Chapter 1

Chief Medical Officer's summary

Chapter lead and author
Sally Davies[1]

1 Chief Medical Officer, England

01 The future is here…

This year for my annual report, I have chosen to focus upon the health of the public in England in 2040. The NHS is often a source of national pride, but despite this, a narrative of health being a cost to society prevails. As the late Hans Rosling said, "When things are getting better we often don't hear about them. This gives us a systematically too-negative impression of the world around us, which is very stressful."

This report offers cause for optimism and I conclude that it is realistic to aspire to better and more equitable health in the next 20 years. As the NHS has developed its long-term plan for the coming ten years, this report looks at the strategic opportunities over the coming two decades for the health of the nation more broadly.

I believe we need to reposition health as one of the primary assets of our nation, contributing to both the economy and happiness. We also must measure and track progress in our development of health as a nation and our fairness as a society in delivering improving health outcomes. We need a composite Health Index developed that recognises this and is tracked alongside our nation's GDP.

We need to track progress in improving health and health outcomes, to and beyond 2040 with a new composite Health Index that reflects the multi-faceted determinants of the population's health and equity in support of ensuring health is recognised and treated as one of our nation's primary assets. This index should be considered by Government alongside GDP and the Measuring National Well-being programme.* We regularly collect most of the datasets that have the individual measures that could be combined.

Recommendation 1

I recommend that the Cabinet Office formally explores the development of a Health Index for England, where that index:

- could be a composite index that is inclusive of health outcome measures, modifiable risk factors and the social determinants of health;
- may be disaggregated by composition allowing tracking of performance of each component additional to the overall metric; and
- reflects the multi-faceted determinants of the population's health.

The investigation should involve the Office for National Statistics, which has experience in index development and should link to their work measuring the United Kingdom's progress on delivering the United Nations' agreed Sustainable Development Goals.

My report highlights that we know what we must do to improve health in 2040, and in many circumstances we are already doing it. Effective population prevention, such as the UK government's Soft Drinks Industry Levy, is already here. Big data and the computing power to make predictive analytics everyone's business is already here. Artificial intelligence that can diagnose disease earlier and improve prognosis is already here. We need to embed and build upon these innovations to accelerate and normalise implementation of what works across England.

Both prevention and the delivery of healthcare can contribute to a more equitable future. My report discusses the need for continued focus on the social determinants of health and as every cause of death, at every age, is more common in the most deprived, healthcare can directly deliver substantial gains too. For example, my report illustrates that achieving equitable cancer survival in England could avoid 10,000 deaths within 5-years of diagnosis (see 'Socio-economic inequalities in 5-year cancer survival: avoidable premature deaths among patients diagnosed in England in 2010" in Chapter 9 of this report).

To deliver the healthier future that is within our reach, we need a new paradigm for research. All health-related data, genomics to social determinants, and every patient contact need to be used to improve the experience, service and prevention for each individual. This dynamic learning and researching environment will require new approaches to evaluation and introduction of technologies that learn and iterate to deliver the best care to patients without delay.

This report has four sections that cover some of the biggest opportunities for health over the next two decades. The first section identifies health as one of England's primary assets through analysing the links between health and the economy, the local health environment, social health and how the maintenance and treatment of health could be experienced in 2040. The next section of this report identifies the potential health gains and reduction in health inequalities that could be possible with a 'prevention first' approach. The third section of this report explores emerging technologies and their potential impact on health promotion, protection and treatment. This section concludes by discussing the ethics of big data, emerging technologies and the fundamental role of mutual trust between the public and health institutions. Chapter 14 explores current and future uncertainties in health and identifying the potential of futures thinking methods to inform and 'future-proof' health policy.

* Office for National Statistics. *Measuring National Well-being: Quality of life in the UK, 2018*. Accessed at: https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/articles/measuringnationalwellbeing/qualityoflifeintheuk2018

02 What is health and what could it be?

Ambition for 2040 That the health of the whole population is considered one of the nation's primary assets.

