Reimagining the Future of Life Sciences 2030

Unlocking the life sciences capabilities to help make the UK healthier, wealthier and more resilient by 2030

In association with

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Bristol Myers Squibb™

A report intended for those interested in UK life sciences

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Foreword from Bristol Myers Squibb

Bristol Myers Squibb (BMS) is a global biopharmaceutical company whose mission is to discover, develop, and deliver innovative medicines that help patients prevail over serious diseases.

The COVID-19 pandemic has demonstrated that now, more than ever, scientific innovation holds the key to our society's health, wealth and resilience. As a significant investor in the UK, BMS commissioned this analysis because we recognise an immediate and important opportunity to build an even stronger innovation ecosystem in the UK, learning from the unprecedented collaboration seen between the NHS, Government, academia, charity sector and industry in the past two years. If we are successful, we can help people live longer, better lives and create jobs and investment in every part of the country.

The UK Government has already highlighted the strategic importance of the life sciences sector and published a Life Sciences Vision. We hope that Life Sciences 2030 will inform the implementation of the Vision and help answer some fundamental questions.

We know that Life Sciences will be one of the great drivers of growth in the twenty first century, but how well placed is the UK to secure a significant share of this growth? What is the size of the prize? And how can the UK maximise the opportunity?

The UK is not alone in identifying the potential opportunities in life sciences; this is a highly competitive environment. As we show, spending on R&D in the UK is 1.7% of GDP, significantly short of many other advanced economies such as Germany, the US and France, as well as the UK Government's own target of reaching 2.4% by 2027. The life sciences sector can play a key role in addressing this shortfall; it performs the most R&D of any sector in the UK and is among the most productive sectors in the country. The UK life sciences ecosystem must therefore be as compelling and internationally competitive as possible if the country is to achieve the Prime Minister's ambition to be the best place in Europe to invest in life sciences. The Life Sciences Index which accompanies this report provides a comprehensive view of this competitiveness in life sciences when compared with other major markets.

The Index shows that the UK ranks seventh out of twelve large economies, based on a set of strategically relevant indicators. This ranking highlights some areas for particular focus for the UK if this positioning is to be improved.

In line with the Government's view, Life Sciences 2030 further underlines the critical role of the NHS in improving this position and as a vital partner in the discovery, development and application of medical innovation. Importantly, it highlights the potential gains for the health service if it embraces this role fully, in improved efficiencies, better health outcomes and economic benefits.

For example, the analysis shows that if the number of people taking part in clinical trials in the NHS is increased to 1.5 million clinical trial participants over the next decade, the NHS could generate efficiencies of £7.2 billion in additional revenue from life sciences companies and money saved on pharmaceuticals received for free.

Bristol Myers Squibb is committed to continuing our work with the Government in England and in the devolved nations, the NHS and other partners to help establish the UK as an innovation powerhouse in life sciences. We hope that this report will provide strong foundations for the critical work ahead. We also hope that the accompanying Index will allow us to measure progress over the coming years as we seek to achieve our shared aspirations.

Scott Cooke
General Manager, UK & Ireland, Bristol Myers Squibb

Foreword from PwC UK

We are delighted to be supporting Bristol Myers Squibb in setting out the opportunities and challenges for the UK life sciences ecosystem in the next decade.

If we are to capitalise on these opportunities, the conclusions of this report will help build a more healthy, resilient and wealthy nation.

We also thank the more than 50 experts from across the sector whose detailed contributions have been central to the conclusions of this report.

The UK already has a rich, diverse and vibrant life sciences ecosystem. The sector is one of the most productive in the UK, investing around £4.8 billion annually in R&D. The challenge now is for the UK to build on this success and become a global hub for life sciences over the next decade.

This report, which is based on extensive research across the sector, sets out some of the priorities for the UK in achieving that aim – including for government, the NHS, academia, and industry. Specifically, we believe there are four 'supercharging' capabilities the UK needs to establish by 2030. These relate to the use of data and artificial intelligence, the way clinical trials are conducted, scaling up complex advanced therapies, and improving access to innovative medicines.

Together, these capabilities will play a crucial role in helping the nation become healthier, wealthier and more resilient. The Life Sciences Vision identified seven healthcare missions that represent some of the biggest current and future healthcare problems facing the UK and the cause of many of its severe health inequalities.

In our report, we have focused on what we could achieve within one of these missions in particular: cancer. Throughout, we have highlighted how the supercharging capabilities have the potential to radically improve the detection, prevention, and treatment of this still challenging disease.

Internationally, there are many other countries with similar ambitions to lead in life sciences. To ensure the UK remains competitive, it will be essential to understand its relative strengths and weaknesses and to track its progress towards its 2030 goals. The Life Sciences Index included in this report will play a crucial role in supporting that progress.

Our hope is that this report can help the UK advance its life sciences ecosystem, ensuring its population can live longer, healthier, better lives.

Johnathon Marshall
Partner, PwC UK

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Executive summary

As it emerges from the pandemic, the UK has a huge opportunity to become a global hub for life sciences over the next decade. Achieving this vision will play a crucial role in helping the nation become healthier, wealthier and more resilient.

Innovations in science and technology are disrupting the way healthcare is delivered, creating new opportunities for diagnosing, treating and curing disease. By fully leveraging the potential of data, Artificial Intelligence (AI) and the latest treatment modalities, prevention, early detection, personalised medicine, and population health management could all become routine in the NHS by 2030. This would help people in the UK live longer and healthier lives. Better engagement of patients will enable this vision to become a reality.

In addition to the health benefits, there are significant economic gains to be realised. Our analysis estimates that increasing health expenditure by 1 to 2 percentage points could add between £45 billion and £90 billion to the UK economy. Investing in health R&D could generate an additional £4.4 billion, while improving cancer treatment through earlier diagnosis and earlier use of immunotherapies could also see the UK gain £1.7 billion*.

To help the UK deliver this vision, we set out four areas where the UK needs to establish world-leading capabilities:

Data and AI

The UK should look to integrate both traditional and non-traditional healthcare datasets, including genomics, phenomics, patient reported data, lifestyle data and wearables, and become the first country to routinely use AI in diagnostics, clinical decision making and disease prevention.

Clinical research

The UK should aim for greater agility in the way it trials and tests innovative treatments by engaging diverse populations in world-class clinical trials and unlocking the full potential of the NHS.

Advanced therapies manufacturing

The UK should aim to become a leading global hub for scaling up and manufacturing complex advanced therapies.

Access to innovative medicines

The UK should rethink how medicines are valued and prioritised, including better accounting for their impact on the social determinants of health.

*Please see appendix for economic impact methodology.

Measuring progress on this journey will be key to its success. For this reason, we've established a Life Sciences 2030 Index to offer a better long-term view of the UK's international competitiveness. In the current Index, the UK ranks seventh out of twelve leading economies. This illustrates room for improvement if the UK is to be a leading life sciences superpower.

To improve the UK's position, the life sciences ecosystem will need to come together in improving access to quality data, progressing clinical research, scaling up the manufacturing of advanced therapies and facilitating access to innovative medicines.

If the UK can also bring its spending decisions into closer alignment with its healthcare priorities, it can start treating the health of its citizens as an asset – and its healthcare spending as an investment rather than a cost.

The result will be better patient outcomes, a more productive workforce, and a better quality of life for UK citizens.

The UK has set an ambition to become a **global life sciences superpower by 2030**

To enable this Vision, the UK should **supercharge four capabilities:**


Data and AI


Clinical research


Advanced therapies manufacturing


Access to innovative medicines

In 2030, this could see the UK achieve considerable **economic and health benefits:**

£45-90bn

could be added to the UK economy if we invested more in healthcare

£4.4bn

could be added to the UK economy if we financed more health R&D

Increasing the number of **clinical trials participants** could see the NHS:

Receiving £4.4bn

in revenue from life sciences companies

Saving £2.8bn

from pharmaceutical products received free

Making real **strides in the way we screen and treat cancer**, could see the UK gaining...

£1.6bn from detecting some lung, colon, oesophageal and breast cancers earlier

58,000 QALYS from catching most lung cancers at stage 1 or earlier

£115mn and 34,000 QALYs from increasing the use of immunotherapies to treat lung cancer

Please see appendix for economic impact methodology

Chapter 1: The UK as a global life sciences superpower

The critical role of the UK life sciences sector

The UK is at an inflection point. The COVID-19 pandemic has shown just how inextricable the link is between health and wealth. And as we come out of the crisis, there is now a rare opportunity to redefine priorities, focusing on the health, wealth and resilience of the country. Put simply, the health of the population needs to be seen as an asset, and healthcare spending an investment rather than a cost.

The UK's rich, diverse and vibrant life sciences sector will be critical to the success of this endeavour. The sector not only plays a crucial role in helping UK citizens live healthier and longer lives, but also represents a key part of the nation's economy. It performs the most R&D of any sector in the UK (totalling £4.8 billion[1] in 2019), had a turnover of £80.7 billion in 2019, supports almost half a million jobs, and is among the most productive sectors in the country, with a Gross Value Added (GVA) of £104,000 per employee.[2]

The UK is also a leader in early-stage clinical research, thanks in part to its availability of public funding. It has played a key role in the development of life-changing treatments, such as 'humanising' monoclonal antibodies which are now used in the treatment of many cancers, autoimmune and infectious diseases[3]. And, in the NHS, it also has the largest single unified healthcare system in the world, covering a diverse patient population 65 million people strong, with access to longitudinal datasets developed over decades.

The benefits of a strong, science-driven pharmaceutical industry were evident in the UK's fast, agile and innovative response to the pandemic. Scientific brilliance, agile and independent regulation, and new forms of collaboration enabled the ecosystem to rally around a joint healthcare mission and deliver innovative breakthroughs in record time. By the end of June 2021, for example, the COVID-19 Genomics UK consortium had sequenced 500,000 SARS-CoV-2 genomes, providing data on viral transmission and enabling the tracking and analysis of viral variants[4].

Where next for UK life sciences?

