinson, D., 'Impact of a per-operative quality improvement programme on postoperative pulmonary complications', *Journal of the Association of Anaesthetists*, Vol. 72, March 2017.

[82] UK-RAS Network, 'Robotics in Social Care: A Connected Care EcoSystem for Independent Living', *Imperial College London*, 2017.

[83] Department of Health and Social Care, *Matt Hancock launches tech vision to build the most advanced health and care system in the world*, 17 October 2018.

Case study 12: virtual eye clinic

Moorfields Eye Hospital was in search of a solution to manage high levels of demand at their eye clinics and also to identify deterioration of eye health earlier and develop a preventative model. As a result, they partnered with a startup called Big Picture.

The technology used by Big Picture has the potential to reduce the number of patients who need to attend clinics in person by 40 per cent. It also has the potential to reduce the time spent in clinic from three hours to 30 minutes. The technology can integrate with all hospital IT and imaging systems and is capable of running in multiple languages.[84]

It costs £1.5 billion each year to treat patients in eye clinics.[85] Therefore, a 40 per cent decrease in attendance could potentially bring significant savings.

Hundreds of patients suffer irreversible sight loss every year in England because services are overstretched. The president of the Royal College of Ophthalmologists has stated: "Many eye diseases which can cause sight loss are more common in older people and our aging population means the demand on ophthalmology, like all areas of healthcare, is increasing like never before".[86]

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[84] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[85] Royal College of Ophthalmologists, *The Way Forward*, 2017.
[86] MacEwen, C., 'Eye risk from "overstretched NHS"', *BBC*, 16 March 2016.

Mental health treatment

One area, in particular, where embracing automation and new technology can make a real difference to patient care is in the field of mental health treatment. Patients suffering from mental health conditions are often at risk of harming themselves. Therefore, it is vitally important that they are assessed and receive treatment as soon as possible.

The impact of mental illness is wider than the harm which patients may cause themselves. There is a high degree of co-morbidity associated with mental illness which can lead to significantly poorer health outcomes and reduced quality of life. For example, patients with chronic lung diseases spend twice as long in hospital if they also have a mental health problem, and depression can lead to a threefold increase in mortality rates after a heart attack.[87]

People with mental health conditions are also more likely to abuse tobacco and alcohol. Smoking rates among people with depression are twice as high as among people without depression. As for people suffering from schizophrenia, the smoking rate is three times higher than among people who do not have the condition.[88] At least two thirds of alcohol-dependent individuals entering treatment show evidence of anxiety, sadness, depression and/or manic-like symptoms. People with severe and chronic mental illnesses, such as schizophrenia, are at least three times as likely to be alcohol-dependent than others in the general population.[89]

Demand is high for mental health services provided by the NHS. 1.2 million people use NHS mental health services every month, with 114,000 new referrals to talking and psychological therapies.[90] This increased pressure has been exacerbated by staff shortages in mental health care.[91]

Research by the British Medical Association has found that long delays for treatment are common in the NHS, including for patients with very serious mental health illnesses. It found that in 2017, 3,700 patients waited more than six months for talking therapies, and 1,500 patients waited for longer than a year. The situation was even worse in some areas, with patients in Leicestershire waiting for up to two years for treatment.[92]

Long waits for treatment are highly distressing for patients and their loved ones. The pressure on mental health services continues to mount, with many patients not getting the help they need.[93]

There is a high demand for therapy on the NHS, meaning that many patients are not able to access the treatment they need in a timely manner. However, as case studies 11 and 12 demonstrate, automation and new technology have the potential to provide treatment for patients from their own homes in an effective and cost efficient way.

Therapy is not the only treatment for mental health conditions, with medications also provided to many patients. Over 12 million prescriptions for insomnia were written in the UK in 2017. This came at a cost to the NHS of £72 million.[94] The NHS in England also spent £266.6 million on anti-depressant prescriptions in 2016.[95] The NHS also spends £30 million on anti-anxiety medicine every year.[96]

[87] Naylor, C., Pasronage, M., McDaid, D., Knapp, M., Fossey, M., Galea, A., 'Long-term conditions and mental health: The cost of co-morbidities', *The King's Fund*, February 2012.
[88] Mental Health Foundation, *Smoking and Mental Health*.
[89] Mental Health Foundation, *Cheers? Understanding the relationship between alcohol and mental health*.
[90] NHS Providers, *The state of the NHS provider sector*, July 2017.
[91] Rimmer A., 'Staff shortages force mental health trusts to cancel patient activities and close wards, says King's Fund', *BMJ*, January 2018.
[92] BMA, *The devastating cost of treatment delays*, February 2018.
[93] BMA, *Breaking down barriers – the challenge of improving mental health outcomes*, 2017.
[94] NHS Innovation Accelerator, *NHS in Thames Valley to tackle sleeping pills epidemic with digital medicine*, March 2018.
[95] NHS Digital, Antidepressants were the area with largest increase in prescription items in 2016, June 2017.
[96] McCrone, P., Dhanasiri, S., Patel, A., Knapp, M., & Lawton-Smith, S., 'Paying the Price: The cost of mental health care in England to 2026', King's Fund, 2008.

Case study 13: mental health treatment

Ieso is a platform which connects patients to therapists who can deliver cognitive behavioural therapy (CBT) to patients in real-time through written online conversation, using a secure virtual therapy room. Therapy is confidential and accessible from the patient's computer, tablet, or smartphone. This allows for flexibility, with appointments able to be scheduled for any time of the day, including evenings and weekends. As the therapy is online and in written format, patients can review their appointment content and transcripts at any time during and after treatment.