Health is generally used to mean the 'absence of ill-health'. Society has a focus on the NHS as an 'illness service' rather than acknowledging the complex interactions in society that influence our health as individuals. Healthcare is often spoken of as a cost to the state and society rather than an investment that generates returns for the individual, communities and the nation. The NHS and public health services are not a burden on our finances – they help to build our future. Moreover, the good health of our nation is the bedrock of our happiness and prosperity – as I have highlighted in my previous reports,† *prevention pays*. As the increases in life expectancy experienced over past decades have begun to plateau, I agree with the OECD‡ – there are a number of factors at play that are affecting many countries, which makes it difficult to ascribe slowing increases to any specific factor or policy.

Health is an asset that we must protect and promote and is affected by the conditions in which we live and work. These conditions can be health-promoting or health-harming, and often governments, industry, and societies are responsible for those conditions, not the individual. We all have some responsibility for our own health, but we are not individually responsible for the house or neighbourhood we are born into, the school we attended, nor the health environment we live in.

The health system must adapt for each individual and ensure both their environment and the care that they receive is helping them achieve 'good health'. One example of this is social prescribing, which acknowledges our expanded understanding of physical, mental and social health and is an opportunity for the traditional health service to utilise, enhance and amplify existing schemes (see Chapter 3 of this report, 'The Local Health Environment'). One size clearly does not fit all, and this requires different types of care accessed through different places and different ways.

03 An uncertain future

Ambition for 2040 That world-leading approaches to thinking about the future are developed and used to inform health and social policy impacting on 2040, creating the capability in the health system to adapt to emergent opportunities and threats to the health of the nation.

The future is uncertain; unless we consider the future and the uncertainties that could affect health, how can we plan effectively and know whether our current plans are 'future-proofed'?

'Futures thinking' is an important part of planning, helping us to imagine what different futures might bring. My report encourages consideration of activities and environments in the light of whether they are health-promoting or health-harming and how much uncertainty they contain as a form of prioritisation for research and policy. In Chapter 14, the authors introduce the 'cone of uncertainty', where they look through the 'lens of now' to health in 2040 to consider different futures for three exemplar areas of interest. The top of the cone represents the best-case or 'utopian' outcome that we might hope for. In contrast, the bottom of the cone represents the worst-case or 'dystopian' scenario. Such a process allows the identification of research and policy considerations to ensure we set the foundations to plan for and protect a healthier future for all.

Futures thinking is vital to planning effective and efficient health environments and services going forward. Strategic leaders in healthcare and public health organisations need to embed futures thinking (and specifically scenario planning) in the development process of long-term plans.

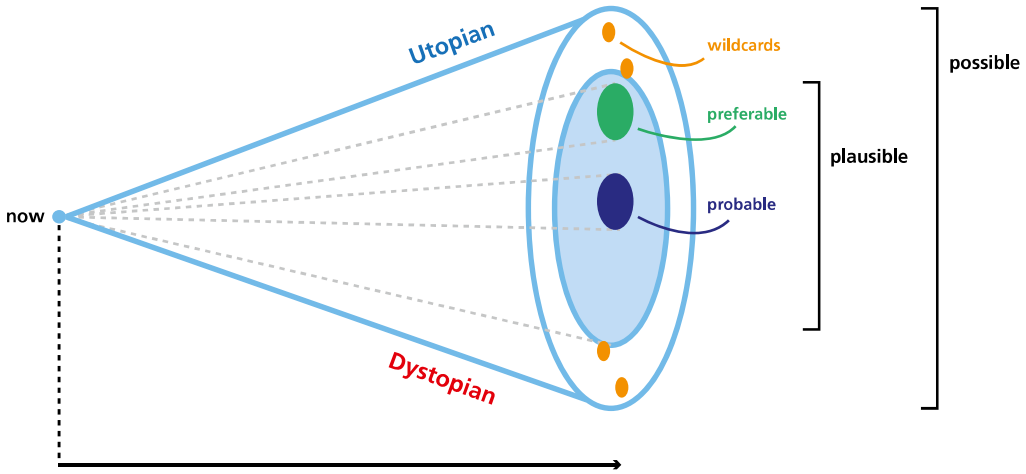
Recommendation 2

I recommend that the Department of Health and Social Care, and the health system, invest in capabilities for "futures thinking" in health, for example through Policy Research Units.