As the UK emerges from the pandemic, there is now a key opportunity for the life sciences sector to build on these strengths and help the nation become wealthier and more resilient, while its people become healthier, live longer, and are better able to avoid disease. The UK government has launched several initiatives that may support this aspiration*, including, most recently, a comprehensive Life Sciences Vision, which sets out an ambition for the UK to be the leading global location for the life sciences sector to innovate, grow and deliver medical breakthroughs[5].

The sector's ability to both drive economic growth and improve population health means it also has a key role to play in the UK government's levelling up agenda. Significant, and often regional, health and economic inequalities remain across the UK population, and have been starkly illustrated by COVID-19. Pre-pandemic, a person aged under 75 in the poorest tenth of the country was already around three times more likely to die in the next year than someone of the same age living in the richest tenth[6].

* Publications include: Department of Health and Social Care, The Executive Office (Northern Ireland), The Scottish Government, and Welsh Government, Saving and Improving Lives: The Future of UK Clinical Research Delivery, 23 March 2021; Prime Minister's Office, 10 Downing Street, Taskforce on Innovation, Growth and Regulatory Reform independent report, 16 June 2021; Department for Business, Energy & Industrial Strategy, UK Innovation Strategy: leading the future by creating it, 22 July 2021.

Between March 2020 and March 2021, moreover, COVID-19 mortality for those aged below 65 was 3.7 times higher in the most deprived areas[7]. The UK needs to look to address health inequities and regional disparities in healthcare to ensure more people live longer and healthier lives.

As the Vision illustrates, the UK already has many of the key facets of a global life sciences superpower and performs well in terms of R&D spend per capita. However, there are a number of systemic weaknesses to address and areas where it lags behind other leading economies. This is especially important as the UK competes against emerging markets that are making bold offers to attract international investment.

Specifically, the Vision recommends building on the new ways of working developed during COVID-19, continuing to develop the UK's scientific and research infrastructure, improving access to innovations in the NHS, and creating the right business environment for life sciences companies to grow. While the UK has strengths in certain areas, we note that there are other areas where the UK can do more to increase competitiveness in life sciences.

This includes the UK's relatively poor performance in late-stage research, where it lags behind global competitors for Phase III clinical trials[8], as well as investment in healthcare and pharmaceuticals, where the UK spends less than other advanced nations. In addition, although the UK has a strong academic science base and history of technology development, talent and intellectual property are often commercialised abroad (for example, early-stage companies often chose to list in the United States through an Initial Public Offering (IPO) or a special purpose acquisition company).

Taking the longer view

Bristol Myers Squibb (BMS) and PwC UK (PwC) fully endorse the Vision's ambition to make the UK a global life sciences superpower. This report is intended to support that ambition by bringing industry and government into closer alignment, quantifying the health and economic impact of achieving the Vision's goals, and establishing a mechanism – a Life Sciences 2030 Index – to provide a better long-term view of the UK's progress.

We also believe there is an opportunity to define a longer-term set of objectives for UK life sciences. Extensive engagement across the UK Life Sciences sector has helped us to paint a picture of a truly transformative future.

The underlying science and technology is evolving fast and the healthcare system of 2030 will look different – and face very different challenges – than it does today. Our aim in this report is also therefore to bring to life this vision of the future for life sciences.

In doing so, we have focused, where appropriate, on the prospects for cancer treatment as this remains a leading cause of mortality in the UK, accounting for 28% of all deaths in 2019[9]. We also assess that patient outcomes in cancer can be particularly transformed by the ground-breaking medical and technological advances of the future.

The insights and recommendations set out in this report have been informed by an extensive review and analysis of relevant existing literature plus interviews and roundtable discussions with over 50 leading experts in the UK and global life sciences ecosystem. We have also drawn on PwC reports such as 'Driving the future of health' and 'Tech powered healthcare'.

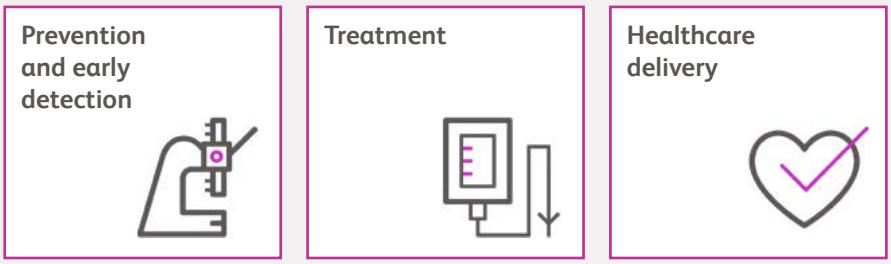
[*] PwC, Strategy&, Driving the future of health: How biopharma can defend and grow its business in an era of digitally enabled healthcare, 2019; PwC, Tech powered healthcare: A strategic approach to implementing technology in health and care, 2020.

Chapter 2: Life sciences in 2030: A revolution in patient outcomes

By 2030, the way we deliver healthcare will be revolutionised

Science and technology are converging to change the future of healthcare delivery. The UK is entering a new era of data-driven healthcare, in which advances in technology, better data, and more personalised care will transform the way diseases are prevented, diagnosed, and treated. This will fundamentally change the way healthcare is delivered and how patients are engaged. Patients will be empowered to make decisions about their healthcare options. Ultimately, these changes will lead to better outcomes, and a better quality of life, for patients.

Figure 1: Drivers revolutionising patient outcomes



Prevention and early detection

Care pathways will undergo a tectonic shift from reactive to proactive medicine. Care will be centred around early detection, faster diagnosis and better prediction of risk at both the individual and population level. Prevention will be prioritised, enabled by the application of artificial intelligence (AI) algorithms, machine learning and digital devices. Disease will be detected earlier, leveraging remote screening technologies, intensive screening and genomic and polygenic risk scores.

In cancer diagnosis, for example, population-wide screening, leveraging new techniques such as GRAIL's Galleri® (a test that can detect over 50 types of cancer through a blood sample[10]) will enable asymptomatic cancer detection and early diagnosis at stages 1 and 2. Even in the near-term, liquid next-generation sequencing will allow for better screening.

And by using certain types of tumour DNA (such as circulating tumour DNA), relapsing cancer could be detectable as much as 200 days earlier than via a CT scan[11].

Treatment

Cutting-edge treatments will combine precision medicine with novel therapies to make care more specialised, more personalised and more curative. These therapies include advanced therapies, such as cell and gene therapies, as well as other targeted agents, such as small molecules designed to target specific mutations. For cancer, earlier diagnosis will enable earlier treatment – with far greater curative potential. Advances on multiple fronts in the field of immuno-oncology are already helping make this a reality.

[1] Please see appendix for economic impact methodology.

As the UK Government's Vision emphasises[12], using therapies like these earlier can transform outcomes for people living with cancer and other disease:

- Messenger RNA ('mRNA') technology offers the promise of treating diseases that cannot be reached by conventional means, including certain types of cancer and infectious diseases (as was successfully demonstrated with COVID-19). An mRNA cancer vaccine, including dendritic cell vaccines and directly injectable mRNA, is a highly personalised treatment that can trigger antigen-specific T cell responses for mutations in cancer cells and can prolong disease-free survival in some cases[13].
- CRISPR gene editing technology has the potential to transform the way we treat and cure disease (including viral disease) by modifying DNA sequences with high precision. Recent advances have leveraged an allogeneic cellular approach using CRISPR to treat certain cancers. CRISPR can also be combined with other new technologies, such as nanotechnology, to selectively target cancer cells via injected DNA nanorobots[14].
- KRAS, a mutated protein present in about a quarter of all tumours, has historically been considered undruggable. However, promising results in early-phase clinical trials for the treatment of lung cancer, could pave the way for treating more mutation variants of KRAS in other types of tumours such as pancreatic and colorectal cancers[15].
- Advanced therapies currently used to treat rare and ultra-rare genetic diseases may be expanded to treat additional rare diseases and solid tumours, as well as diseases with larger patient populations, including cancers, diabetes, cardiovascular indications, and certain neurodegenerative disorders, such as Alzheimer's and Parkinson's Disease[16]. For example, ImmTune Therapies is developing in-vivo cell therapies to be infused intravenously, directly to the patient, as an off-the-shelf product[17].

Healthcare delivery

Data-driven health management, at both the individual and population level, will become far more advanced. Healthcare delivery will be more focussed on connected care, health equity and the patient experience. A better understanding of the social determinants of health outcomes will help the UK to better address health equity, putting more control in patients' hands and enabling them to access the right treatment at the right time. Blockchain-enabled databases will improve both the security of patient data and the ability to share it with the patient's consent[18]. An ecosystem of integrated digital solutions will support citizens along the entire care continuum, revolutionising patient experience across social care, primary care and specialist care. Traditional healthcare data will be combined with other kinds of data – citizen-generated, phenomic data, outcomes-related – to improve decision making and better target health interventions.

Spotlight on Digital twins, paving the way for predictive, preventative and personalised care

Digital twins – dynamically updated digital representations of real-world objects, people, or systems – have a growing role to play in healthcare. By twinning a patient's profile digitally, and updating it with real-time insights from wearables or other connected devices, healthcare professionals are able to run clinical trials, validate new drugs and more accurately predict or simulate how a patient will react to a particular treatment.

Not only does this pave the way for a more predictive, preventative and personalised form of healthcare, it also reduces the cost of care and improves disease management for patients.

At the Arab Health Exhibition & Congress in 2018, Siemens Healthineers unveiled an AI-powered digital twin of the human heart that can be used to visualise and test responses to treatments before actual intervention.

The company is now extending the technology to other organs, such as the human liver, with the ultimate aim of creating a digital twin of the entire human body to predict the effects of a lifestyle change on each individual and personalise medicines accordingly[19]. Neom, Saudi Arabia's development project, has ambitious plans to create digital twins for every resident – modelling everything from daily habits and patterns of behaviour, to facial recognition, blood type and individual genetic sequences[20].