It has demonstrated clinical effectiveness in over 20,000 patients' treatments. It has also resulted in better than average recovery rates and fewer missed appointments.[97]

Case study 14: virtual reality therapy

Psious has developed a mental health virtual reality therapy solution, called PsiousToolsuite. The online system enables therapists to apply hyper-virtual reality therapy to patients through a smartphone, low-cost VR goggles, and a biofeedback sensor.

The system provides treatment for a range of medical health conditions, including anxiety disorders, depression, and extreme phobias. It also offers mindfulness and meditation exercises. There is also a live control function, which allows therapists to get a real time look at what their patients are seeing, and adjust the features of a treatment to ensure maximum efficacy.[98]

Case study 15: sleep improvement

Sleepio is a digital sleep improvement programme which has been clinically proven to help overcome sleeping problems. Over a number of weekly sessions, patients are taught cognitive and behavioural techniques by a virtual sleep expert.

The evidence reveals that Sleepio is exceeding national targets for recovery. For example, 68 per cent of patients suffering from anxiety and depression who use Sleepio move to recovery. This is compared to a national average of 45 per cent.[99]

Given the extent of medications prescribed for insomnia, depression and anxiety, it is reasonable to estimate that £75 million annually could be saved by adopting such technology.

[97] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[98] *Ibid*.
[99] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.

Patient attitudes towards automation

When it comes to their healthcare, there is a real appetite among the public to embrace technology. A survey conducted by the Nuffield Trust found that 60 per cent of respondents would monitor their chronic condition using a mobile app. 80 per cent would like to view medical records online. 90 per cent would use a service allowing them to ask a clinician a question. However, despite this enthusiasm on the part of the public, only 2 per cent of the population have had any digitally enabled transaction with the NHS such as booking an appointment or viewing their medical records online.[100]

Chart 4: percentage of patients who would use certain technologies to improve their health[101]
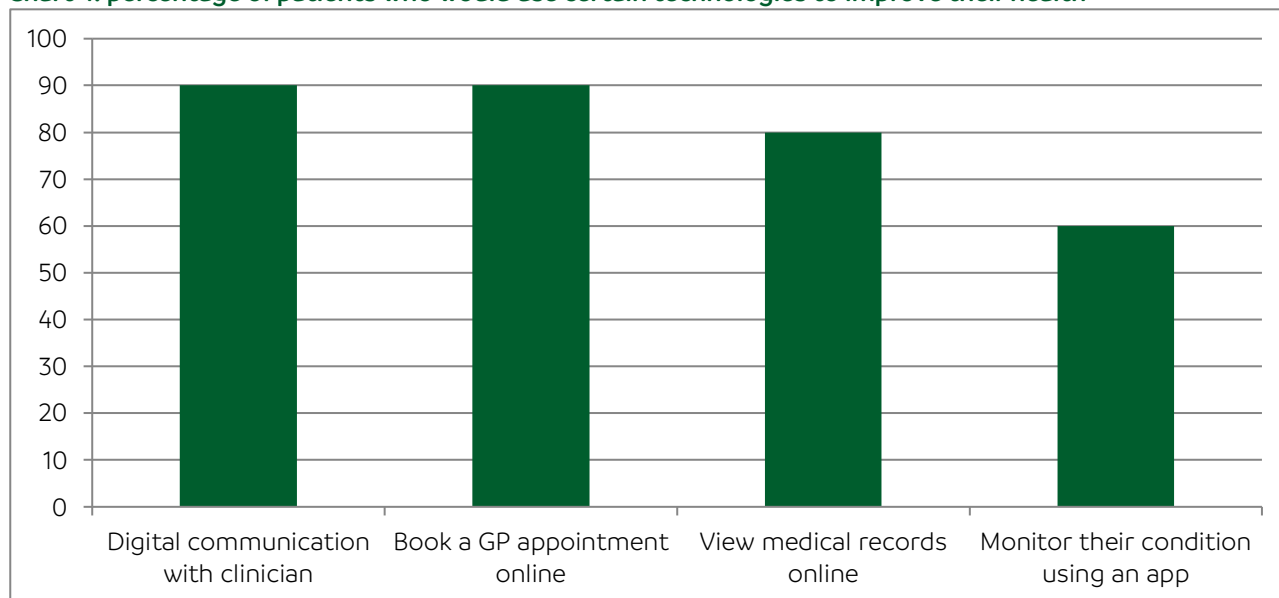
Despite funding the NHS through their taxes, members of the public have also chosen to pay money again in order to access solutions provided by the private sector. For example, an artificially intelligent medical app which allows patients to have a consultation with GPs over instant message on their smartphones.[102] The service has been incredibly popular with the public, and a recent Care Quality Commission inspection found the service safe, effective, caring, and responsive.[103]

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[100] Imison, C., Castle-Clarke, S., Watson, R., & Edwards, N., 'Delivering the benefits of digital health care', *Nuffield Trust*, February 2016.
[101] *Ibid.*
[102] Hitchcock, A., Laycock, K., & Sundorph, E., *Work in Progress: Towards a leaner, smarter public-sector workforce*, February 2017.
[103] *Ibid.*

Case study 16: medical records

Patients Know Best allows patients to hold all their medical information in a single record which they directly control. If a patient chooses, they can invite anyone they wish to have access to their profile, allowing them to construct a comprehensive care network.

