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# Better and more efficient NHS care through innovative approaches to treatment

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# Introduction

New ways of approaching treatments have the potential to bring fundamental changes to the quality and safety of patient care and to the efficiency and effectiveness of NHS services during the NHS 10-Year Plan's timeframe. These are built on new understandings of how the body works and the mechanisms through which therapies can act, such as making use of genetic tools and new technologies, devices and data.

This discussion paper draws on desk research and stakeholder consultation to outline a vision of 'what good looks like' in relation to new treatment approaches (i.e. new treatment paradigms) and key elements of a strategy that could help realise the vision. While some novel treatment paradigms are more mature and closer to impact than others, the most significant opportunities lie not in picking technology winners but in creating a supportive ecosystem for innovation in treatment in and around the NHS.

# A vision for the future of treatment through the NHS 10-Year Plan

In a vision for the future of treatment in the NHS:

- Precise and personalised biological and health technology treatment approaches will improve patient outcomes and the efficiency and effectiveness of NHS services.
- New therapeutic approaches will reduce the need for repeated treatments and hospitalisations, improve access to care and help address unmet needs.
- Novel treatment approaches will help address major public health challenges, including those related to social inequalities.
- Being a world-leading location to trial innovative treatments, alongside efforts to secure access to treatments, will deliver health and economic benefits.

Appendix 1 provides a more detailed review of different types of novel treatment approaches and their potential.

## 1. Precise and personalised biological and health technology treatments will improve patient outcomes and the efficiency and effectiveness of NHS services

Genomic medicine uses information about a person's genes to diagnose, prevent or treat diseases. This enables more precise and personalised therapies for diseases like cancer,[1,2] sickle cell disease and rare blood disorders.[3] Personalised treatments can also help improve the efficiency and effectiveness of NHS services. For example, ineffective or unsuitable medicine prescriptions that cause adverse drug reactions in patients cost the NHS an estimated £2bn annually.[4] Using genetic information is already helping clinicians understand how a patient is likely to respond to medication, informing better treatment decisions to ensure patients receive effective medications that they can tolerate well, particularly in areas like cancer[5] and HIV.[6] There is a significant opportunity to expand this approach in the future, improving patient outcomes and saving resources. Other types of treatments, like tiny biological compounds (nanomaterials), are also beginning to deliver treatments to specific places in the body more precisely, supporting better, more personalised care. There is potential for these novel treatments to be applied to innovation for a more diverse range of conditions and to benefit more people.

Advances in health technology can also help patients receive more precise and personalised treatment. An example is robot-assisted surgery, which uses robotic arms to assist doctors in performing precise surgeries. The NHS already utilises this technology, especially for patients with urological conditions. In the future, robot-assisted surgery could help the NHS deliver even more precise, less painful operations for a broader range of complex surgical procedures, minimising tissue damage and enabling faster recovery.[7,8] However, further evidence is required to understand the long-term effects on patients and cost-effectiveness. Other treatment approaches, like 'smart pills' (pills with sensors or tiny cameras),[9] are also being explored for their potential to deliver medication to specific areas of the gastrointestinal (GI) tract.[10] However, research in this area is still relatively nascent.

Other developments in personalised treatments, such as those related to the microbiome (a collection of tiny organisms living inside our bodies in organs like the gut and helping the body function), also have the potential to help tackle conditions for which current options are limited.[11,12] However, significant impacts on the NHS are likely beyond a ten-year horizon.

In addition to altering the *type* of treatment provided, improved and more efficient care can also be achieved by changing the *timing* of treatment. Some treatment approaches have already been found to be more effective when they are timed to align with body rhythms, such as for asthma,[10] cardiovascular diseases,[11] and certain cancers.[12] There is potential to explore this more widely, and unlike some other novel therapies, timing therapies better does not require a significant overhaul of existing NHS care pathways.[13]

## 2. New therapeutic approaches will reduce the need for repeated treatments and hospitalisations, improve access to care and help address unmet needs

Personalised medicine also has the potential to enable fewer but more effective treatments. For example, treatments have been developed by applying engineering methods that modify or create new biological compounds to treat diseases, a field known as synthetic biology. Such treatments already help patients receive fewer treatments within a shorter timeframe. One example is long-acting CAR-T therapies, which are already used in the NHS to treat some blood cancers.[17]

Other examples include long-acting therapies for HIV[18] and Chronic Obstructive Pulmonary Disease (COPD).[19] While some therapies are already in use for specific diseases, there is potential to expand treatments such as CAR-T to a wider range of cancers[20] that place a heavy burden on patients and NHS capacity. New therapies that build on advances in our understanding of human genetics and protein expression offer significant hope for better ways to treat conditions such as heart disease, dementia and muscular dystrophy. Such therapies could reduce the need for long-term and repeat needs for hospital-based care.