Chapter 3: Unlocking the 2030 Vision: Four supercharging capabilities

To secure its place as a global life sciences superpower by 2030, the UK will need to unlock a range of capabilities.

There are four in particular that we believe will supercharge the evolution of the sector over the next decade:

- **Data and AI.** The UK should look to integrate both traditional and non-traditional healthcare datasets, and become the first country to routinely use AI in diagnostics, clinical decision making and disease prevention.
- **Clinical research**. To enable patients in the UK to be the first to trial and test innovative treatments from across the globe, the UK should engage diverse populations in world-class complex clinical trials and unlock the full potential of the NHS as an engine for innovative clinical research.
- **Advanced therapies manufacturing.** The UK should aim to become a leading global hub for scaling up and manufacturing complex advanced therapies, changing the way we treat diseases.
- **Access to innovative medicines.** To improve access to and the uptake of new and innovative treatments, the UK should rethink how medicines are valued and prioritised, including accounting for social determinants of health and societal value.

Together, these capabilities could make a real difference to the health and wellbeing of the UK population and will support the UK in tackling regional health inequalities. In cancer treatment, for example, a growing understanding of tumour biology and genetics could improve our understanding of the disease and help the UK take a lead in the development and manufacturing of experimental cancer treatments, such as in-vivo CAR-T and cancer vaccines.

It is important to recognise that these capabilities are not static and will continue to evolve over the course of the next decade. In the remainder of Chapter 3 we look at each in turn, identifying both the immediate priorities (over a five-year horizon) and the longer-term priorities for the UK. We also consider some of the more universal cross-cutting drivers of change in the life sciences sector.

If the UK is to succeed in realising the vision and delivering on the supercharge capabilities, it will need to effectively align its priorities for a healthier and wealthier nation with its healthcare spending decisions. This will require strategic thinking and ambitious spending targets.

Data and AI

The UK should aspire to be the first country to fully integrate healthcare datasets and use AI routinely in diagnostics, assisted clinical decision-making and long-term disease prevention. This will revolutionise everything from drug discovery to disease treatment.

View to 2030:

- Fully integrated datasets across integrated care systems (ICSs) – including formal health data, genomics, phenomics and outcomes data – will enable personalised care pathways that provide the right drug for the right patient at the right time
- AI algorithms will enable population-wide screening for the earlier diagnosis of chronic diseases such as cancer
- Improved population-level health data insights will help the UK better understand where health inequalities exist and what causes them
- A deeper understanding of tumour biology and genomic-led diagnosis will trigger a step change in our understanding of cancer (including genetic variations and rearrangements).

The UK has the building blocks to lead in the medical use of data and AI, but there are hurdles to overcome

The UK has some of the richest healthcare data in the world. It has a cradle-to-grave dataset for a large and diverse patient population, generating over 500 million patient 'days' of data every year[21]. It has also made significant progress in harnessing data across digital health, early diagnosis and genomics:

- Salford Royal NHS Foundation Trust is piloting Social Linked Data (SOLID) technology to develop personal data stores that allow people to control their data, and health and care systems to deliver better patient care. The UK has also started to develop synthetic datasets to keep patient data safe, such as NHS England's SynAE project to develop predictive models for prevention[22].
- Recent developments in the UK's thriving £5 billion genomics market include the 100,000 Genomes project, a commitment to whole genome sequencing for the 500,000 UK Biobank cohort, and a plan to generate genome-wide analysis of 5 million genomes over the next five years[23].
- The NHS is willing to consider innovative arrangements with healthcare companies, including a partnership with GRAIL to make the Galleri® multi-cancer early detection blood test available to approximately 165,000 patients. Similarly, Sensyne Health has entered into strategic research agreements with a number of NHS Trusts to build datasets of secure, anonymised patient data, enable the development of new AI technologies and accelerate the introduction of personalised therapies. Sensyne is also enhancing the UK's clinical research capability through its SENSIGHT™ tool, which harnesses the potential of real-world data for clinical trials.[24]

However, fundamental challenges remain. Much of the UK's data remains inaccessible in practice due to a siloed and fragmented data ecosystem, as well as information and research governance practices. There is also room for greater citizen engagement with data and AI programmes, to reduce misperceptions and improve trust. Additionally, a skills gap is emerging caused by the difficulties of attracting and retaining healthcare-related data scientists, and there is a lack of diversity in both the data analysed and the data scientists that conduct the analysis.

While the UK looks to resolve these challenges, other countries are competing fiercely in this field. The United States, for example, leads the world in healthcare-related data and AI, conducting the highest number of AI-related healthcare research studies and trials.

Yet, it is increasingly challenged by a fast-growing healthcare AI sector in Asia (and in particular China). The European Union is also strongly positioned, benefitting from a large and diverse set of national health data, vast research studies, clusters of innovation, and pan-European collaboration[25].
In particular, France set out a five-year national AI strategy in 2018 ('AI for humanity'), with health as one of the priority sectors. This included pledging investment of over €1.5 billion in AI, including €700 million for research[26]. Additionally, the French Health Data Hub was launched in 2019 to facilitate the use of available health data by both private and public entities for research projects[27].

Priorities for the UK

In the short term, the UK must look to improve the understanding and acceptance of the use of data for research – including how AI algorithms are used with that data – among both clinicians and citizens.
The way citizens engaged with COVID-19 data research can provide a useful template. Within 36 hours of being launched in March 2020, for example, the Zoe symptom-tracking app had been downloaded over a million times[28]. The greater the understanding and buy-in from citizens, the better placed they will be to engage with, and consent to, research conducted on their health data.

To drive AI research forward, the UK also needs interoperable research-ready datasets that give researchers and innovators fast access to the data. To enable this, the UK will need to establish minimum data standards, system interoperability, and computing infrastructure capable of managing vast volumes of data.

For example, NVIDIA have committed to building a "Cambridge-1" supercomputer – a powerful computing resource harnessing the capabilities of AI[29]. Any approach to data should prioritise and protect the privacy of individual health records and support and encourage informed consent, while unlocking the vast possibilities of big data to improve lives. At the same time, data will need to be more representative of the UK population, including its gender and ethnic make-up.

The UK will also need a competitive and diverse healthcare data science workforce, supported by academia-led health AI programmes (such as MD PhDs), better incentives to attract and retain data scientists, and system integration architects that can drive system interoperability at all levels within the NHS.

Partnerships with organisations which have the requisite skills should also be considered. This should create a virtuous circle in which the UK finds it increasingly easy to attract new talent and incubate new health-related AI companies, encouraging UK-based companies to IPO in the UK rather than in the United States.

Longer-term, the UK's health data will need to traverse the whole patient journey across social, primary, secondary and tertiary care. Health data and conventional patient records will need to be supplemented by world-class 'omics assets contained in longitudinal cohorts, imaging, pathology, and citizen-generated remote monitoring data assets. This will allow far more personalised and holistic care for an individual and, in aggregate, bring benefits of scale to researchers and industry and enabling fully informed decision-making. The development of these capabilities should be planned in tandem with the creation of Integrated Care Systems (ICSs).

In cancer treatment, for example, the effective use of data will increase the prevalence and reach of Living Beyond Cancer. Real World Evidence (RWE) will demonstrate the longer-term and downstream economic and societal impact of a treatment.

For example, an emphasis on risk stratification and personalised medicines will reduce the treatment stage of the pathway and enable more patients to "manage their condition".

The effective use of RWE will thus help the UK better manage critical challenges around treatment and palliative care as greater numbers of people live longer with cancer.

Short-term priorities

1. Develop a citizen engagement strategy to address public concerns about sharing health data for research
2. Define a data consent model, that builds on GDPR, in collaboration with citizens
3. Develop 'research ready' healthcare data that reflects the diversity of the UK population
4. Recruit and train and retain a diverse and skilled health data and AI workforce

Longer-term priorities

5. Develop a nationally representative health and non-health dataset across primary, secondary and tertiary care
6. Nurture an internationally recognised commercial environment for health AI companies.

Case study:

How Sweden's national registries drive quality improvements and deliver RWE studies

Sweden boasts a collection of over 100 National Quality Registries which the health ecosystem uses to collect RWE, monitor the quality of healthcare, and develop more innovative treatments.

Each registry is supported by an organisation of healthcare professionals and patient representatives and contains individualised real-time data about medical interventions and patient outcomes. Not only does this allow researchers to better understand complex diseases, but it also underpins value-based pricing and attracts foreign researchers interested in using AI to leverage Sweden's data.

The registries have been made possible by a combination of policies and collaborative initiatives, including favourable patient data regulation, a focus on quality improvement, professional self-governance and multi-level government funding. In 2019, for example, the Swedish government pledged around €18.6 million for the further development of the registries[30].

Clinical research

The UK should be a trailblazer in transforming clinical research capabilities, aiming to lead the world in experimental medicine and conducting fully data-driven, virtual and decentralised clinical trials.

View to 2030:

- Late-stage clinical trial processes will be reimagined to increase efficiency, while transforming experiences for patients, industry and clinicians.
- Trials will see a broader adoption of in-silico methods, capitalising on the exponential growth in patient data, the emergence of new technology, supported by AI and analytics and increasing computing power.
- New and decentralised models will include non-traditional players, such as pharmacies and community hubs, to better enable remote trials.
- A deeper understanding of genetics and tumour biology will enable the UK to take a leading role in innovative experimental medicine studies for cancer.

While UK clinical research provided a 'beacon of hope[31]' during the pandemic, there are still fundamental issues to resolve

In the NHS, the UK has the world's largest integrated health service, covering a population of over 65 million. It is therefore an ideal place to run early-stage complex trials. Indeed, it is a leader in Phase I commercial clinical trials in Europe and it delivered 12% of all global trials for innovative cell and gene therapies in 2019[32]. During the COVID-19 pandemic, UK regulators, the NHS and trial sponsors also successfully worked collaboratively to set up and deliver large-scale trials safely, quickly and effectively[33]. This included the UK's innovative COVID-19 RECOVERY trial.