Patients have created over 217,000 records using the system. There has been a 58 per cent growth in the number of sites using the system.[104]

The majority of people have never seen their own medical records. This means that they may contain errors, which go undetected. This is a serious problem as medical records guide healthcare professionals in the treatment of patients. As such, any error could lead to the wrong treatment being prescribed which could have dire consequences for patients.[105]

New technology therefore has the potential to empower patients by allowing them to easily access their medical information. It could also lead to fewer medical mistakes as a result.

Over 70 per cent of citizens in the UK own a smartphone, and spend an average of two hours every day using them to access the internet. 50 per cent of the population use the internet to self-diagnose while 75 per cent search the internet for health information. Over 43,000 medical apps are currently available on iTunes, with 500 million people around the world using a healthcare app this year.[106]

People want to take control of their health care using technology. The technology is sitting in the pockets of patients with access to countless healthcare apps, so the NHS should allow patients to use the technology that is already available.

Case study 17: smartphone analysis

Healthy.io has developed Dip.io, a product which uses computer vision and user centric design to turn a smartphone into a urinalysis device. Built around existing semi-quantitative urinalysis dipsticks, it complements established clinical efforts by empowering patients to test themselves at home with no quality compromise, and securely share results with a clinician.[107]

In 2017-18 there were 21.8 million diagnostic tests performed in England's hospitals. This is 4 per cent higher than in 2016, and 31 per cent higher than in 2011-12. Patients sometimes have to wait up to six weeks before they can receive a diagnostic test.[108]

Such smartphone analysis is another example of how embracing technology can reduce the burden on the NHS and improve the quality of care for patients.

104 Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
105 Smith, O., 'Broken, illogical and full of errors: Our medical records are a mess', *The Memo*, 9 December 2015.
106 Imison, C., Castle-Clarke, S., Watson, R., & Edwards, N., 'Delivering the benefits of digital health care', *Nuffield Trust*, February 2016.
107 Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
108 Baker, C., 'NHS Key Statistics: England, May 2018', *House of Commons Library*, 21 May 2018.

Case study 18: cognitive health tracking

> BrainWaveBank allows people to measure and track their cognitive health at home, taking just a few minutes each day. Cognitive health is measured using a wireless headset, while playing mobile games for a few minutes a day. They use machine learning and brain-reading technologies to build a detailed record over time of personal cognitive health, providing insights and advice to the user on how their individual lifestyle factors affect their performance.
>
> The system can securely gather, store, and analyse data from users, building cognitive profiles of individuals, populations, and demographic groups. This data can then be used to support clinical trials and the development of new therapies and diagnostics.[109]

Case study 19: COPD treatment

> MyCOPD is an integrated online education, self-management, symptom reporting and pulmonary rehabilitation system to help people with Chronic Obstructive Pulmonary Disease (COPD) manage their condition more effectively.
>
> It is available on any device that can connect to the internet and delivers a personalised COPD management system by asking patients a few key questions about their condition. Clinicians are provided with a dashboard, geographical population map view, education, and patient management suite to allow them to monitor and manage their patients remotely.
>
> The platform can also be used by local healthcare providers to monitor exacerbation burdens in real-time and review potential inequalities in healthcare to plan support services effectively.[110]

While the NHS has often lagged behind in this regard, individual trusts and the NHS as a whole have been making positive steps. For example, Chelsea and Westminster Hospital NHS Foundation Trust formed a consortium with commercial partners to establish an online sexual health service.

The system involves patients answering questions online. The technology assesses their symptoms and decides which testing kit to send them. The patients then send their sample to a laboratory for analysis. Once the laboratory has the results, patients are sent a message asking them to log on to the website, which advises them what steps to take. As a result, only patients who need to attend a clinic or receive further treatment do so.. The system is expected to achieve savings of £4.2 million over the next nine years.[111]

Although patients are enthusiastic about using technology to interact with doctors and to manage their care, there is a reluctance among patients in the UK for robots to be used during surgery. For example, a survey conducted by PwC found that whereas respondents in Nigeria, Turkey, and South Africa were willing to undergo minor surgery performed by robots (73 per cent, 66 per cent, and 62 per cent respectively), the UK was the least willing at 36 per cent. In regards to major surgery, the UK was again the least willing at 27 per cent. This is compared to Nigeria at 69 per cent.[112] The NHS should engage with this problem and educate the public on the benefits of robotics in surgical procedures to promote increased uptake.
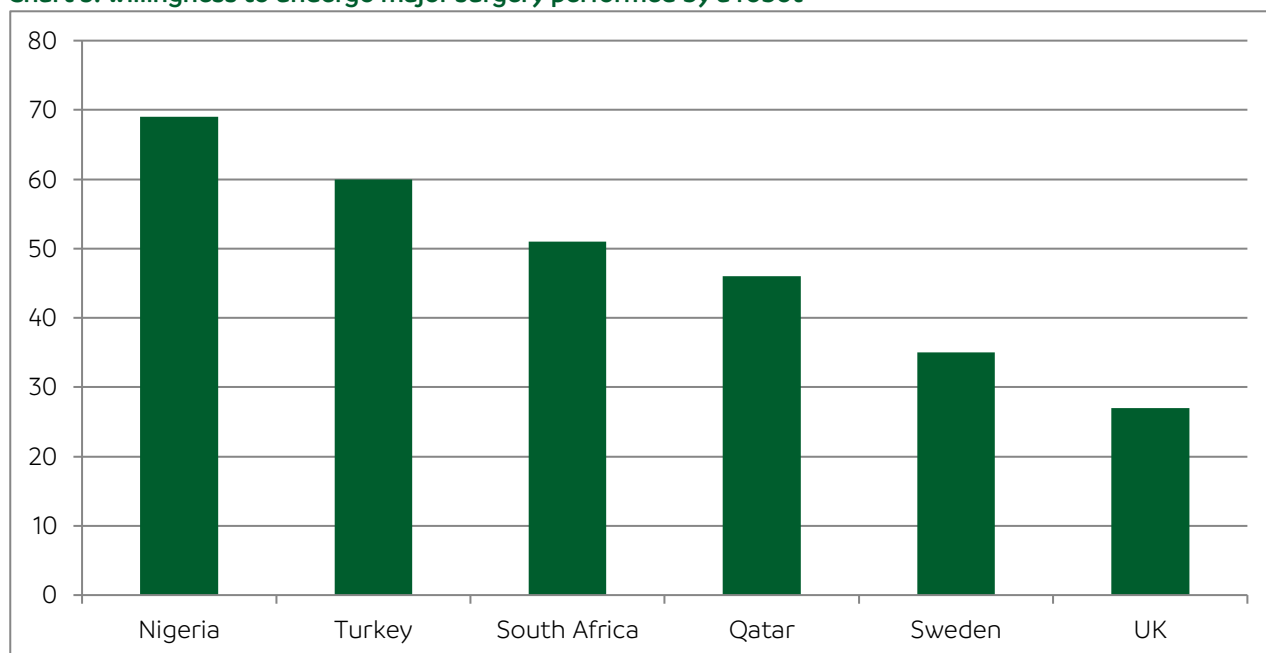
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[109] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[110] *Ibid*.
[111] HFMA, *Modernising sexual health services*, 2018.
[112] PwC, *What doctor? Why AI and robotics will define New Health*, June 2017.