Advances based on new understandings of viral, bacterial and human genetics also enable the development of novel therapies that can help reduce unnecessary hospitalisations. For example, vaccines based on modified viral genetic material (mRNA vaccines) were key to the COVID-19 pandemic response.[21] New preventative and therapeutic uses for this technology are being researched for influenza[22] and cancer.[23]

Regenerative medicine is another innovative area that could reduce the need for repeated hospitalisations and treatments. Regenerative medicine uses techniques like stem cells (cells in the body that can differentiate into various specialised cell types) and engineering methods to develop treatments like artificially produced organs or tissue. The NHS has already tested regenerative medicine applications in areas like trachea replacement,[24] bone repair and hip replacement.[25] Treating hip fractures costs the NHS around £2bn annually; if scaled, regenerative medicine could yield significant savings by reducing the need for repeat surgeries and improving quality of life.[25]

In addition, innovative health technology approaches to treatment are helping tackle NHS waiting lists and significant areas of unmet need. For example, mental health conditions like anxiety and depression affect an estimated one in six adults in England[26] and account for over 20% of the disease burden in the United Kingdom (UK), yet they receive less than 10% of NHS expenditure.[27] Mental health is one of the most neglected NHS areas. However, the UK is at the forefront of developing new and improved mental health interventions with the promise to deliver a far greater level of personalisation and targeted support. Digital technologies are emerging that can help patients access therapy remotely, with the support of mental health professionals or via self-guided apps. These include a groundbreaking approach to supporting people hearing voices (AVATAR therapy), which is currently being trialled in the NHS, as well as innovative approaches to treatment using virtual reality and gaming technologies.[25, 26] Digital technologies can help treat conditions such as depression, anxiety, insomnia and schizophrenia. In the future, digitally-enabled mental health treatments could help overcome logistical and geographical barriers to providing care at a greater scale.[30] Being able to access therapy digitally can also help mitigate stigma and improve patient uptake.[31] There are also new medications, such as Cobenfy (used for treating schizophrenia), which, if they were to be approved by regulatory authorities and become available in the UK, could help treat patients with a condition where there has been little significant progress with improving treatment options for decades.[32] Research into the efficacy of exercise as a targeted treatment for depression is also ongoing.[33]

While some new therapies may not benefit all patients, they provide significant hope for those they do. Such therapies have the potential to tackle disease areas that have historically seen limited progress and attention. For example, new technologies can restore functions for some people with neurological and neuromuscular disorders. Cochlear ear implants can already restore hearing to profoundly deaf patients,[34] and brain stimulation methods are emerging for conditions like depression and Parkinson's.[35] In the future, the NHS could provide technological solutions to support immobile patients (e.g. those with quadriplegia) and help them control prosthetic limbs,[36] wheelchairs and other tools,[37] restoring patients' autonomy or communication.[38,39]

## 3. Novel treatment approaches will help address major public health challenges, including those related to social inequalities

Medications used to manage conditions affecting large numbers of people, such as Wegovy or Ozempic (used to treat diabetes[40] and obesity),[41] are costly at present but may be an effective way of addressing a major public health concern in combination with other public health measures, and if affordability and pricing challenges are resolved. Research is examining the potential of this new class of drugs (called GLP-1 agonists) to treat depression[42] and alcohol addiction,[43] and there is potential to consider these treatments alongside social interventions (such as those that could help tackle loneliness, social isolation, poverty or other social determinants of health). Other novel treatment types can 'turn off' genes that cause health problems and have the potential for treating diseases like hepatitis B and liver damage more effectively. Some novel medicines show promise in treating liver disease more broadly and respiratory diseases such as COPD.[19] Such novel therapies can potentially offer new ways for the NHS to address societal health challenges, some of which are related to wider inequalities. New treatment approaches could help improve people's well-being and ability to work, supporting broader efforts towards a fairer UK.