In late-stage clinical research, however, the UK has been losing ground to other advanced countries. In terms of its volume of Phase III clinical trials, the UK ranks fourth, behind the United States, Germany, and Spain[34], and its share of patients recruited to global studies is under 2%[35]. Late-stage trials present an opportunity for the NHS given they involve significantly larger number of patients, while also offering the chance to provide treatment with innovative therapies free of charge. The UK must change this if it is to be a true global superpower in clinical research.

Specifically, the UK must address the fact that it does not have a single centralised way to run late-stage clinical trials and that its current processes for costing, contracting, and approvals hinder late-stage trial setup and recruitment. Even nationally sponsored trials, such as the NHS-Galleri trial, have seen persistent delays[36]. On top of this, both patient awareness and patient experience need to be improved. Potential participants often don't know how to access trials or have difficulty getting access even when they do. Moreover, NHS Trusts are often not incentivised to support clinical research and the NHS workforce lacks capacity to deliver it as part of its day-to-day activities. Funding for clinical research is also decreasing, with Cancer Research UK funding having been cut by up to 10% for example[37].

The Life Sciences Vision and the Taskforce on Innovation, Growth and Regulatory Reform (TIGRR) set out recommendations for the UK to increase its capacity and capability for clinical research. TIGRR, for example, outlines initiatives to streamline clinical trial set up, standardise patient recruitment and reduce the time to first patient recruitment to 60 days. The UK will need engagement across the life sciences ecosystem to implement these initiatives and lead in clinical research globally[38].

Priorities for the UK

The immediate need for the UK is to streamline costing, contracting and regulatory approvals for late-stage clinical trials. This is particularly relevant at a hospital level – making it easier both for sponsors to access patient cohorts and for patients to identify and participate in trials. This should include encouraging greater participation from women and ethnic minorities and from research centres and NHS Trusts outside London and the South East, as well as, importantly, developing metrics to track diversity.

These more efficient arrangements will make it easier for the NHS to support late-stage clinical research, while also collaborating with the life sciences sector

to maximise the productivity and visibility of research. ICSs, for example, should look to provide support and resourcing for clinical research, allowing it to be delivered in a 'real world' context with greater ease. Incentives will need to be developed within the NHS to encourage this active participation.

There is also a huge opportunity for the UK to take a leading role in innovative experimental medicine studies, provided appropriate funding is available. This includes trialling adjuvant and neoadjuvant therapies earlier in disease to treat pre-metastatic cancers, leveraging an improved understanding of tumour biology through the application of data and AI.

Looking further ahead, the UK should be aiming to increase digitalisation throughout the research ecosystem, enabling clinical trials to leverage higher volumes of more complex data as well as new technology applications.

This will enable the routine use of innovative, virtual and decentralised trials which should increase patient engagement. A larger, more diverse and more distributed patient population should be able to access and be accessed in clinical trials. It should also help hospitals decrease their backlog of care by supporting trial participants outside of a hospital setting.

To achieve this, the UK will need to get better at harnessing RWE from the NHS to provide a real-time, holistic view of patient health. It will also need to enhance the anonymisation of data for synthetic control arms, make it easier for patients to register their interest in participating in trials (and strengthen the associated consent model) and invest in infrastructure such as 5G and community hubs to enable remote trials. The delivery of innovative and virtual clinical trials also rests on implementing the data and AI capabilities described in the preceding section.

Short-term priorities

1. Deliver late-stage commercial clinical research more efficiently
2. Enable patients to identify and participate in trials with ease
3. Reflect a diverse population in clinical research
4. Embed clinical research across the NHS
5. Pioneer experimental medicine studies, with appropriate funding for R&D

Longer-term priorities

6. Increase the routine use of virtual and decentralised clinical trials.

Case study:

How Spain broadened patient participation in clinical trials

In the years following the financial crisis, Spain launched a national strategy to increase participation in clinical trials. This included a public campaign to raise awareness of research and an initiative to recruit more patients from rural areas.

In addition, the Spanish Council of Ministers passed a Royal Decree to simplify regulatory approval for clinical trials, and set up the Ethics Committees for Investigation (CEIm). These policies have led to better recruitment and more sites per study, supporting an increase of over 25% in the number of clinical trials between 2010 and 2015[39].

Advanced therapies manufacturing

The UK should aim to be one of the top three countries in the world in which to scale complex advanced therapies, enabling the cost-effective treatment of chronic conditions.

View to 2030:

- Advanced therapies will be scaled to broader patient populations, meaning they can treat chronic diseases cost effectively rather than being limited to rare and ultra-rare genetic diseases.
- New treatment modalities and technologies will revolutionise medicine, and cancer treatment in particular – in-vivo CAR-T therapies, CRISPR and DNA editing technologies could all be deployed at scale within ten years.
- The UK's expertise in tools and services to support advanced therapies manufacturing will be internationalised.

To be a true leader in advanced therapies manufacturing, the UK needs a stronger strategic direction

Advanced therapies include novel cell and gene therapies. They are seen to offer "unprecedented promise for the long-term management and even cure of disease, especially in areas of high unmet clinical need"[40]. The UK benefits from having taken an early lead in the innovation and research of advanced therapies. It represents the largest advanced therapies cluster outside of the United States, conducting 12% of cell and gene therapy clinical trials globally[41], delivering significant benefits for patients. By 2020, it was home to more than 90 companies developing Advanced Therapies Medicinal Products (ATMPs), 26 manufacturing facilities and nine licensed ATMPs. In the period 2018–2020, total financing for UK ATMP companies reached £1.7 billion[42].

This success is built on a strong advanced therapies ecosystem, which includes NIHR, Innovate UK, the Medical Research Council, Cell & Gene Therapy Catapult, the Advanced Therapy Treatment Centre (ATTC) network, Vaccine Manufacturing and Innovation Centre (VMIC) and Advanced Therapeutics UK. The UK is also a world leader in academia, discovery and innovation, and there is significant patient engagement on cell and gene therapies with active patient advocacy groups.

However, challenges remain. First, there is no lead organisation or governance structure in the UK to coordinate the advanced therapies manufacturing value chain strategically, meaning initiatives are often short-term and tactical. The UK also has limited capacity for academic and early-stage clinical trials, with investments tending to rely on specialist hospitals rather than being dispersed more widely.

Moreover, there are not enough specialist centres to take on the challenge/opportunity, nor is there an appropriately developed "hub and spoke" model.

On top of this, companies often experience difficulties in translating early ideas into commercial opportunities and the high cost of manufacturing advanced therapies means both market access and reimbursement opportunities are restricted.

Limited access to finance means start-ups are not incentivised to remain in the UK, and many SMEs are not able to grow into mature companies. There is also a shortage of skilled workers across a range of technical, operational and clinical delivery roles.

As a result, some manufacturers have decided to base their cell and gene therapy hubs elsewhere. Belgium, for example, offers significant incentives for innovation, such as tax advantages and government grants, making it an attractive investment location[43].

Case study:

The United States hosts a thriving funding environment for biotechs, which often choose to list on the Nasdaq

The United States has an attractive funding ecosystem which encourages the translation of early ideas into commercial opportunities. Global biotechs, including UK-headquartered, venture-backed start-ups, tend to list in the country through an IPO on the Nasdaq, or through a special purpose acquisition company. This can be explained by the significantly higher valuations and market capitalisations available in the US, as well as its exemptions from compensation reporting rules. US investors also typically have a greater risk appetite and willingness to support early-stage companies. The country's extensive pool of capital, investment by pension funds, and better prospects for follow-on financing are also key factors, allowing early ideas to translate into early stage clinical trials, spin outs or mature companies[44].

Priorities for the UK

In the short term, the UK's advanced therapies manufacturing ecosystem needs to be brought together more effectively. Initiatives need to be more strategic and coordinated, and offer a single point of entry to help participants navigate the ecosystem more effectively. This will enable new partnerships to be established more easily, such as between private and public organisations and with patients and patient advocacy groups.

That enhanced coordination needs to be supported by the right skills, expertise and investment. The UK should therefore look to ensure that there are more routes into the industry (including via innovation hubs and apprenticeships). At the same time, more R&D investment is needed to ensure early-stage research can be dispersed across a greater number of hospitals.

There should also be a reassessment of how advanced therapies are appraised. Given the high upfront costs involved, traditional assessments of cost effectiveness may not be appropriate, and new financing models, including outcomes-based mechanisms, may be required.

This could include developing and piloting frameworks for innovative funding routes, such as structured reimbursement schemes.

While the opportunity for the UK to be an early global hub for cell and gene therapies may have passed, it still has a long-term opportunity to lead in advanced therapies.

It should also, moreover, be looking further ahead to become a hub for the next treatment modality. To do so, the UK will need to generate intellectual property in new technologies, such as in-vivo CAR-T therapies and cancer vaccines, and develop services to support ATMPs (such as equipment or consultancy services).

Start-ups and SMEs represent an important source of innovation for advanced therapies, and the UK will also need to ensure that early innovations are more routinely translated into commercial opportunities (such as via early-stage clinical trials, spin outs or mature companies). This should be supplemented with broader access to finance for start-ups and SMEs, and a coordinated cross-government approach, including tax incentives and grants (in particular R&D tax credits and patent box tax relief) to attract multinationals and enable more UK start-ups to scale into unicorns, which are startups with valuations of over $1 billion.

Short-term priorities

1. Define a governance structure and service infrastructure to better coordinate the advanced therapies ecosystem
2. Recruit and train a skilled advanced therapies manufacturing workforce
3. Take a lead in conducting early-stage clinical trials for advanced therapies
4. Reimburse advanced therapies
5. Improve access to finance for start-ups and SMEs so they can grow in the UK

Longer-term priorities

6. Develop manufacturing hubs in the UK for the next treatment modality

Access to innovative medicines

The UK should aspire to be a pioneer in facilitating access to personalised, innovative treatments, with NHS patients consistently among the first in the world to benefit from the latest scientific breakthroughs.