Chart 5: willingness to undergo major surgery performed by a robot[113]

[113] Tarantola, A., 'Robot caregivers are saving the elderly from lives of loneliness', *Engadget*, 29 August 2017.

Barriers to entry in the NHS

Despite the availability of exciting new technologies, many are not currently available to the majority of patients in the UK. This is because they are either not being used by the NHS at all, or are only being used in a few trusts.

The greater use of technology can achieve significant savings for the NHS. It can also dramatically improve health outcomes for patients and potentially saves lives.

One area in which improvements could be made is with patient records. For example, a recent report found that: "many records are insecure paper-based systems which are unwieldly and difficult to use". The review uncovered evidence of doctors, frustrated with the system, using SnapChat to send patient scans to one another.[114] The report stated: "It is difficult to criticise these individuals, given that this makes their job possible. However, this is clearly an insecure and non-auditable way of operating, and cannot continue".

The NHS also holds the dubious title of being the world's largest purchaser of fax machines.[115] However, as we shall see later in this paper, the Health and Social Care Secretary has recently banned the NHS from buying fax machines and has ordered a complete phase-out by April 2020.[116] Compared to other countries the UK spends far less on healthcare IT than other countries. For example, 1.5 per cent of total hospital spend is allocated to healthcare IT compared to the European average of 1.8 per cent, while the Netherlands spends 4.0 per cent.[117]

Case study 20: Japan

Japan, which is struggling with the demands of an ageing population, has been an early adopter of automation in health and social care.[118] For example, robots are already being used in hospitals to perform tasks such as lifting patients and serving food.[119] Robots are also used to help to provide social care in thousands of homes in Japan.[120]

The Japanese government has spent heavily on automation for health and social care. It has spent the equivalent of £3.6 billion on a project to promote the development of future medical systems and devices and a substantial amount on a project to accelerate the development and introduction of nursing robots.[121]

There is also the robotic seal pup called Paro, which has been used by Japanese nursing homes since 2003.[122] This has had a positive impact on patients with difficult cases of depression.[123]

Japan has been at the vanguard of research into the use of automation in health and social care, with numerous studies being conducted.[124] By 2020, four out of every five care recipients in Japan will have some form of robotic support.[125]

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[114] DeepMind Health, *Independent Review Panel Annual Report*, July 2017.
[115] *Ibid*.
[116] Department of Health and Social Care, *Health and Social Care Secretary bans fax machines in the NHS*, 9 December 2018.
[117] Deloitte, *Digital Health in the UK: An industry study for the Office of Life Sciences*, September 2015.
[118] EU-Japan Centre for Industrial Cooperation, *Human Assistant Robotics in Japan-Challenges and Opportunities for European Companies*, March 2016.
[119] *Ibid*.
[120] *Ibid*.
[121] Team Finland, *Future Watch: Trends of healthcare robots in Japan*, July 2017.
[122] Centre for Addiction and Mental Health, *The healing effects of a White 'Seal'*, 2017.
[123] *Ibid*.
[124] Bemelmans, M., Gelderblom, G., Jonker, P., & Witte, L., 'Socially Assistive Robots in Elderly Care: A Systematic Review into Effects and Effectiveness', *Journal of Post-Acute and Long-Term Care Medicine*, vol. 13. February 2012.
[125] Headquarters for Japan's Economic Revitalization, *New Robot Strategy*, February 2015.