Other treatment innovation areas could help tackle major public health challenges, such as antimicrobial resistance (AMR), and enable better care in the community, reducing the need for hospitalisations and other adverse effects due to severe infections. Bacterial resistance to existing medicines was linked to 4.95 million deaths globally in 2019.[44] Ongoing research and innovation show promise in finding new ways to fight infections and antimicrobial resistance more effectively, using methods like very small viruses (called bacteriophages which are already used in some countries)[45] to kill bacteria and improve our body's immune response, or proteins made in a lab (monoclonal antibodies) to destroy bacterial and viral infections.[46]

## 4. Being a world-leading location to trial innovative treatments, alongside efforts to secure access to treatments, will deliver health and economic benefits

Novel treatments can bring health benefits for patients, improve the quality and efficiency of care provided by the NHS, and bring wider benefits to the economy and society. For patients, taking part in clinical trials can enable earlier access to new treatments. For the NHS, involvement in research is linked to high-quality care.[47] Keeping people healthy can also improve productivity and tax revenue and reduce welfare costs. For example, one study found that talking therapies for people with mental health conditions can increase economic productivity by helping people return to work and reduce welfare benefits by over £650 per person within two years of receiving therapy.[48] More broadly, health-related research and development attracts investment, supporting enterprise and job creation.[49] For example, the UK genomics sector's turnover was £3.6bn in 2021/2022, and employment in the sector more than doubled between 2016/17 and 2021/22.[49]

The UK is not as large a market for innovations as some other countries with different healthcare service financing and treatment pricing models and larger populations. However, the UK has significant and highly respected global strengths in life sciences and health technology research and development, and it has the NHS.[50] There is a significant opportunity to utilise the NHS better as a unique base for testing novel solutions, with clinical trials also supporting efforts to give patients early access to novel treatments prior to wider-scale market authorisation, health technology assessments and NHS adoption. This could create a distinct competitive advantage for the UK in terms of attracting clinical trials, given the UK cannot compete on cost (prices it can pay for medicines) with some other high-income countries.

A key block to realising these benefits is that NHS currently has an overwhelming focus on immediate delivery and wider resource constraints. However, as Lord Darzi's independent investigation of the NHS in England highlighted, research and innovation has a key role to play in NHS transformation.[27] Research and innovation is also a fundamental part of the solution to making the UK competitive and should not be seen as a second-order priority.

## Creating a supportive ecosystem

This section sets out key considerations for realising the potential of new and emerging treatments for patients and the NHS.

Some novel treatment types are at more advanced stages of development than others and thus have a greater likelihood of impact on the NHS in a ten-year horizon. Examples include more personalised and precise therapies for cancer, novel therapies for obesity, and digitally enabled mental health therapies. Other novel treatment paradigms are less advanced, such as chrono-therapeutics (optimising timing of treatment), smart pills (tiny pills with sensors or cameras that can gather information in a person's body to help diagnose diseases or help ensure patients are taking their medicines properly) and nanobots (small robots that are invisible to the human eye and designed to work inside a person's body and perform tasks like delivering medicine precisely to where the disease is located or helping repair damaged tissues).

Other factors beyond technological maturity will influence the timeframe and scale of achievable impact. For example, the impact of different treatment paradigms will vary depending on the diversity of the conditions they can address and the types of patients that stand to benefit. For example, as described above, brain stimulation technologies may help relatively few people but make a substantial difference to those individuals, while other types of treatments based on altering and repairing faulty genes could have applications across a wider range of health conditions.

The investment needed to accelerate the development and adoption of different new treatments also varies and will affect the scale of achievable impact over the time horizon of the 10-Year Plan. For example, the UK has already made significant investments in some areas like genomic medicine and synthetic biology, although it has the potential to further support progress and the translation of innovation into NHS practice. In relative terms, there has been far less investment in bolstering capacity and advancing the potential in areas such as functional restoration and the microbiome.

The UK has world-leading strengths in health and life sciences research to build on, but the NHS is cost-sensitive and not typically quick to adopt innovations compared to other health systems. The potential to move more quickly exists, and the benefit of doing so has been demonstrated in some areas, such as being the first European country to provide access to life-saving CAR-T cancer therapy for some blood cancers[51] and introducing new incentive and payment models for encouraging innovation in treatments to tackle antimicrobial resistance.[52] However, engaging with innovation – both the development of new solutions and their adoption – requires time and resources.