† All of my reports may be accessed online at https://www.gov.uk/government/collections/chief-medical-officer-annual-reports

‡ OECD/EU (2018), *Health at a Glance: Europe 2018: State of Health in the EU Cycle*, OECD Publishing, Paris. Available online: https://doi.org/10.1787/health_glance_eur-2018-en

Figure 14.2 The cone of uncertainty



Source The Policy Institute, King's College London

As we look to 2040, there are numerous scenarios for the health of England, some of which are explored in this report. The evidence throughout this report suggests we are currently at a fork in the road, with two vastly different pathways, both plausible for England in 2040. One scenario concerns me: if certain current trends were to continue and even worsen, we could live in a society where the most deprived are cut adrift from that society. The gap in life expectancy and healthy life expectancy could worsen substantially, aggravated by a digital divide – we must not let this unfair future be our reality.

Alternatively, our society could prioritise health as one of the nation's primary assets, making the health of our nation a source of national pride. This society would bring prevention to the public underpinned by a 'health-promoting environment' coupled with prevention that is personal to the individual. This is the future within our reach.

The final chapter (Chapter 14) in this report specifically looks at the uncertain future for three illustrative areas of varying uncertainty: anti-microbial resistance (AMR), obesity and the impact of technology on mental health.

In my 2011 Annual Report I identified AMR as a leading threat to our future infection prevention, diagnosis and appropriate effective treatment. This chapter states that we are now certain that without significant action, AMR will have a substantially damaging effect upon future health and the global economy.

The future is less clear for obesity. While a dystopian scenario where obesity is the greatest cause of preventable deaths and disability is possible, this is not inevitable; embracing and scaling up the population approaches to obesity and creating a health-promoting environment would allow England to lead the world in successfully changing behaviours and tackling obesity.

In contrast, the future impact of technology on mental health is very uncertain. There is concern about the potential harm of technologies, particularly social media on mental health and it is important to assess the evolving evidence. Further, we must remain cognisant of avoiding a 'digital divide', which could reshape health inequalities in coming decades. This report however, suggests that the 'connected world' has the potential to transform mental health services and address social isolation.

Despite the many uncertainties, we know that the population will age to 2040. We expect the most rapid period of population ageing to occur in the next 20 years, with the old age dependency ratio[§] rising from 0.27 now to 0.40 in 2040. It is therefore no surprise that estimates suggest a 50% increase in years of life lost due to Alzheimer's disease and other dementias by 2040. Estimates from the Global Burden of Disease Study in this report (see Chapter 14) forecast ischaemic heart disease will remain the leading cause of years of life lost in 2040, but we can expect the current transition of disease burden from cardiovascular disease to cancers to continue. Smoking and overweight/obesity are shared risk factors for both of these diseases and have the largest range between 'better' and 'worse' scenarios in these forecasts. This should be cause for optimism; the epidemic of smoking and obesity and sedentary-related diseases is reversible.

Health and society as a whole must prepare for the future by recognising this change in population. Futures thinking is one way to help challenge our current thinking and prepare.

§ The old age dependency ratio is the number of individuals aged 65 and older in the population as a proportion of those aged 16-64.

04 A culture of health for all

Ambition for 2040 That healthy life expectancy does increase by five years for all, with the gap in healthy life expectancy between the most and least deprived communities halved.

A healthier working-age population in 2040 is expected to translate into an economy with higher overall productive capacity, increased tax revenues and subsequently reduced spending on health-related social security payments, strengthening public finances (see Chapter 2). We know that investment in health, and the causes of ill-health, pays.

Inequalities in life expectancy have worsened from 2001-2016, with the gap in life expectancy between the most and least deprived deciles increasing from six to eight years in women, and from nine to ten years in men (see Chapter 9). Every cause at every age has a higher death rate in the most deprived communities despite our NHS. This demonstrates that both preventing ill-health through addressing the social determinants of health and the environment and the treatment of ill-health have great potential to deliver a more equitable future.

The majority of people living in poverty now are in working households (see Chapter 4). This report not only highlights the links between poor health, low educational attainment and poor job prospects but also the stark regional disparities and clustering of these links (e.g. the North East of England consistently has high claimant rates). Rebalancing the cost of living with income (earned or otherwise) presents as low hanging fruit to improve the health of the nation. Indeed, I am concerned that social determinants of health such as housing conditions could worsen for the most vulnerable, which would risk a re-emergence of communicable diseases that were eradicated from England decades ago.