Chart 6: healthcare IT spend as a percentage of total hospital spend[126]
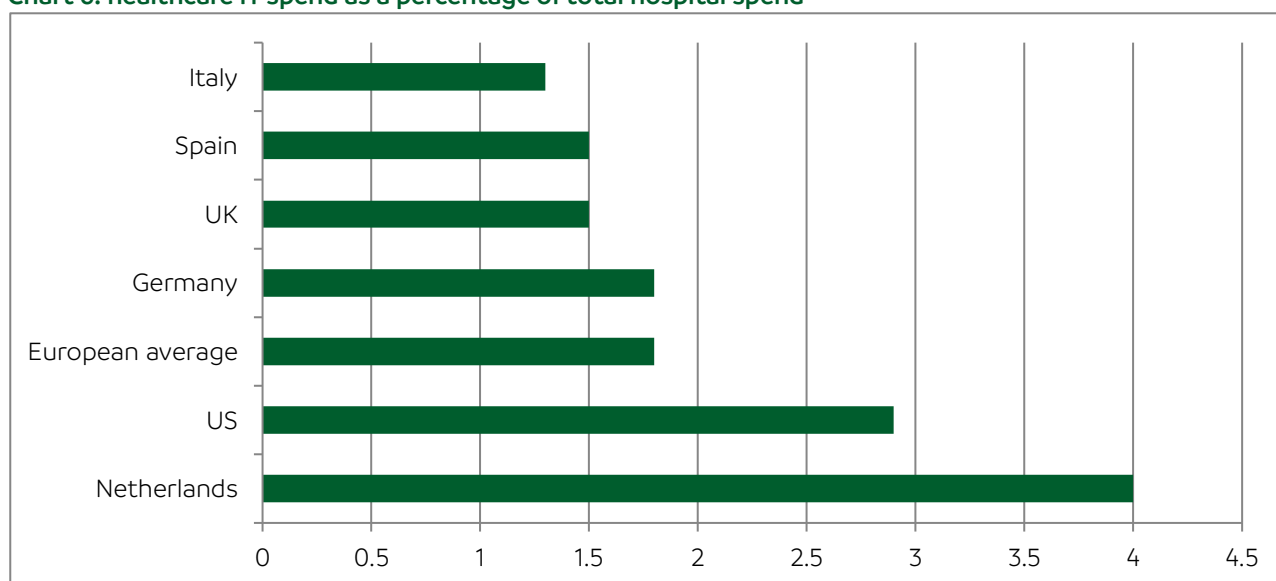
This failure to embrace new technology also means that the NHS is failing to meet the expectations of the public. For example, fewer than 10 per cent of people had booked GP appointments online, with fewer than 4 per cent having accessed their medical records.[127] This is despite research suggesting that 90 per cent of the public would prefer to book their GP appointments online.[128] It is perhaps unsurprising that a study found that the job which most people wanted to see automated was GP receptionist.[129]

The digital health sector in the UK is growing rapidly.[130]   The UK is also one of the most attractive countries for the digital health industry, ranking second out of 15 countries.[131] This attractiveness stems from the growing demand from consumers and corporations, readily available investment from firms offering venture capital finance, as well as the fact that the UK has life science hubs and a high number of technology startups.[132]

[126] *Ibid.*

[127] Hitchcock, A., Laycock, K., & Sundorph, E., *Work in Progress: Towards a leaner, smarter public-sector workforce*, February 2017.

[128] Imison, C., Castle-Clarke, S., Watson, R., & Edwards, N., 'Delivering the benefits of digital health care', *Nuffield Trust*, February 2016.

[129] HR News, *Replace GP receptionists and Train Drivers with robots, say UK workers*, January 2017.

[130] Deloitte, *Digital Health in the UK: An industry study for the Office of Life Sciences*, September 2015.

[131] Office for Life Science, *Strength and Opportunity 2016: The landscape of the medical technology and biopharmaceutical sectors in the UK*, 2017.

[132] Reilly, K., 'Who will be the VC winners? An expert's view on where and how we should be investing in digital health', *MedTech Engine*, 23 May 2017.

Table 5: most attractive countries for digital health solutions[133]

Country	Rank
US	1
UK	2
Germany	3
Israel	4
Canada	5
Netherlands	6
Denmark	7
India	8
Sweden	9
China	10
Finland	11
Switzerland	12
Estonia	13
Spain	14
Norway	15

Case study 21: Germany

There are numerous examples of robots being used in a health and social care context, not just assisting with practical tasks, but also offering emotional and social support to patients. For example, the Care-o bot has been deployed in a number of German assisted living facilities. [134]

In addition to transporting food and drinks to the residents, it also helps to keep them entertained by playing memory games.[135]

However, there are numerous barriers to entry into the NHS faced by companies providing these new inventions.

One major barrier to entry is interoperability. This is the ability of different systems to integrate and work together.[136]

There are also the poor procurement practices that are a major barrier to entry. Many parts of the NHS and trusts rely on large IT vendors, many of whom operate out-of-date business models and closed systems.[137]

The problems caused by poor procurement practices in the NHS were highlighted by one company founder who stated: "Pilots never translate into scalable solutions because of fragmented procurement".[138]

The Carter Review brought into focus the issues with procurement in the NHS. It found that: "Whilst there have been excellent improvements by some trusts, most still don't know what they buy, how much they buy, and what they pay for goods and services. Very few trusts are able to demonstrate even a basic level of control or visibility over total inventory or purchase order compliance that is common practice in other health systems and commercial sectors such as retail. For example, a

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[133] Office for Life Science, *Strength and Opportunity 2016: The landscape of the medical technology and biopharmaceutical sectors in the UK*, 2017.

[134] Tarantola, A., 'Robot caregivers are saving the elderly from lives of loneliness', *Engadget*, 29 August 2017.

[135] *Ibid.*

[136] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.

[137] Office for Life Science, *Strength and Opportunity 2016: The landscape of the medical technology and biopharmaceutical sectors in the UK*, 2017.