Overall, there is an opportunity to accelerate the impact on patients and the NHS by focusing short and medium-term efforts on the testing, refinement and adoption of comparatively more mature treatment modalities that can achieve impact at scale within the next ten years. At the same time, emerging but high-potential areas of science and technology can progress through support for research and innovation in and with the NHS, with a longer timeframe for impact on patients.

An ecosystem of seven support mechanisms is the key platform needed to translate the potential of novel treatment paradigms into NHS practice. We have identified fifteen specific actions for discussion across the seven support mechanisms, as summarised below.

### Workforce:

1. Mainstream training on research and innovation related to novel treatment priorities into professional education and development (e.g. technical skills to deliver novel treatments).
2. Provide resources for staff to support the adoption of novel treatments (e.g. via job structures and career pathways, ring-fenced time and rewards and accountability for best practice).

### Data, information and evidence:

3. Invest in a functional data access and sharing infrastructure supported by interoperability and public trust. Better data access, sharing and linkage can enable those involved with research and innovation to develop new treatments and support their adoption. This needs to be secured using a mix of technical solutions to ensure data privacy and security, regulation and effective public engagement.[53] There is an opportunity to build on more developed data environments already in place (e.g. genomics/multi-omics and genomic medicine). Using existing digital infrastructure (e.g. potentially the NHS App) could also help establish better ways of raising awareness, recruiting patients for clinical trials and helping them decide what data they are happy to share. The newly announced partnership between the UK Government and Wellcome to establish a new health data research service is a promising development.[163]
4. Fund and steer an evidence pipeline for data on emerging treatments (such as promising developments in gene therapies, mRNA vaccines and digitally enabled mental health therapies) from clinical trials and real-world implementation studies. This can help secure accountable, evidence-based practice and inform the business case for NHS commissioning (e.g. long-term clinical and health economic impact data to inform optimal eligibility criteria and better data on clinical and cost-effectiveness of robotic surgery).

### Funding, commissioning and procurement:

5. Prioritise investments considering the levels of technology maturity (e.g. using frameworks such as Technology Readiness Levels), the potential for scale and depth of impact and the scale of improvement (including scope for long-term improvement).

6. Use methods/tools such as horizon scanning, consensus exploration and target product profiles (TPPs)[54] to clearly signal demand to innovators and maximise the likelihood that new treatments meet NHS needs; set clear expectations for adopting new treatments in terms of criteria related to technical performance and cost/fit with NHS care pathways, with an advance commitment to support those that meet the requirements; consider the need to balance national priorities against regional and local population-specific needs.
7. Create longer-term budget cycles in the NHS to enable more strategic and realistic approaches to commissioning new treatments, helping fix funding flows and recognising value, including in the context of overall cost-savings for the NHS and other spheres of government over time. This could help mitigate the upfront investment needed for some treatments (e.g. long-acting gene and cell therapies and regenerative medicine, GLP-1 agonists for obesity, advanced medicines for respiratory diseases and robotic surgery). Consider what could be commissioned centrally and what is more appropriate to commission regionally and locally using a more solutions-focused approach.
8. Reinvigorate the clinical trial landscape, maximising the NHS's potential as a testbed for trialling innovations focusing on novel treatment paradigms.

### R&D governance and regulation:

9. Ensure a single, more streamlined overarching R&D approval process (learning from efforts to streamline ethics approval processes) across the NHS, alongside a national training programme for staff working in R&D offices.
10. Establish clear and flexible regulatory processes for new treatments (e.g. standardised protocols for manufacturing and preparation of antimicrobial phages,[55] regulatory sandboxes in synthetic biology,[56] regulation related to neurotechnology and new forms of data and the potential for influencing cognition).[57]

### Physical infrastructure:

11. Establish the underpinning physical and technical infrastructure to scale priority new treatments (e.g. to deliver genomic medicine, CAR-T therapies[58] or mRNA vaccine[59] manufacture), including basic IT systems, hardware, Wi-Fi and safe physical environments.