Within our reach is an alternative for 2040. A person's health is an important component of 'human capital'** – indeed it is pivotal to other components including the development of educational attainment and productivity. The NHS is built upon a social contract: solidarity where we prioritise collective health security and collective wellbeing. Applying this approach of collective wellbeing to the causes of ill-health could have a marked change upon health in England in 2040.

05 Bringing prevention to the public

Ambition for 2040 That the health environment is health-promoting, incentivising and normalises healthy behaviours.

Fifty percent of the disease burden in England is due to four modifiable health behaviours – poor diet, tobacco, excessive alcohol and physical inactivity – which should be cause for optimism. However, projections to 2040 suggest that tobacco will continue to be the leading cause of years of life lost (see Chapter 14). This is not inevitable, and we must take measures now to eliminate tobacco-associated diseases and inequalities over the next two decades. Recent reductions in smoking prevalence in England over past decades are pleasing. However, there are shockingly vast disparities in smoking in pregnancy, with children born in one part of England having a 17-fold higher chance than the least deprived areas of their mother having smoked in pregnancy. This is one contributor to child health inequalities that can and must be addressed. Effectively tackling tobacco and other leading risk factors such as poor diet, obesity, physical inactivity, air pollution and excess alcohol consumption, would transform the health landscape and current inequities in drivers of ill-health such as obesity.

Smoking in pregnancy damages the health of children and contributes to child health inequalities. In 2017/18 there was a 17-fold difference between Clinical Commission Groups in smoking at childbirth.

Recommendation 3

I recommend that NHS England and Local Authorities commit to halving existing inequalities in smoking in pregnancy by geography by 2024.

Obesity and obesity-related diseases are among our greatest health challenges. Children and adults in the most deprived communities are at greatest risk of obesity and suffer the burden of obesity-related ill-health earlier, and for longer, than their least deprived peers. Obesity is an inequalities issue.

Recommendation 4

I recommend that the UK government ensure that future developments of the Childhood Obesity plan include a specific target to halve current inequalities in childhood obesity by 2030 or sooner, with support for Local Authorities to meet this target.

Chapter 8 of this report identifies interventions that alter the environment for health – 'structural' changes that require little or no action from individuals – are consistently more effective and see the largest population health gains in the most vulnerable communities when compared to individual-based approaches. One example is the innovative, tiered approach to the Soft Drinks Industry Levy, which resulted in

** Human Capital is a measure of the skills, education, capacity and attributes of labour which influence their productive capacity and earning potential.

50% of soft drink beverages reducing their sugar content before it was even implemented. These measures are effective and they are also equitable. We must not allow a situation where we look back on this era and regret allowing less effective policies to be implemented because they were either easier or avoided facing difficult trade-offs.

The Soft Drinks Industry Levy has been effective in reducing sugar consumption from soft drinks. In order to mitigate obesity and diet-related diseases, further sustained action is required.

Recommendation 5

I recommend that HM Government extend the Soft Drinks Industry Levy to sweetened milk-based drinks with added sugar and take action to eliminate added sugar in commercial infant and baby foods.

Recommendation 6

I recommend that HM Government review the use of fiscal disincentives in relation to foods that are high in sugar and salt and also incentives to increase fruit and vegetable consumption.

I welcome the Secretary of State's vision paper, 'Prevention is better than cure' [††] and his commitment to build upon past success in reducing salt consumption. From 2003 to 2011, an 11% reduction in population salt intake was achieved. This was attributable to the Food Standards Agency's approach to salt reduction, which was transparent, with close monitoring and evaluation, but holding the threat of sanctions to the food industry if reformulation targets in foods were not met. This policy has been emulated across the world. Since 2011, progress on reduction of salt consumption in England has stalled.

Recommendation 7

I recommend that in 2019, HM Government through Public Heath England, set more ambitious targets for salt reduction in food. This should apply equally to the out-of-home sector, which has lagged behind. If these targets are not met then they should be mandated and a range of other interventions considered, including mandating front of pack labelling.