[138] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.

sample of 22 trusts covering approximately 16 per cent of NHS spending showed that in one year they used 30,000 suppliers, 20,000 different product brands, and over 400,000 manufacturer product codes with more than 7,000 people able to place orders".[139]

There is a lack of clarity about evidence, with no consensus about what 'good looks like' with respect to evidence. Therefore, innovators struggle to scale from one trust to another. Some trusts impose their own standards and so the companies have to demonstrate the value of their product all over again.[140]

One company leader stated that: "The biggest barrier to scaling within the NHS is the sheer number of different purchasers and regulatory organisations". Another said of the NHS that: "Regulation is tight and constantly changing".[141]

As the Accelerated Access Review stated: "The approach to accessing innovation in the NHS has become increasingly challenging; creating frustration for innovators who see the NHS as an interesting environment for demonstrating the value of their products, for patients who often have to wait long periods of time before life-saving therapies are available, and for clinicians who are frustrated by the multiple barriers to both approval and adoption".[142]

It is clear that if the NHS is to take full advantage of automation, it will need to improve its regulatory and procurement practices. There have been some promising signs in this regard, with one company offering a new procurement platform called the Edge. It is designed to perform as a consumer-style, procure-to-pay online marketplace. It enables eProcurement, stock and inventory management, product information management, catalogue management, e-invoicing, track and trace, and analytics. Although it has been adopted by some NHS trusts, this has not been widespread.[143]

Although there are barriers to entry for new technology in the NHS, it is encouraging to see that these have been identified and are being addressed, especially in the area of interoperability. There is a dedicated team working towards improving interoperability, with a specific focus upon the following areas:

- Working with services to identify their strategic business needs in relation to interoperability to inform development of required solutions

- Development of priority use cases for interoperability to provide business justification for local investment and development of supporting systems and products nationally

- Supporting local organisations with tools and guidance to enable them to develop effective solutions to interoperability problems

- Developing standards to support the move from paper to electronic transfers of care

- Developing standards to support the move to systems enabling access to patient information through open interfaces

- Commissioning NHS Digital in the delivery of interoperability standards

- Work with INTEROPen in the adoption of interoperability.[144]

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[139] Department of Health, *Operational productivity and performance in English NHS acute hospital: Unwarranted variations*, February 2016.
[140] Castle-Clarke, S., Edwards, N., & Buckingham, H., 'Falling short: Why the NHS is still struggling to make the most of new innovations', *Nuffield Trust*, December 2017.
[141] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[142] HM Government, *Accelerated Access Review: Final Report*, October 2016.
[143] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[144] NHS England, *Interoperability*, 2018.

Table 6 sets out the Chief Clinical Information Officer for health and care in England's seven priority areas for the adoption of interoperability.

Table 6: priority areas for the adoption of interoperability[145]

Area of focus	Desired outcome
NHS number/Citizen ID	Real time access to the NHS Number at the point of care across the service, ensuring that the NHS Number is associated with care record elements
Medications	All medication messages in the NHS to be interoperable and machine readable across the service
Staff ID	Ensuring that there is a consistent way to identify and authenticate staff across the service
Dates and scheduling	A consistent set of interoperability standards for dates and scheduling information that enables a consistent approach to appointment booking across venues of care and the creation of historic and forward views of appointments
Basic observations	A consistent set of interoperability standards for the sharing of a core set of structured observations
Basic pathology	A consistent set of interoperability standards for the sharing of a core set of pathology tests
Diagnostic coding	Implementation of SNOMED CT across the wider service

The Secretary of State and NHS leaders have set out their vision for increasing the use of technology in the NHS and removing barriers to entry. For example, Health and Social Care Secretary, Rt Hon Matt Hancock MP has said:

"A modern technical architecture for the health and care service has huge potential to deliver better services and to unlock our innovations. We want this approach to empower the country's best innovators – inside and outside the NHS – and we want to hear from staff, experts, and suppliers to ensure our standards will deliver the most advanced health and care service in the world".[146]

There are also a number of schemes in operation to ensure that leaders in the NHS are equipped with the skills they need. For example, the Digital Academy has been commissioned by NHS England. It is a partnership between Harvard Medical School, Imperial College London, and the University of Edinburgh. The aim is to provide a one year digital health training course to Chief Clinical Information Officers, Chief Information Officers, and other potential digital leaders.[147]

What is more, at the NHS Innovation Expo 2016, the former Health and Social Care secretary set targets to be achieved by 2019 in order to embrace the benefits of new technology. These included several proposals: a library of assessed apps, instant access to personal health records online, and an online 'triage' service for minor health problems.[148]

Specific steps are already being taken to ensure that the NHS is using the best available technology. For example, as previously discussed in this paper, Rt Hon Matt Hancock MP has recently banned the

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[145] *Ibid.*

[146] Department of Health and Social Care, *Matt Hancock launches tech vision to build the most advanced health and care system in the world*, 17 October 2018.

[147] Seed, J., 'NHS Digital Academy launces first cohort of digital health leaders', *Imperial College London*, 23 April 2018.

[148] Department of Health and Social Care, *New plans to expand the use of digital technology across the NHS*, 7 September, 2016.

NHS from buying fax machines and has ordered a complete phase-out by April 2020. NHS trusts will instead be required to invest in new technology to replace outdated systems. NHS organisations will be monitored on a quarterly basis until they declare themselves 'fax free'.[149]

It is clear that in the past, the NHS has often been reluctant to embrace new technology, and there have been significant barriers to entry. However, the NHS has recognised this, highlighted issues, and are implementing plans to improve the situation. These plans have received widespread support from NHS staff, doctors, nurses, and patients. Once these barriers to entry have been overcome, and the use of new technology becomes widespread across the NHS, then medical staff will be able to provide an even higher quality of care, and so it will be patients who are the ultimate beneficiaries.