### Collaboration and coordination:

12. Establish a cross-sector governance and coordination arrangement for funding and orchestrating initiatives that can support the pathway from R&D through to adoption, scale and spread. This arrangement should include closer coordination between regional and national efforts, industrial and health policy bodies and funders, and R&D governance, regulatory and health technology assessment bodies.
13. Create national and international communities of practice for novel treatment paradigms involving clinical, health services, biomedical, engineering, and data science expertise, as well as public and patient voices and industry. The UK has already established collaborations that provide a basis for building new collaborative efforts in key strategic areas (e.g. genomic medicine, synthetic and engineering biology, regenerative medicine).[60–63]

### Patient and public involvement, engagement and participation-related actions:

14. Pursue timely public and patient consultations and engagement around relevant questions (e.g. ethical considerations, equality in access and eligibility). Personalised medicine requires patients to commit to data sharing with

confidence, for which an unfortunate legacy of past concerns needs to be overcome.

15. Address inequalities by ensuring the relevance of and access to new treatments for the full spectrum of the UK's population. For example, 80% of genome-wide association studies currently focus on individuals of European ancestry,[64] although progress is being made with initiatives such as Genomics England Diverse Data.[65]

This discussion paper has illustrated the current importance and future potential of novel treatment paradigms to support high-quality, safe, effective and efficient care, as well as to generate wider societal and economic benefits. Responsible political choices and policy developments such as the 10-Year Plan will need to balance short-term priorities, such as dealing with waiting times for access to NHS services and crowded A&E departments, with a visionary commitment to take actions today that can help achieve medium and longer-term improvements in the NHS. In doing so, decision-makers can build on the UK's existing strategic advantages, thus supporting care excellence and NHS sustainability well into the future.

# Appendix 1

**Table 1: New treatments - definition, application and potential**

| Novel treatments | What they are | Existing applications | Potential within a 5-10 year time horizon | Longer-term impacts (>10 years) |
|---|---|---|---|---|
| **Genomics and multi-omics supporting personalised medicine** | Genomic medicine uses information about a person's genes (DNA) to diagnose, prevent or treat diseases like cancers and rare diseases. Genomic data can be coupled with other types of information to develop more personalised, precise and effective treatments. Pharmacogenomics helps understand how a person's genes affect their response to medications. | Targeted cancer therapies and early access through trials (e.g. PARP inhibitors,[1,2,66] glioblastoma)[67]; pharmacogenomics (e.g. cancer,[68,69] HIV)[70,71]; CRISPR and gene therapy (e.g. sickle cell and β thalassaemia).[3,72] | Scaling existing gene therapy applications, novel epigenetic therapies (cancer, heart disease, dementia[73]), gene therapies (e.g. amyloidosis,[74,75] muscular dystrophy[76]).<br>Expansion of epigenetics-based personalised medicine from cancer and rare diseases to other disease areas (e.g. cardiovascular, liver, respiratory).[77] | While there is likely to be innovation in proteomic therapies and treatments over the next ten years, the benefits will likely be realised later. Innovations in proteomics could change how drugs are developed and enable widespread disease treatment before diagnosis (Int 2). |
| **Synthetic and engineering biology supporting personalised medicine** | Synthetic biology uses engineering methods to modify biological organisms, giving them new functions or creating new types of biological compounds to develop treatments that work better for patients and improve their survival and quality of life. It creates prospects to treat diseases that are currently very hard to treat, like cancers and genetic disorders, and to develop treatments quickly and more efficiently. | CAR T-cell therapies (lymphoma,[78,79] leukaemia[80]), mRNA vaccines for SARS-CoV-2,[81] liposome nanomaterials for hereditary transthyretin amyloidosis,[82] oncolytic viruses for melanoma.[83] | CAR T-cell therapies for solid tumours,[84] tumours infiltrating lymphocytes and synthetic biology (mRNA) immunotherapies for cancer,[85] expanded use of oncolytic viruses.[86] | Potential areas for progress over the next ten years are in immune reset stem cells (e.g. for autoimmune diseases)[87] and programmable cells.[88] |