Data driven public health, using predictive analytic models to test public health interventions in silico can allow decision makers both locally and nationally to compare policies. This can help provide sufficient evidence to act, thus encouraging evidence informed policy making for many complex public health challenges.

Those who shape the environment for health should be held to account. We have seen promising first steps, but to fiscally optimise the food environment from producer to plate in order to encourage healthy dietary patterns to be the norm for all, we need sustained and effective action. This approach has to encourage more focus upon the quality, rather than quantity of food produced and sold. Those sectors that damage health must pay for their harm or subsidise healthier choices.

Local Authorities need to be supported with legal powers and tool kits that allow them to improve the health environment for their populations, particularly in areas surrounding schools.

Recommendation 8

I recommend that the Ministry of Housing, Communities and Local Government explore, with the Local Government Association, how it can better support local government action to encourage healthier food options on the high street.

†† Department of Health and Social Care. *Prevention is better than Cure*. London 2018. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/753688/Prevention_is_better_than_cure_5-11.pdf

06 Data driven prevention to target those at highest risk

Ambition for 2040 That intelligent "predict and prevent" services, integrating advances in biomedicine, technology and behavioural science, are implemented progressively in order to match services to needs. These services enable everyone to have accurate information and support them to engage in positive change.

By 2040, we will be able to accurately predict chronic diseases a decade before they become symptomatic and thus enable individualised prevention measures. Vast progress in computing power and predictive analytics will be able to integrate unstructured data that sits outside of organised and traditional medical databases. This will improve disease progression prediction, allowing optimal preventative and treatment options for each individual.

Point of decision technologies that combine genetic information, nutritional guidelines, behavioural science and emerging technologies using 'nudges' in one's own environment offer the potential to achieve personal behaviour change in specific patient groups (see Box 'Personalised DNA-based dietary guidelines to nudge the public to better health' in Chapter 9).

This report identifies wearable technology with novel biosensors that offer continuous monitoring and titration as a way to transform chronic disease management outside of traditional settings (see Chapter 11). Diagnostics' high predictive value that combine novel biomarkers, genomics and wider clinical datasets will bring the diagnostics laboratory to the patient as part of their daily lives.

These impressive advancements in predictive analytics should be accompanied by tools and support that enable individuals to absorb the knowledge, be empowered and use it. This could make prevention of ill-health a routine part of daily life, particularly for those with chronic diseases.

07 The best care, in the best form, for the best you

Ambition for 2040 That healthcare is delivered through a segmented service that achieves equity of access and uptake through embracing emerging technologies based upon world-leading standards.

Chapter 7 of this report found that multimorbidity is common and will be more common in 2040. By then, we will identify multimorbidity as a non-random series of predictable clusters of conditions and health risks, identifying opportunities for early and effective intervention. I commend the ethnographic research by the Richmond Group's Taskforce on multiple long-term conditions ‡‡that seeks to understand the lived experience of patients with multimorbidity to ensure the individual is central to how care is delivered in a dynamic landscape. Indeed, by 2040 the current biomedical model of health will be transformed to integrate biomedicine, technology and behavioural sciences to provide personalised medicine in a service that remains personal to the individual.

Multimorbidity represents a substantial health challenge now and is expected to increase in prevalence to 2040. Prevention and treatment need to adapt to effectively manage the non-random series of predictable clusters of conditions and health risks within multimorbidity.

Recommendation 9

I recommend that research funders, led by NIHR and MRC, commission research to identify and understand the disease clusters that make up common multimorbidity.

Recommendation 10

I recommend that NICE, alongside specialist bodies, develop multi-disease guidelines for common clusters of disease to avoid multiple single disease guidelines applying to the same groups of patients.

We will evolve from Electronic Health Records to an individualised 'Electronic Health Engine' that integrates high dimensional data about the individual, including social and economic determinants of health, behavioural risks, biomedical, genomic and citizen-generated data, to generate real time dynamic risk trajectories (see Chapter 10). This will inform individualised prevention, management and treatment decisions accessible to both the patient and their clinical and prevention team. Interoperability will be an essential building block to achieving this step-change.