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[149] Department of Health and Social Care, *Health and Social Care Secretary bans fax machines in the NHS*, 9 December 2018.

Looking to the future: challenges and opportunities

Embracing new technology will help to address this challenge. It will result in the burden on staff being eased, while also ensuring that patients receive world class care that is delivered in a fast, compassionate, and cost effective manner.

There is still a long way to go in realising the full potential of automating healthcare, as the technology is constantly developing. Table 7 sets out a potential timeline for technological advances in health and social care.

Case study 22: remote care

Kraydel has developed TV-enabled video software that allows family members and professional care workers to provide remote care for the elderly in their own homes. In addition to built-in video chat, the service also includes medication, housekeeping, and event reminders, as well as data-driven automated alerts to caregivers if something appears wrong.

The system includes a user-friendly dashboard service, which allows caregivers to quickly and easily view data about those in their care at daily, weekly, and monthly intervals. They have also developed an integrated intelligent wristband, which can detect falls and seizures, and also monitor heart rate and skin temperature.[150]

Such technology can ensure that the elderly and the disabled can receive high quality care in their home, in a way which is less labour intensive.

Case study 23: care of elderly and dementia patients

RemindMeCare is a system to improve care of elderly and dementia patients. Patients build profiles which are then automatically matched to sourced internet content. Built with remote family participation, the system learns and grows through activities undertaken with the individual.

Person centred care, community engagement, and care circle interaction all improve when the profile of the individual is better defined. The system puts the patient at the centre of the care process. As a result, it is applicable to many care sectors and therefore becomes ideal for people with multiple conditions.[151]

[150] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[151] *Ibid*.

Table 7: advances in automated social care, 2018-2035[152]

Area of automation	Advances to be delivered by technological development		
	2018-2020	2021-2025	2026-2035
Physical capability of robotics and autonomous systems (RAS) technology for social care	Robotic devices for maintenance of the home and support for some activities of daily living	RAS modifications to home and care environments to provide help with a wider range of physical tasks including dressing, eating, and toileting	Robots can provide safe, dexterous close physical interaction for care and support
AI capabilities of RAS technologies	Mapping the home, recognising people and everyday objects, understanding basic tasks, limited learning, some dialogue capability	Understanding user preferences, intentions, and emotions. Planning more complex tasks, learning from experience, and by sharing data, providing more personalised care	Good understanding of the home as a physical and social setting, and of people and their care needs, able to have natural conversations with users based on shared experience and knowledge and give an account of own behaviour
User interfaces	Voice command and touch screen technologies, Wearables for health monitoring and remote operation of devices. Low bandwidth brain-machine interfaces	Voice control for people with speech disorders, control by gesture or sign language. Teleoperation of remote RAS devices using wearable controls	High bandwidth wearable and brain-machine interfaces
Integration of RAS technologies	Integration of robot home devices with internet of things. Open robotic platforms and standards to facilitate a modular robot ecology and app-based development of robot services	Healthcare and social care better integrated. Robotic technologies integrated into furniture and existing assistive devices for physical support and mobility	New build homes incorporate ecosystem of robotic and digital devices designed to support ageing in place
RAS alongside human care	Consultation with carers, first cycles of participatory design of next generation assistive systems	Carers trained to work alongside assistive RAS technologies in order to make more efficient use of carer time and create a more professional role	Social care provided by human-robot teams with human carers able to prioritise the interpersonal aspects of care
Rehabilitation and robotic augmentation	RAS rehabilitation systems available at home to promote faster and more complete recovery from accident or illness	Significant advances in sensory prostheses. Robotic exoskeletons replace wheelchairs	Advances physical prostheses and robotic implants such as smart artificial knees or hips

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[152]UK-RAS Network, 'Robotics in Social Care: A Connected Care EcoSystem for Independent Living', *Imperial College London*, 2017.

The use of automation in health and social care obviously raises important ethical questions. For example, empathy and compassion are key aspects of providing high quality services in this area, and are highly valued by patients.[153] As such, this has been identified as a barrier to the wide scale rolling out of automation.[154]

However, there are two important reasons why this is not an insurmountable obstacle to automation. First, humans have a tendency to anthropomorphise robots – even when they do not appear in any way human – and project human personalities onto them.[155] Second, automation would actually lead to more human interaction. This is because it would be the robot undertaking repetitive tasks, and also performing those which both carers and patients often find most uncomfortable such as dressing and toileting. These tasks being performed by robots will free up carers who will be able to spend more time interacting with patients and providing them with a higher standard of care.

Given the increased pressure which will be placed on health and social care over the next five decades, it is essential that the government starts to think seriously about accelerating automation. The UK has world leading universities which are already conducting cutting-edge research in robotics and automation. As such, the UK should lead the way in this field and the government should reprioritize budgets toward research and implementation in order to ensure that the health and social care system is sustainable, high quality, and cost effective over the coming decades.

Case study 24: door-to-door care

Cera is a technology-enabled homecare provider, delivering door-to-door healthcare services. This allows a patient to order not only the treatment and prescriptions they need, but also auxiliary services such as food or taxi services.