| Novel treatments | What they are | Existing applications | Potential within a 5-10 year time horizon | Longer-term impacts (>10 years) |
|---|---|---|---|---|
| **Regenerative medicine** | Regenerative medicine creates prospects for using techniques like stem cells, engineering of tissue and gene therapies (which use tools like CRISPR to edit, alter or replace faulty genes) to repair, replace or restore damaged tissue (e.g. hip fracture), to stop the body rejecting transplanted organs to enable more success in transplant procedures. | Regenerative medicine (trachea replacements,[89] hip fractures[25,90] and sickle cell disease).[91] | Regenerative medicine in cartilage repair; simple bioengineered organs and on-demand bioprinting; stem cell treatments for transplant rejection.[91]<br>Early applications of regenerative medicine to address chronic conditions such as Type 1 Diabetes.[92] | Regenerative medicine has the potential over a longer timeframe to address and repair the causes of disease and treat long-term diseases such as epilepsy[93] and Parkinson's disease.[94] |
| **Next-generation biologics (besides those covered above)** | Next-generation advanced medicines are made from modified cells or organisms that can help treat diseases more effectively. They include therapies to fix genes (gene therapies) or switch them on and off (i.e. epigenetic therapies) to treat diseases like cancer, new treatments that restore a healthy gut microbiome (e.g. helpful bacteria in the gut) to help fight infections and keep the immune system strong, or novel formulations of medicines that control blood sugar levels to help treat major public health challenges like obesity (e.g. GLP-1 agonists). | GLP-1 agonists (diabetes[95] and obesity[96]), faecal microbiota transplantation (Clostridioides difficile),[97] antibody-drug conjugates (cancer)[98,99]; some treatments for Alzheimer's (but limited effectiveness and high cost).[100,101] | Scaling the use of GLP-1 agonists for treating obesity and exploring the potential in treating depression[102] and alcoholism and substance use.[103]<br>Bi-specific antibodies (cancer),[104] RNA therapy (e.g. hepatitis B[105]), monoclonal antibodies (COPD[106] and asthma[107]). | After ten years, there is a potential for novel microbiome applications for chronic autoimmune and inflammatory conditions, cardiovascular disease, cancer and psychiatric disorders.[108] Another possible growth area is in mRNA vaccines for AMR.[109] |

| Novel treatments | What they are | Existing applications | Potential within a 5-10 year time horizon | Longer-term impacts (>10 years) |
|---|---|---|---|---|
| **Novel antimicrobials and alternatives to antibiotics** | Novel antimicrobials and alternatives to antibiotics are giving us opportunities to find new ways to fight infections and tackle antimicrobial resistance, using methods like very small viruses (called bacteriophages) to kill bacteria or improve our body's immune response. | Phage therapy for bacterial infections and monoclonal antibodies against viral infections.[110,111] | Scaling of phage therapy,[110,112] antimicrobial peptides,[113] monoclonal antibodies for bacterial infections and AMR.[46] | Over a longer timeframe, it may be possible to see more regular use of personalised antimicrobial therapies in NHS practice, specifically using bacteriophages.[114] Another growth area could be personalised and engineered phages, including genomically engineered phages, to better target specific infections and resistant bacteria.[55,115] |
| **Chronotherapeutics** | Chronotherapeutics is an approach to treating diseases that considers our body's natural rhythms to identify the best times of day to give a person medication to make it more effective and to reduce side effects | Considering treatment timing (e.g. cardiovascular diseases).[116] | Novel chrono-therapeutic applications (cancer chemotherapy,[117] medicine administration for patients with bipolar disorder.[118] | After ten years, there may be further innovations in personalised treatment administration and treatment timing based on age, sex, or chronotype (types of circadian rhythm). After this time, chronotherapeutics may also be a regular and embedded approach to multiple diseases, pending the production of evidence. |

| Novel treatments | What they are | Existing applications | Potential within a 5-10 year time horizon | Longer-term impacts (>10 years) |
|---|---|---|---|---|
| **Technology, digitally and data-enabled mental health** | Innovation in mental health treatment is allowing us to use digital technologies (e.g. via the internet, apps, chatbots and avatars) to deliver treatments for conditions like depression, anxiety and insomnia through talking therapies or other online therapies that help people change unhelpful thoughts and behaviours. This helps people get the care they need in timely ways and helps manage long waiting times for NHS mental health services. | NHS talking therapies using online and/or app-based programmes (depression, insomnia, anxiety)[119–121] broaden options and patient access.<br>Avatar therapy is offered for people who hear voices.[122]<br>Digitally enabled triage pathways improve patient access and reduce workload for NHS staff.[123] | Improving access and scope for digitally enabled treatments could save staff time, improve the efficiency of mental health treatments and improve uptake by helping to overcome stigma.[30,31,124] Digital and remote therapies can also help overcome logistical and geographical barriers to providing care,[30,124–127] and help manage waiting times.[119]<br>AI could expedite the review of complex case files and improve care efficiency.[31] VR could be used for mental health services.[128]<br>Collection of more and more diverse data could enhance understanding of mental health conditions and treatment impacts[30,31,129,130] (e.g. Akrivia database creation efforts,[131] NHS Talking Therapies data set[132]).<br>Small molecule drug combinations, such as Cobenfy, could offer novel treatment for schizophrenia.[133] | Beyond ten years, further improvements in AI and the integration of digital services could bring even greater gains in efficiency and patient outcomes. |