View to 2030:

- Patients will have world-leading access to innovative personalised treatments
- Medicines will be valued by a more holistic understanding of the social determinants of health
- Payments for medicines will be based on real and measurable patient outcomes.

To deliver world-leading health outcomes, the UK needs a world-leading access environment

R&D investment alone will not drive the gains in productivity, wellbeing and prosperity the UK seeks. These gains can only be achieved through the wide diffusion and adoption of life sciences innovation[45].

The UK government has taken steps to improve its population's access to and uptake of new and innovative medicines. There are now multiple frameworks, mechanisms and reviews in place, including the Accelerated Access Collaborative (2016), the Commercial Medicines Directorate (2018), the Voluntary Pricing and Access Scheme (2019), the NHS England Commercial Framework (2021), the Innovative Licensing and Access pathway (2021), the Innovative Medicines Fund (2021, building on the success of the reformed Cancer Drugs Fund) and the NICE Methods Review (the implementation of which will begin in 2022).

However, the UK still invests less in medicines than comparable countries. The UK spent only 1.2% of GDP on pharmaceuticals in 2019 (compared with 2.1% in the United States, 1.7% in Canada and Germany[46]).*

This relatively low level of investment translates into poor access to innovative medicines. For every 100 patients that get a new medicine in its first year of launch in parts of the European Union, for example in France and Germany, just 21 patients in the UK get access[47]. Moreover, those medicines which are recommended by NICE may be approved for a more restricted population than the licence, meaning fewer NHS patients are eligible for treatment compared to other European countries. And while the UK generally makes medicines available to patients faster than the EU average, it still trails countries like Germany and Switzerland. In England, for example, the median number of days between a medicine's marketing authorisation and availability to patients is 297 (compared with 50 in Germany, 87 in Switzerland, and 94 in Denmark[48]).

The challenging access environment means some patients in the UK don't benefit from the latest advancements in medicine discovery, which can result in poorer health outcomes. This is an area in which the UK already underperforms compared to other advanced economies, for example in cancer survival and avoidable mortality rates.

Priorities for the UK

There is an opportunity for the UK to improve patient outcomes by increasing the use of innovative medicines. To do so, it needs to focus on two areas:

1. Reconsider the value of medicines. Too often, the long-term value of innovative medicines is not fully considered. This can lead to protracted negotiations and negative decisions from NICE. It is also a factor in the restrictiveness of many NICE decisions, which often limits a medicine's use to smaller patient cohorts than the licence.

Consider, for example, the discount rate used by NICE. Discounting is a mechanism for adjusting future costs and benefits based on the principle that society generally prefers to have benefits sooner but spend money later. This is done by including a 'discount rate' in the economic analysis of an appraisal. The Treasury Green Book applies a reduced rate of 1.5% per annum to policies that impact health or life outcomes. In contrast, the current discount rate used by NICE is 3.5%. And while NICE has found evidence in favour of switching to the 1.5% rate, there are currently no plans to implement such a change[49].

The NICE cost-effectiveness threshold has remained largely unchanged since the organisation was established in 1999. However, over that time, there has been a 77% decline in the value of the pound due to inflation.

* OECD methodology does not include specialty medicines.

There is a case for the NICE threshold to be index-linked to avoid further real-term decline, and to allow a more appropriate assessment of the value of medicines today.

Longer term, innovative commercial agreements, such as NICE's work with NHS England and NHS Improvement to pilot a new payment model for antimicrobial resistance (AMR)[50] pose an opportunity for the UK to lead in valuing innovative medicines more effectively. Outcomes-based pricing agreements between NHS England and manufacturers may also provide important means of overcoming existing access challenges and should be piloted where appropriate.

2. Address adoption. The Life Sciences Competitiveness Indicators show that the use of new medicines in England lags behind most comparator countries. The latest Innovation Scorecard, which compares expected uptake to the actual volume of medicines used in the NHS in England, confirms that between January and December 2020, medicine use for six of the 12 estimated groups was lower than expected[51]. It is apparent that, once reimbursed, new medicines need greater and more rapid availability and uptake in the NHS.

This will mean looking again at incentives within the NHS, switching the focus from short-term costs to long-term investment in the health of the population. The Voluntary Pricing and Access Scheme (VPAS) agreed between the NHS, government and the pharmaceutical industry, caps annual growth in the NHS branded medicines bill at 2% for the next five years[52]. This should provide the financial certainty for the NHS to increase investment in innovative medicines.

Looking further ahead, the UK should establish a more holistic framework for valuing and prioritising innovative treatments to increase access to medicines. This framework should include the broader social determinants of health (SDOH) so that health improvements can be spread universally across the population and regional inequalities addressed. The SDOH can, for example, account for factors like education, employment, social inclusion and access to affordable health services. This will be supported by the increased use of RWE, which will also enable the greater use of outcomes-based contracts and pricing models that take into account comorbidities, patient adherence and patient outcomes. This overall improvement in health equity should have a significant impact on cancer outcomes in particular.

Short-term priorities

1. Bring the discount rate used by NICE to appraise medicines in line with the reduced 1.5% rate recommended for policies that impact health or life outcomes.
2. Establish a system of benchmarking and incentives to improve the uptake of NICE-approved therapies, with the aim of ensuring that the UK is in the upper quartile of competitor countries for uptake of medicines.

Longer-term priorities

3. Value the impact of medicines more holistically by including social determinants of health (such as education, employment, social inclusion and access to affordable health services).
4. Make sophisticated outcomes-based contracts and dynamic pricing models routine.

Cross-capability drivers of change

The UK will also need to consider a series of cross-cutting drivers of change.

Foster ecosystem collaboration

Underpinning the UK government's Vision is a need for a culture of greater collaboration and engagement between the NHS, academia, industry and government. This should cover not only research, but also risk sharing and a commitment to develop and adopt new healthcare models. To foster this collaboration, the life sciences sector will need to rethink the respective roles of the organisations involved and look to new collaboration and partnership models. It will also need to define incentives for critical ecosystem members across everything from discovery to development to healthcare delivery.

For cancer treatment specifically, the UK needs to foster a community that can better coordinate priorities between academia, industry, the NHS and patients, as well as serve as a focal point for engagement with the various government and regulatory bodies involved.

Align spending with objectives

There is currently a gap between ambition and funding in the UK life sciences sector. If it is to make its vision for 2030 a reality, the UK government needs to align its healthcare spending and pharmaceutical spending more closely with its healthcare objectives. The former, healthcare spend as a percentage of GDP, is described in Chapter 4.

Aligning spending with objectives applies across infrastructure, clinical research budgets and innovation funding for strategic projects. Across the four capabilities described above, funding should therefore be prioritised for projects which maximise the benefits for patients and the life sciences ecosystem. These will typically be strategic projects that are scalable across the ecosystem, and that deliver the highest return on investment at a system and societal level. In clinical research, for example, research needs to be prioritised to ensure truly innovative programmes have the greatest chance of success. Similarly, in data and AI, an approach for stronger demand signalling and horizon scanning between the NHS and industry needs to be defined.

Use regulation to stimulate innovation

Now the UK has an independent regulator in the MHRA, it needs to use that agility to ensure regulatory skills and infrastructure keep pace with the rate of change across the sector. In data and AI, for example, regulation will play a crucial role in the reimbursement of digital health solutions and the sharing of sensitive/patient data. The reimbursement of advanced therapies and other innovative medicines also needs to be considered to ensure that novel medical technologies are brought to the UK.

Similarly, regulation can help accelerate approvals for clinical research. Given the complexity involved, the UK is unlikely to have all the skills and knowledge required at a national level. It therefore also needs to build on examples of international collaboration, such as the MHRA's work with international regulators.

Increase patient engagement with policy

The patient voice is clearly critical in any analysis of the life sciences sector. Not only do patients need to be involved in their own healthcare so that they have the best chance of living longer and healthier lives, but also the public needs to be involved in policy development and system design. From identifying unmet needs to prompting academic research to improve access to medicines, more needs to be done to engage patients and improve their healthcare experiences as well as their health outcomes. There are existing efforts to incorporate patient input into medicines development, including the MHRA's Patient and Public Involvement Strategy and manufacturer strategies such as BMS' Patient Expert Engagement Resource. The UK needs to continue to build on these efforts.

Case study:

Singapore has positioned itself as a leader in biomedical activities, from innovation through to manufacturing

Singapore's evolution into a leading global biomedical hub began over 20 years ago, and has been underpinned by a supportive regulatory environment, significant investment in R&D and tax and grant-based incentive schemes. It has also managed to attract international talent while developing domestic capabilities and improving infrastructure with the development of the Tuas and Biopolis clusters. The result is a rich, diverse and vibrant biomedical ecosystem which is home to more than 60 large medtech companies (plus the R&D bases of 30 such companies), 50 regional headquarters, and over 220 medtech start-ups and SMEs. The sector is a significant contributor to the Singapore economy, adding up to 4% of GDP (£11.12 billion) and over 24,000 jobs in 2019[53]. Singapore's success shows that a well-coordinated government strategy, supported by proactive policies, is crucial to becoming a leader in biomedical activities.

Chapter 4: The size of the prize: Quantifying the health and economic gains*

I. Aligning spending with priorities

The success of the UK's Life Sciences Vision rests on its ability to align its healthcare spending with its priorities. If the UK wants to truly be a life sciences superpower, it will need to ensure that its spending is focused on strategic, scalable projects that have the highest benefits for patients.