'Intelligent triaging' will have evolved by 2040 to learn how best to achieve uptake of services in each sub-population, ensuring the most rapid, effective and appropriate assessment and management. By 2040 we will have the technology to identify the best mode of accessing healthcare for each individual, whether that is by video call, virtual reality headset or in-person, day or night, as well empowering patients in self-management and control of their conditions. This could reduce inequities in accessing treatment and preventative services (see Chapter 5).

Interoperability will be central to the successful and equitable implementation of emerging technologies. Interoperability must also apply to non-NHS healthcare service providers, public health services and providers of preventative and ancillary services.

Recommendation 11

I recommend that NHS Digital should develop an open-source infrastructure that reduces the cost and complexity of integrating new technologies with existing healthcare systems, through the open Fast Healthcare Interoperability Resources standard.

†† https://richmondgroupofcharities.org.uk/sites/default/files/final_just_one_thing_after_another_report_-_singles.pdf

We are already seeing the potential of artificial intelligence delivering in practice, specifically in imaging and digital pathology. This report highlights many areas of promise for AI, particularly in imaging where quick gains could be achieved across England (see Chapter 12).

As discussed in my introduction, healthcare, as well as prevention, can deliver rapid improvements in health inequalities. AI in imaging is one example that has the potential to reduce geographical inequalities such as in diseases that depend upon time-sensitive imaging (such as stroke). One striking example in this report demonstrates that if cancer survival was equitable, 10,000 deaths within five years of diagnosis would be avoidable (see Chapter 9). Strategically harnessed, emerging technologies will standardise high quality care pathways. This will offer reductions in geographical disparities in the speed and effectiveness of diagnosis, access to and quality of care, to provide world-leading care for all across England.

08 New paradigm for research and partnership

Ambition for 2040 That England has a regulatory, evaluation and commercial framework for health research that embraces emerging technologies with ambition, relevance, and a high ethical standard.

The health system should be a dynamic learning and researching system, where all data and every patient contact is used to improve the experience and service provided to that individual, and to push the boundaries of new treatment and prevention approaches. Co-production with all stakeholders will be pivotal to this success; a health service that is learning with you, about you and for you.

England has long been a leader in both discovery science and applied health research, capturing the unique test-bed research ecosystem of the NHS. The randomised controlled trial is the 'gold standard' for clinical studies for medical interventions, but this approach is often not the most effective method for evaluating either emerging technologies or complex public health problems. Iterative research that allows in silico learning and improvement post-implementation and simulation modelling for complex public health challenges such as obesity, are key to moving fast to improve health.

This report identifies several opportunities for applied health research. To realise this potential requires a realignment of research and healthcare appreciating the interdependencies.

All advances in healthcare must continue to be evidence-based. As emerging technologies develop, a new research paradigm involving novel methods for research and evaluation must also be developed. Emerging technologies, especially those that are dynamic, provide new challenges; 'anticipatory regulation' that is proactive and 'future-proof', cognisant of emerging products and services, would provide a platform to deliver benefits to patients in a safe and expedient manner. Currently, most emerging technologies are classified in the lowest category of medical devices, along with Zimmer-frames and bandages; so, determination of safety and effectiveness is done by the company itself with no requirement for external validation. This holds some risk for patients while also stifling safe innovation that could result in large benefits to patients.

A new approach to the evaluation of emerging technologies that is relevant and proportionate to the intervention while commanding the trust and confidence of patients and clinicians is required. The recently published evidence standards framework for digital health technologies[§§] begins to outline the level of evidence required by innovators. We need a proportionate evaluation of the safety of patients before implementation, but then allows the technology to learn dynamically and improve in real time, building in evaluation, thus allowing patients to receive the best care without delay.

Emerging technologies are transforming delivery of health services and improving health outcomes. We need effective frameworks for regulation and evaluation of emerging technologies that while promoting safety allow timely implementation.

Recommendation 12

I recommend that the Secretary of State for Health and Social Care seeks advice on the best mechanism for developing, delivering and maintaining frameworks for regulation and evaluation of emerging technologies and devices. Decisions should be based upon the following principles:

a. Emerging technologies should have safety reviewed (do no harm) by an independent body.

b. Evaluation of effectiveness should be both iterative and proportionate to the purpose of the technology.

c. Exacerbation of health inequalities must be mitigated against.