| Novel treatments | What they are | Existing applications | Potential within a 5-10 year time horizon | Longer-term impacts (>10 years) |
|---|---|---|---|---|
| **Functional restoration and Brain-Computer Interfaces (BCIs)** | These are novel techniques that can help people regain their lost abilities, including technology allowing a person's brain to communicate via a computer or to give people physical (e.g. controlling prosthetic limbs) or cognitive abilities (brain stimulation to treat depression), improving quality of life. | Limited application in the NHS beyond specific cases (cochlear implants,[134] deep brain stimulation for Parkinson's,135 and transcranial magnetic stimulation for depression).[136,137] | BCI and neuromodulation could be further used to treat specific conditions, including those affecting the ageing population[138]: retinal degeneration,[35] substance use disorders,[139] neuropathic pain,[138] immune function[140] and others.<br>It could help immobile patients to control prosthetic limbs and wheelchairs, [37,39,141,142] or enable patients to communicate,[38,143–145] e.g. those with locked-in syndrome[145] or quadriplegia.[38,143,144] | Beyond ten years, BCI and related therapies offer the potential for curative treatment, better patient outcomes and autonomy,[139] and less long-term impact on the NHS and social care systems. It could offer non-invasive, personalised, long-term relief for conditions ranging from chronic pain to depression and restore functioning in severely disabled patients. |
| **Nanobots** | These are minuscule molecular-scale engineered devices designed to perform tasks inside a person's body, like delivering medicine to a disease's precise location or helping repair damaged tissues. | Clinical applications are still being developed. | Unlikely to see an impact at scale during a five-to-ten-year timeframe, given its early and experimental stage.[146] | Beyond ten years, nanobots could be applied for treating aneurysms[147] and cardiovascular disease,[148] improve effectiveness and reduce side effects of cancer treatment,[146,149] promote faster and more efficient tissue growth and healing,[150,151] and tackle antimicrobial resistance.[152] |

| Novel treatments | What they are | Existing applications | Potential within a 5-10 year time horizon | Longer-term impacts (>10 years) |
|---|---|---|---|---|
| **Robotic surgery** | This allows doctors to use machines with robotic arms to help perform high-precision operations, supporting better patient outcomes, less pain, and faster post-surgery recovery. | Established technology with relatively high adoption within the UK (especially for urology surgery),[8,153] which continues to increase. | Potential for smaller robotic systems[8] that may be more cost-effective,[154,155] and to incorporate AI and other technologies to increase the device's capabilities towards semi-autonomous or autonomous surgery.[8,156] | Beyond ten years, robotic surgery might be further applied for inter-vascular[8] and microsurgery procedures,[7] while also transforming the training of surgeons. |
| **Smart pills** | These are small pills with sensors or cameras that can gather information in a person's body to help diagnose conditions, monitor treatment effectiveness or deliver medicines in ways that are easier for patients and the NHS (e.g. pills instead of injection). | Current applications for diagnosis[9] (e.g. capsule endoscopy).[157] Applications for drug adherence monitoring have not been widely used in practice.[158] | Potential to expand diagnostic smart pills, such as for motility testing and measuring pressure, pH, transit time and temperature[159,160] for GI diseases. | Beyond ten years, smart pills could offer a novel, painless, minimally invasive way to deliver drugs such as GLP-1 agonists and RNA molecules through the GI wall, including an option without any needles, reducing the risk of tissue damage.[162]<br>Smart pills could deliver local treatment for GI diseases such as inflammatory bowel disease[10] and reduce side effects of treatment.[9]<br>They could also offer an alternative, more straightforward way of administering drugs that are currently available only as injections, thus increasing adherence,[161] and offer non-pharmaceutical treatments for conditions such as obesity or constipation.[9] |

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