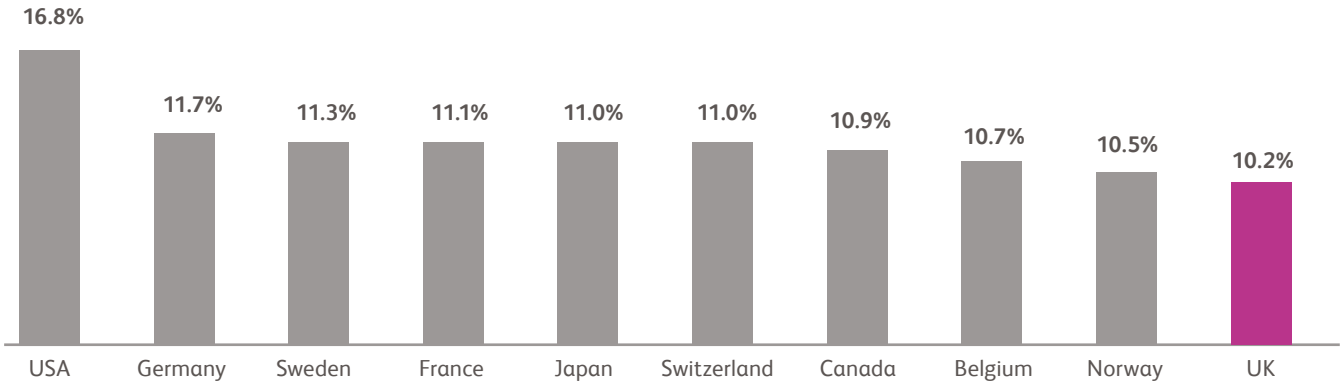
Today, however, the UK spends relatively less on healthcare and medicines than other advanced economies. The UK's healthcare expenditure as a percentage of GDP (10.2%) is less than that of the United States (16.8%), Switzerland (11.3%), Germany (11.7%) and France (11.1%) (see Figure 3)[54].

In addition, the UK's R&D investment as a percentage of GDP (1.7% in 2019) is below both the European Union average of 2.1% and the OECD average of 2.5%[55]. There are also looming gaps in research spending. In March 2021, for example, UK Research and Innovation identified a funding gap of £120 million in projects to which the UK is already committed[56], which if left unfilled would mean reneging on promises made to universities and research organisations in this country and overseas.

This is happening at the same time as the UK's ability to access European Union funding is at risk. The UK was, for example, a net beneficiary of EU research funding from sources such as Horizon 2020, the European Investment Bank and the European Investment Council.

If the UK wants to improve the health and wealth of its citizens, it needs to set ambitious spending targets for healthcare, including R&D. The alternative is to risk lower innovation in medicines discovery, poorer health outcomes for citizens, and reduced economic productivity for the country as a whole.

Figure 3: Current health expenditure (% of Gross Domestic Product, 2019)



* Please see Appendix for further detail on economic impact methodology.

Investing in healthcare

Lower healthcare expenditure often leads to poorer health outcomes. For the NHS, managing this challenge has been made all the more difficult as it faces a combination of ongoing financial constraints and growing demand. Performance indicators suggest the UK is lagging in many health outcomes and population health measures. Indeed, its cancer survival and avoidable mortality rates are some of the worst among advanced economies.

Take breast and colon cancers, for example. In the UK, these exhibit very poor five-year survival rates (85.6% and 60% respectively) compared with the average in comparable advanced economies (87.4% and 64.8%) (see Figure 4)[57]. Survival rates in lung cancer are also particularly stark – in Europe only Bulgaria has worse five-year survival rates compared to Wales, Scotland and England[58].

Overall, only one in two people diagnosed with cancer in England and Wales survive their disease for ten years or more[59]. The UK also exhibits a lower life expectancy at birth in 2019 (81.4 years) compared with other advanced economies such as Switzerland (84 years), Sweden (83.2 years), and Australia (83 years)[60]. It also has a higher prevalence of risk factors, including in obesity and diabetes[61].

Figure 4: Five-year cancer survival rates (%, 2017)

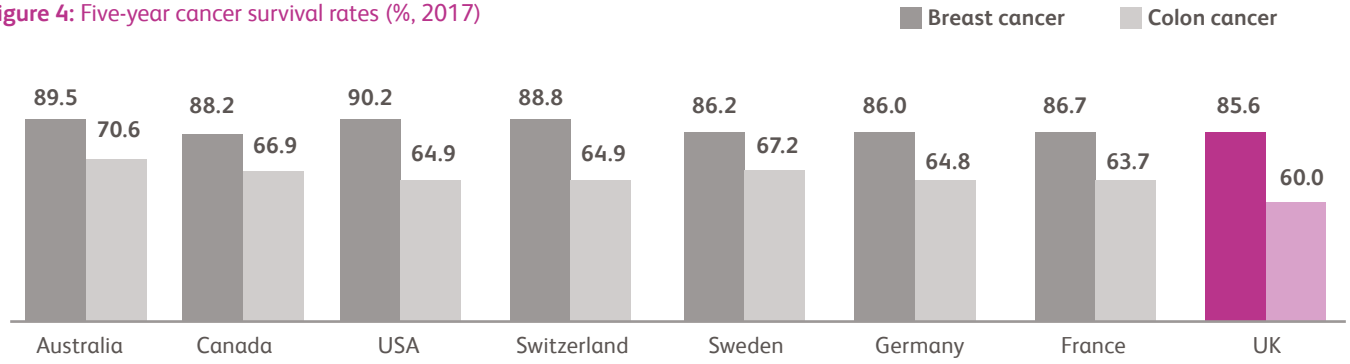
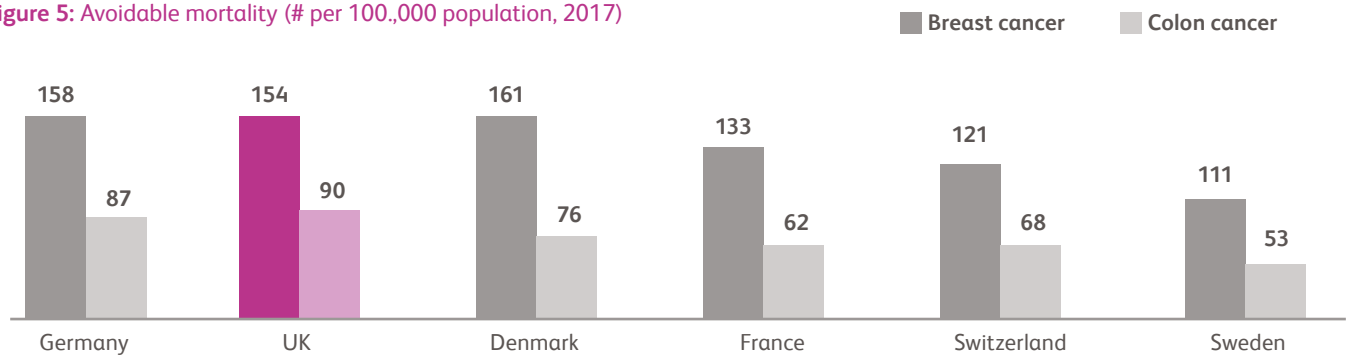


Figure 5: Avoidable mortality (# per 100.,000 population, 2017)



We believe the UK should invest more in healthcare spend in the period to 2030. This will enable the country to tackle regional health inequalities, deliver better health outcomes for its population and drive economic growth.

In fact, we estimate that a 1 to 2 percentage point increase in healthcare spend in 2030 could translate to additional economic value of up to £90 billion in GDP.

The multiplier effect of healthcare spending

To arrive at our estimate, we have assumed a healthcare fiscal multiplier of 3. The multiplier refers to the increase in final income arising from any new injection of spending, and our assumption both falls within the range identified in previous studies and reflects healthcare's historical position at the upper end of the general fiscal multiplier long-term range.

Generally, an increase in healthcare spending results in a strong multiplier effect due to its impact in areas like enabling people to get back to work, as well as its small leakage effects (such as drawing in imports rather than supporting domestic economic activity), its low 'crowding-out' of private sector activity, and the impact of induced spending from some higher-paid healthcare employees[62, 63]. Indeed, previous studies have found healthcare to have a fiscal multiplier in the range of 2 to 4[64]. This is one of the highest multipliers of all forms of public spending behind education.[65] It compares favourably, for example, with spending on defence (-9.8)[66], public infrastructure (0.8 to 1.6)[67], and transport (1.8)[68].

Our analysis also assumes the UK's healthcare spend will be around £257 billion in 2030.

This is informed by the OECD base scenario that the UK will spend approximately 11.4% of its GDP on healthcare in 2030 (compared with 20.2% in the United States, 14.5% in Switzerland, and 12.3% in Germany)[69].

We therefore estimate that an increase in healthcare spend by 1 to 2 percentage point of projected 2030 GDP would translate to a £67.5 billion to £135 billion increase in GDP. The additional economic impact would be equal to a £45 billion to £90 billion expansion of the UK economy.

This estimate captures the economic value of increased human capital and the reduced need for medical treatment or social care (specifically, higher labour supply and productivity and lower health and social care costs)[70]. However, it likely underestimates the increased social benefit to the UK as a result of greater healthcare spending. This is because GDP is not a perfect measure of total welfare, which also includes improvements to wellbeing, the environment, and quality of life due to higher educational attainment.

Additionally, this estimate does not account for the variation in the impact of healthcare spending on different activities.

For example, the impact is likely greater for young people relative to old people. Similarly, there could be higher marginal benefits to investment in life-saving medicines relative to pain relief. Our analysis presents an aggregate view of the impact of increased healthcare spending. Therefore, not every additional £1 invested will create the average multiplier effect.

Finally, it is important to note that the assumed increase in healthcare spending can come from a variety of sources, including increased borrowing or higher taxation, each of which will have its own implications for economic growth. For example, the literature has found that higher rates of borrowing may lead to slower growth[71], whereas increased tax rates can have positive or negative effects on the economy depending on who bears the burden and when the tax is introduced. Our estimate should therefore be interpreted as the possible economic impact associated with increased healthcare spending, rather than a projection of the overall net GDP impact after taking into account consequential effects.

Investing in healthcare R&D

If it is to be a life sciences superpower in 2030, the UK will also need to be at the forefront of scientific discovery. That means providing appropriate funding for the country's leading research capabilities – not only in academia and in industry, but across the overall life sciences ecosystem. Here, too, there are challenges to overcome.