As research is conducted on emerging technologies in healthcare, patients and professionals should have confidence in the standardised quality of such research. CONSORT[***] reporting standards for RCTs dramatically reduced issues arising from inadequate reporting and improved the interpretability and usability of research findings for clinicians and policy makers alike. Similar standards should be a cornerstone of emerging technologies research in health.

Specific research standards for emerging technologies are required to earn the trust of patients and clinicians, and to enhance interpretability of research findings.

Recommendation 13

I recommend that NHS Digital should work with the Office for Strategic Coordination of Health Research and Health Data Research UK to develop, consult on and agree an appropriate system for research standards in artificial intelligence health and care research studies for England.

The development of the proposed system should build on the work by the Collaborative Research Group (CRG) on Applied Artificial Intelligence in Healthcare led by the Institute of Global Health Innovation at Imperial College London.

---

§§ National Institute for Health and Care Excellence. Evidence standards framework for digital health technologies. London. 2018. Available at: www.nice.org.uk/digital-evidence-standards

*** http://www.consort-statement.org

Large, representative and longitudinal datasets are essential to developing many such technologies in the NHS; incorporating integration with wider health determinants and citizens-generated data has the potential to be a unique test-bed for such technologies to be developed, and for the benefits to be reaped by patients. The Clinical Record Interactive Search (CRIS) system at the Maudsley Hospital (see Chapter 13) is an example of influential research using integrated electronic health records within a robust, patient-led data governance framework, funded by NIHR.

To ensure that the UK is a leader in emerging health technologies and that the benefits are delivered equitably across all of England, a commercial framework that is standardised across the NHS and health-related bodies is required. This should leverage our national assets, the NHS, and world-leading academia and the life sciences industry to deliver improved services for patients within a robust data governance framework that works for citizens, clinicians and researchers. This requires healthy partnerships, building on the Life Sciences Sector Deal[†††], that reduce the risk for partners through representative datasets to develop and improve technologies while delivering for the NHS and its patients.

Health-related data needs to be of a uniformly high standard to facilitate the timely development and implementation of many emerging technologies and predictive analytics. In order for AI-based technologies to effectively serve our population, the health data used to develop that product needs to be representative of us. The UK Government's Code of Conduct for data-driven health and care technology is a welcome and important step in guiding the development of emerging technologies.

Recommendation 14

I recommend that NHS Digital, with Public Health England and partners, develop and publish best practice standardised guidance for the NHS (hospital trusts, primary care, community hospitals, etc.) on data collection, standards, structure, handling, storage, and sharing for the development of AI tools.

Recommendation 15

I recommend that the Department of Health and Social Care ensure that 'data banks' are available which are representative of the population of England to allow testing, quality assurance and validation of AI-based tools at scale before implementation into service, and for calibration of AI-based tools developed overseas to the England population for use in the NHS and broader health arena.

The success and sustainability of a health and research ecosystem such as this depends upon the existence of a shared understanding, and acceptance of, reasonable expectations underpinning the relationship between the public, healthcare and research (see Chapter 13). This requires the NHS, research institutions and researchers to constantly prove their trustworthiness, whether from the public or private sector – that they act first and foremost in the best interests of the patients and public.

[†††] Department for Business, Energy, and Industrial Strategy. *Life Sciences Sector Deal 2, 2018*. London.

09 Conclusion

Nothing is inevitable about health in England in 2040. We have the potential to dramatically improve health for all and reduce health inequalities, creating a healthier and fairer future for our children and a stronger economy. To achieve this, and to avoid worsening of health inequalities, health must be seen as one of England's primary assets. We also need to start to measure and track progress through a new composite Health Index alongside GDP. I found in reading the chapters in this report, that now more than ever, an aspirational future is in our hands and that is a real cause for optimism.

If we harness the exciting potential to transform health and the delivery of healthcare, not only will this benefit the health of the nation, but it will also make the UK world leaders in healthcare technologies through an innovative ecosystem based upon world-leading standards that protect and promote the interests of patients and the NHS. The UK could export clinical leadership in emerging technologies globally, as a beacon nation in valuing health fairly in society and in effectively tackling the growing burden of behavioural and lifestyle diseases.