The system provides 24/7 access to care while alleviating pressure on front-line nurses and care workers. This is supported by a live dashboard, allowing patients, families, and health professionals to see real-time updates in care delivery. The system also includes a functionality which assists carers with elderly patients by giving them advice based on past interactions.[156]

There is a shortage of care workers in the UK. This places pressure on those in the profession, with many reporting having to work much longer hours. It also raises concerns about the quality of care being received by patients as a result of carers being pressed for time. Furthermore, it leads to patients being kept in hospital longer than they need to be as there is no care package available for them. This increases the pressure on NHS staff and resources.[157]

Embracing automation and new technology also has the potential to help patients who are approaching the end of their lives. This is important, as a 2016 report by the Royal College of Physicians and Marie Curie found that improvements need to be made to end of life provision in the UK. The report concluded that: "…the vast majority of dying people and those close to them still have limited or no access to specialist palliative care support when they need it in hospital. This is not right, not good enough".[158]

Automation of health and social care also makes sense from a business perspective. The UK is not alone in having an ageing population. Globally, the proportion of people aged 60 or over was just 8 per cent in 1950, but this is projected to rise to 20 per cent by 2050.[159] In many European countries, and in

[153] Sinclair, S., Beamer, K., Hack, T., McClement, S., Bouchal, S., Chochinov, H., & Hagen, N., *Sympathy, empathy, and compassion: A grounded theory study of palliative care patients' understandings, experience, and preferences*, May 2017.
[154] Sharkey, A., & Sharkey, N., 'Granny and the robots: ethical issues in robot care for the elderly', *Ethics and Information Technology*, July 2010.
[155] Fussell, S., Kiesler, S., Setlock, L., & Yew, V., *How People Anthropomorphize Robots*, March 2008.
[156] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.
[157] Connolly, M., 'Care workers "exhausted" by staff shortage', *BBC*, 28 November 2017.
[158] Royal College of Physicians, *End of Life Care Audit – Dying in Hospital: National report for England 2016*, March 2016.
[159] UK-RAS Network, 'Robotics in Social Care: A Connected Care EcoSystem for Independent Living', *Imperial College London*, 2017.

Asian countries such as China, Japan, and Korea, the proportion of people over the age of 60 is projected to be approximately 40 per cent by 2050.[160]

The worldwide medical robotic systems market size was valued at more than $7 billion in 2014.[161] Given the growing size of this market, it represents a significant export opportunity for UK companies, which should be welcomed by the government. It will provide opportunities for companies operating in the UK which will grow the economy and increase revenues for HM Treasury.

Case study 25: end of life care

Coordinate My Care is a web-based IT platform enabling digital, multidisciplinary urgent care planning for end of life care. Frequently, a lack of continuity and coordination can lead to fragmented delivery of urgent care.

Patients using the system have seen 78 per cent compliance with their stated preferred place of death, equating to 17 per cent dying in hospitals, compared to 47 per cent nationally. The system is on average saving the NHS £2,100 per patient where applied, equating to a potential saving of £556 million in England a year.[162]

Therefore, the use of innovative technologies not only has the potential to bring substantial savings to the NHS, it can also make a real difference to the quality of care received by patients towards the end of their lives.

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[160] *Ibid.*

[161] *Ibid.*

[162] Blackwood, N., 'The Promise of HealthTech', *Public*, April 2018.

Conclusion

Over the next five decades the UK will experience a demographic change in which there will be a significant increase in the proportion of elderly people. This will place an extra burden on taxpayers and on the health and social care system. As such, there needs to be a sustainable solution.

Automation can help the NHS to improve productivity and efficiency. There are already new technologies which can undertake many of the tasks of healthcare professionals, and are often able to perform these tasks more quickly with a lower chance of error. This can speed up the provision of care in a more cost effective manner and allows healthcare professionals to focus more attention on interacting with patients.

Despite the many benefits of automation, new technologies face significant barriers to entry in the NHS. While the NHS is taking steps to remove many of them, the NHS must be more open in the future so that the benefits of automation can be fully realised. It is essential that the NHS embraces these new technologies to ensure that taxpayers get value for money, staff can focus on frontline care and - most crucially - more lives are saved.

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Appendix

Figure 1: annual savings calculations

Annual saving	Calculation
£1.1 billion in pathology services	Based on the calculations of Professor Sir John Bell which found that the NHS currently spends £2.2 billion on pathology services and that automation could reduce this by 50 per cent.
£12.5 billion in time released for NHS staff through improved productivity	IPPR analysis of McKinsey 2018, NHS Digital 2018, NHS Digital 2018. https://www.ippr.org/files/2018-06/better-health-and-care-for-all-june2018.pdf
£5.9 billion in time released for staff in the social care sector through improved productivity	IPPR analysis of ONS 2015, McKinsey 2018, NAO 2017. https://www.ippr.org/files/2018-06/better-health-and-care-for-all-june2018.pdf
£75 million on insomnia, depression and anxiety medication	68 per cent of patients suffering from anxiety and depression who use the technology move to recovery. This is compared to a national average of 45 per cent. Given combined expenditure on these medications of £370 million annually. £75 million is a reasonable estimate of the cost savings that could be achieved by the adoption of this type of technology.
£300 million from improved cardiovascular diagnosis	Based on the University of Oxford's calculations. https://www.rdm.ox.ac.uk/news/artificial-intelligence-added-to-cardiologists-toolbox
£556 million from improvements to end of life care	Patients using Coordinate my Care have seen 78 per cent compliance with their stated preferred place of death, equating to 17 per cent dying in hospitals, compared to 47 per cent nationally. The system is on average saving the NHS £2,100 per patient, equating to a saving of £556 million in England each year.
£100 million due to improvements in patient recovery	ERAS+ modelling.

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