Total gross expenditure on R&D in the UK was just £38.5 billion in 2019, equivalent to 1.7% of GDP, a proportion that has barely changed in 20 years. This is lower than countries like France (with R&D investment equivalent to 2.2% of GDP), the United States (3.1%) and Germany (3.2%)[72].

And while the government has committed to working with businesses to raise R&D investment to 2.4% of GDP by 2027, we believe this needs to be sustained at least to 2030. Based on current GDP forecasts, this would equate to around £53 billion for R&D overall. If the share allocated to health R&D were to remain in line with current values, that would mean spending around £9.9 billion on health R&D in 2030, about £2.9 billion more than if spending stayed at 1.7% of GDP.

Meeting the government's 2.4% target would also have wider economic benefits, principally through additional spending on business operations and supply chains, as well as employee spending.

These second-order effects could have an additional positive impact on the UK economy of around £4.4 billion.
In addition, increasing the number of research studies has the potential to reduce health inequalities. Medicines can have different effects in different patient groups. Increasing the number of studies that capture a diverse patient population and account for social determinants of health can therefore improve clinical outcomes overall. It can also improve access to services by generating evidence as to the best approach for each community.

Spotlight on clinical trials

Clinical research can have a broad range of impacts. Not only does it improve patient lives and help address health inequalities, but it also has wider social and economic value. As those treated become healthier, they become more productive, as workers and consumers, with gains for the economy as a whole. The NHS also benefits, both through additional income from commercial clinical research and from the use of pharmaceutical products free of charge in trials.

In 2019/20, over 700,000 people from England took part in clinical trials according to data from NIHR. In 2020/21, while COVID-19 paused or slowed clinical research globally, the number of participants in the UK almost doubled to over 1.39 million participants, with the vast majority supporting urgent public health studies into new treatments and vaccines to tackle the pandemic[73].
This shows that the UK system has the potential to support wider patient involvement in clinical studies.

Our analysis suggests that if the UK could reach 1.5 million clinical trial participants in 2030, we approximate that this could translate into the following gains per annum from 2030:

- £2.1 billion productivity gains from increased labour participation of participants.
- £4.4 billion income for the NHS from additional patients in commercial studies.
- £2.8 billion saving for the NHS from pharmaceutical products provided free of charge.

II. What we could achieve by focusing on cancer

Cancer is a global health issue that touches nearly all our lives. One in two of us will get the disease in our lifetimes[74]. In 2020, it accounted for almost 10 million deaths worldwide and is the second most common cause of mortality globally after cardiovascular disease[75]. In the UK, someone is diagnosed with cancer every two minutes[76]. In the Healthcare Missions identified by the Life Sciences Vision, enabling early diagnosis and immunological interventions for cancer are both acknowledged as critical to improve the health of the UK nation[77].

As this report has explained, the UK's cancer survival rates are currently poor. Only half of people diagnosed with cancer in England and Wales survive their disease for ten years or more[78]. A cancer diagnosis can be devastating for an individual, with the mental and emotional fallout affecting friends and family. But the disease also exerts an individual economic toil, with as many as 53% of patients seeing their income fall by at least one income bracket[79]. The total economic burden of cancer in the UK is also staggeringly high at £7.6 billion[80].

The abundance of data being generated in today's healthcare systems means there is now an opportunity for a step change in the way we screen, treat and prevent cancer. In our analysis, there are significant economic and health gains that could be realised by unlocking the four supercharging capabilities described in Chapter 3. That includes, in particular:

- Earlier detection of lung, colon, oesophageal and breast cancer.
- Earlier use of immunotherapies in the treatment cycle for lung cancer.

Earlier detection

In England, almost half of cancers are diagnosed at a late stage[81]. This impacts survival rates. Cancers diagnosed early, before they have had the chance to spread, have an overall five-year survival rate four times higher than those diagnosed at a later stage[82]. This is why initiatives like the NHS-Galleri trial are so important in ultimately saving lives. But they are not the only tool in the toolbox. The UK's data and AI capabilities could soon see machine learning supported screening programmes that can identify even more cancers at an early stage.

In 2019, for example, Mozziyar Etemadi and his team reported that their deep learning model correctly identified the early stages of lung cancer in 94% of cases, outperforming a panel of six veteran radiologists[83].

If, by 2030, the UK was able to capture 75% of cancers at stage 1 or earlier (which is in line with the NHS's ambition to diagnose three in four cancers at an early stage from 2028[84]), there are significant productivity and quality-of-life gains we can achieve:

- A greater proportion of working age individuals would have a higher probability of survival. For lung, colon, oesophageal and breast cancer, this could lead to productivity gains of approximately £1.6 billion to the UK economy from increased labour participation.
- Quality-adjusted life years, or QALYs, would improve for all patients (one QALY equates to one year in perfect health[85]). For example, over 58,000 QALYs could be gained by detecting lung cancer earlier.

Earlier use of immunotherapies

The last decade has seen a shift in the care of cancer patients. The focus has switched from cytotoxic therapies to approaches that enhance anti-tumour immunity[86]. Immunotherapies offer the possibility for long-term remission and decrease the risk of recurrence by stimulating a long-lasting immune guard against the cancer[87].

If, by 2030, the UK was to facilitate the earlier use of immunotherapies in the patient treatment pathway, we could achieve further productivity and quality-of-life gains:

- In lung cancer alone, expected productivity gains could reach approximately £115 million in the UK.
- Over 34,000 QALYs could be gained by earlier use of immunotherapies for the treatment of lung cancer.

Our calculation for the gains we could achieve are limited to four tumour types, which represent only one in 20 of cancer diagnoses. We can therefore assume that the actual gains the UK could achieve by extrapolating these findings to other cancer types would be far greater.[88*].

* These four cancer types represent 47% of deaths in the UK in 2019. Note: Lung cancer includes tracheal and bronchus cancer too.

Chapter 5: The path to the future: Measuring the UK's progress

Meeting the UK's ambitions for the life sciences sector by 2030 requires not only commitment, but also accountability and a willingness to measure progress. This will be important in assessing the UK's international competitiveness, identifying both its successes and its areas of lagging performance.

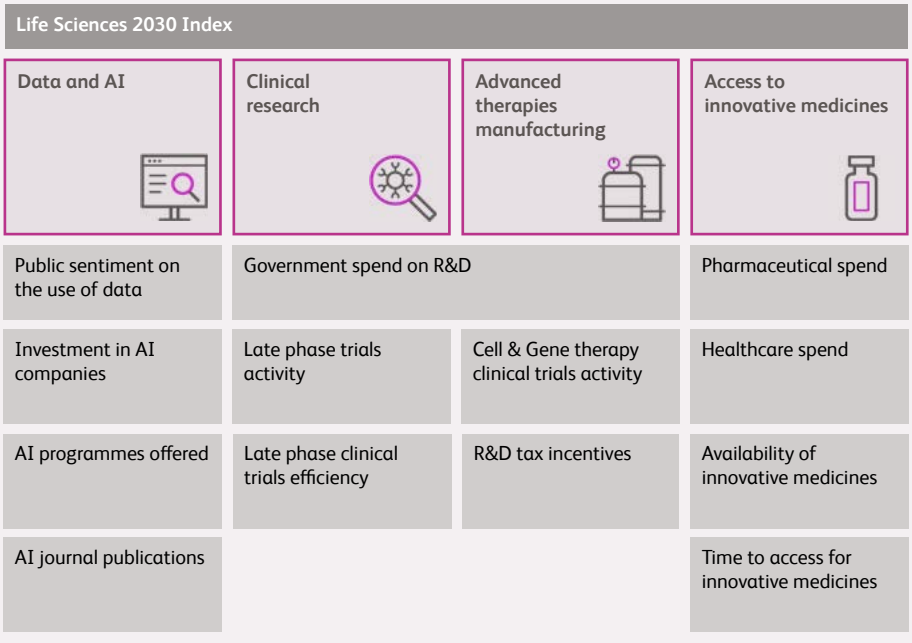
Some of this data exists already. For example, existing Office for Life Sciences (OLS) sector data[89] contains some useful indicators for tracking the health of the UK life sciences industry. However, they do not fully reflect the priorities of investors in life sciences and do not allow a full international comparison. Moreover, the OLS indicators are largely unchanged since 2015 and, given the rapid pace of change in the sector, a refreshed approach is needed.

The Life Sciences 2030 Index

To provide a better long-term view of the UK's international competitiveness and progress towards delivering on the Vision, we have established a Life Sciences 2030 Index (see Figure 6*). This combines multiple indicators to create a ranking of the relative performance of the UK against a number of comparator markets**. It is built around the four supercharging capabilities described in Chapter 3, namely data and AI, clinical research, access to innovative medicines and advanced therapies manufacturing.

The Index provides the best view available with current data, including strategically relevant metrics that are publicly available and benchmarkable today. As data collection evolves across the ecosystem, and as the four supercharging capabilities are better represented, the Index will be reviewed and adjusted accordingly. We also believe there is value in tracking UK-specific indicators that are not internationally benchmarkable but still provide insight into the UK's progress.

Figure 6: Life Sciences 2030 Index build up



* Based on data quality and availability, each of the four capabilities in the Index carry a different weighting in the overall Index score

** Comparator countries the UK has been benchmarked against include: Belgium, Canada, France, Germany, Italy, Japan, Norway, Spain, Sweden, Switzerland, USA

Where does the UK rank today?

Overall, the UK currently ranks seventh in the Index (see Figure 7). Within this, however, the UK demonstrates strengths and weaknesses in different capabilities. For example, the UK's strengths in data and AI mean it currently comes top in this measure, mainly driven by the large number of AI programmes offered and the relatively high investment in AI companies. It also ranks highly in government spend on health R&D and R&D tax incentives.

In contrast, the UK performs relatively poorly in the access to medicines and clinical research capabilities. This is due to its lower levels of pharmaceutical and healthcare spending and lower rate of full publicly available medicines. Of 152 medicines approved by the European Medicines Agency between 2016 and 2019, only 43% were available without restriction in England and 26% in Scotland[90].

Our performance in clinical research is driven by the UK's relatively low number of Phase III clinical trials and trial participants, and its longer lead times for patient recruitment and enrolment in research studies.

Figure 7: Life Sciences 2030 Index rankings

Country	Overall rank
USA	1
Germany	2
Switzerland	3
Belgium	4
Norway	5
Canada	6
UK	7
Spain	8
Italy	9
France	10
Sweden	11
Japan	12

How can the Index be improved?

As data collection intensifies across the ecosystem, the UK's comparative progress in these four capabilities can be more accurately measured. However, there are other relevant indicators for which data are not currently collected in key comparator markets. For example, to better measure the UK's relative attractiveness to manufacturers of advanced therapies, the Index could record how many of these therapies it is reimbursing and how long it takes on average to make them available to patients. It would also be valuable to measure how many advanced therapies companies had IPOs in the UK and how much capital they raised. Similarly, we should look at how the UK compares with other countries in terms of trial cost per patient and what percentage of trials run in the UK are complex, innovative or decentralised.

There are also UK-specific indicators that cannot be benchmarked internationally, but which we believe should be included as a measure of standalone progress in the UK. In data and AI, for example, these include the number of public datasets published by NHS Digital, the percentage of the UK population with data accessible for research, and how many Integrated Care Systems have integrated datasets. Similarly, to understand if UK patients are benefiting from the latest advances in treatment modalities, the Index should track the relative uptake (in terms of days of therapy) for new and innovative NICE-approved medicines.

Chapter 6: Conclusion: A call for the ecosystem to come together

Advances in technology, better use of data, and more personalised care will all fundamentally transform the way we prevent, diagnose and treat disease over the next decade. At the same time, patient-centred care will empower people to take more ownership of their health and wellbeing.

This could have far reaching effects for the UK. The nation can become healthier, wealthier and more resilient. Its patients can have better outcomes, its workforce can become more productive, and its citizens can enjoy a better quality of life.

The UK has all the building blocks to deliver this vision and be recognised as a leading global hub for life sciences by 2030. That has hugely positive implications for the UK's economy. Ensuring life sciences businesses can grow and run their organisations in the UK will not only drive economic growth and bring greater prosperity but also create a healthier and more productive workforce.

To do so, the UK will need a concerted, holistic effort from the whole life sciences ecosystem with clear leadership from Government. The four supercharging capabilities presented in this report are strongly interlinked and require that government, industry, the NHS and other life sciences organisations work together to deliver them.

An exciting road lies ahead for UK life sciences. The vision for 2030 is the right one. The ecosystem must now seize this opportunity to make it a reality.

Appendix

Appendix 1: Endnotes

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Appendix 3: Impact assessment methodology

The impact assessment methodology draws upon relevant literature to understand the potential benefits the UK could achieve in 2030 if:

- R&D expenditure was to increase to 2.4% of GDP
- The number of clinical trials participants increased
- Healthcare spend was to increase by 2 percentage points
- 75% of cancers were captured at stage I or earlier (productivity gains were derived for lung cancer, colon cancer, esophageal cancer and breast cancer and QALYs were derived for lung cancer)
- Immunotherapies were used earlier in the patient treatment pathway (productivity gains and QALYs were derived for lung cancer)

As per Green Book guidance, the economic impacts have been discounted by 3.5% and QALYs by 1.5% yearly.

Estimating the impact of increasing R&D expenditure

1. The current spend on R&D and the proportion dedicated to health R&D have been calculated
2. The expected UK GDP in 2030 was calculated based on OECD forecasts. The Dollars to Pounds conversion has been based on historic exchange rates
3. The expected GDP in 2030 has been multiplied by the relevant proportion of direct GVA spent on each of the following areas: (1) Medical tech, (2) Pharmaceuticals development and manufacturing and (3) Life Sciences Research if R&D expenditure was to stay at the current value of 1.7% of GDP
4. Similar calculations have been made if R&D expenditure was to increase to 2.4% of GDP. In both scenarios the proportion allocated to health R&D out of total R&D remained constant, in line with the current value
5. The additional increase in health R&D was then multiplied by the relevant multipliers from the literature for each of the three areas to obtain the additional total contribution to the UK economy

Estimating the impact of increasing the number of participants in clinical trials

1. An analysis of current levels of clinical trials participation in the UK has been conducted
2. A hypothetical scenario of the UK enrolling 1.5 million people in clinical trials in 2030 has been set
3. Based on literature, the following impact areas have been estimated:
    a. Economic impact: An estimate for the additional number of hours worked each week by clinical trials participants has been identified. The value of average wage in 2030 has been deducted. The yearly increase in wages for each participant in clinical trials has been calculated and applied to the additional number of working age clinical trials participants in 2030
    b. Revenue for the NHS: An estimate for the average revenue from life sciences companies per clinical trials participant has been identified. Using historic inflation, a 2030 estimate has been applied to the additional number of clinical trials participants in 2030
    c. Cost savings for the NHS: An estimate for the average pharmaceutical cost-saving for each patient recruited into a commercial study, where a trial drug replaced the standard of care treatment has been estimated. Using historic inflation, a 2030 estimate has been applied to the additional number of clinical trials participants in 2030

Estimating the impact of increasing health expenditure

1. The expected UK GDP and relevant healthcare spend in 2030 were calculated based on OECD forecasts. The Dollars to Pounds conversion has been based on historic exchange rates
2. The fiscal multiplier for public spending on healthcare has been identified based on evidence from the literature
3. Using this multiplier, the economic impact on the UK economy of a one and two percentage point increase in healthcare spend of the projected 2030 GDP has been estimated
4. The additional economic value of a one to two percentage point increase in healthcare spend of the projected 2030 GDP has been calculated

Appendix 3: Impact assessment methodology

Estimating the impact of 75% of cancers being captured at stage 1 or earlier

Economic impact - calculated for lung cancer, colon cancer, oesophageal cancer and breast cancer

1. Incidence of each cancer type in the UK for 2030, broken down by age group, has been identified from the literature
2. Values for the current staging of each cancer type have been identified. The 2030 scenario assumes 75% of cancers are identified at stage I or earlier and the remaining 25% were split into relevant stages stages (II, III and IV) based on current proportions
3. The probability of survival depending on the stage at which the cancer was caught as well as cancer recurrence rates have been identified for each cancer type from the literature
4. The number of additional working years in 2030 for working age people that survived cancer and had no recurrence was calculated
5. Values for the labour market participation and the average wage in 2030 have been identified
6. The monetary value of the additional working years in 2030 from identifying 75% of cancers at stage I or earlier has then been calculated

QALYs gained – calculated for lung cancer

1. Incidence of lung cancer in the UK for 2030 has been identified from the literature
2. Values for the current staging of lung cancer have been identified. The 2030 scenario assumes 75% of cancers are identified at stage I so the number of additional lung cancers identified at stage I in 2030 has been calculated
3. Based on current staging values, for the additional lung cancers identified at stage I in 2030, the stage at which they would have otherwise been detected has been identified
4. From the literature, the additional QALYs gained per lung cancer for stage I detection rather than stage II, III or IV and total QALYs gained calculated

Estimating the impact of earlier use of immunotherapies in the patient treatment pathway

Economic impact - calculated for lung cancer

1. Incidence of lung cancer in the UK for 2030, broken down by age group and staging, has been identified from the literature
2. The probabilities of survival depending on the stage at which the cancer was caught have been identified from the literature
3. The eligibility rate for immunotherapy if it was universally available and the recurrence rates for those who undertake immunotherapy treatments versus traditional treatments have been identified from the literature
4. The number of additional working years in 2030 for working age people that survived lung cancer and had no recurrence was calculated
5. Values for the labour market participation and the average wage in 2030 have been identified
6. The monetary value of the additional working years in 2030 has then been calculated

QALYs gained – calculated for lung cancer

1. Incidence of squamous and non-squamous lung cancer in the UK for 2030 has been identified from the literature
2. Values for the additional QALYs gained from using immunotherapies over chemotherapy for each of the lung cancer types have been identified from the literature
3. The total QALYs gained have been calculated

Appendix 4: Life Sciences 2030 Index methodology

The Life Sciences 2030 Index was designed to compare the UK's life sciences sector performance against Belgium, Canada, France, Germany, Italy, Japan, Norway, Spain, Sweden, Switzerland and the USA in four capabilities:

- Data and AI
- Clinical research
- Access to innovative medicines
- Advanced therapies manufacturing

Based on a review of the existing literature as well as engagement with multiple sector experts, a long list of indicators have been identified to measure competitiveness in each of the four capabilities. A systematic approach was then used to prioritise the most appropriate KPIs to be included in the Index, using a scoring mechanism that accounts for their availability, strategic relevance as well as ability to be benchmarked internationally.

It is worth noting that our analysis also identified KPIs that are strategically relevant for the future of life sciences, however these are not currently collected across key comparator markets, as well as UK-specific indicators that reflect the healthiness of the UK life sciences ecosystem, however these cannot be benchmarked internationally due to the specific nature of the UK system.
The Index reflects the best possible version of current competitiveness based on relevant metrics that are publicly available and benchmarkable today and as data collection evolves across the ecosystem and the four capabilities are better represented, the Index will be reviewed and adjusted accordingly.

The latest available KPIs for each country included in the Index have been identified from the relevant sources. The values of the KPIs have then been converted into a score of 1 to 100 using linear interpolation, where 1 was defined as the worst performing value amongst comparator countries in a specific KPI, minus ten percent, and 100 was defined as the best performing value, plus ten percent.

Capability scores for a country have been determined by averaging all the KPI scores in a specific capability; where data has been missing, the KPIs have not been included in the calculations.

The overall country Index score has been determined by taking a weighted average of the four capabilities scores. Based on the number of KPIs identified in each capability and their respective data quality, the following weights have been used in calculating the overall Index score: 5% for data and AI, 45% for clinical research, 45% for access to innovative medicines and 5% for advanced therapies manufacturing.

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