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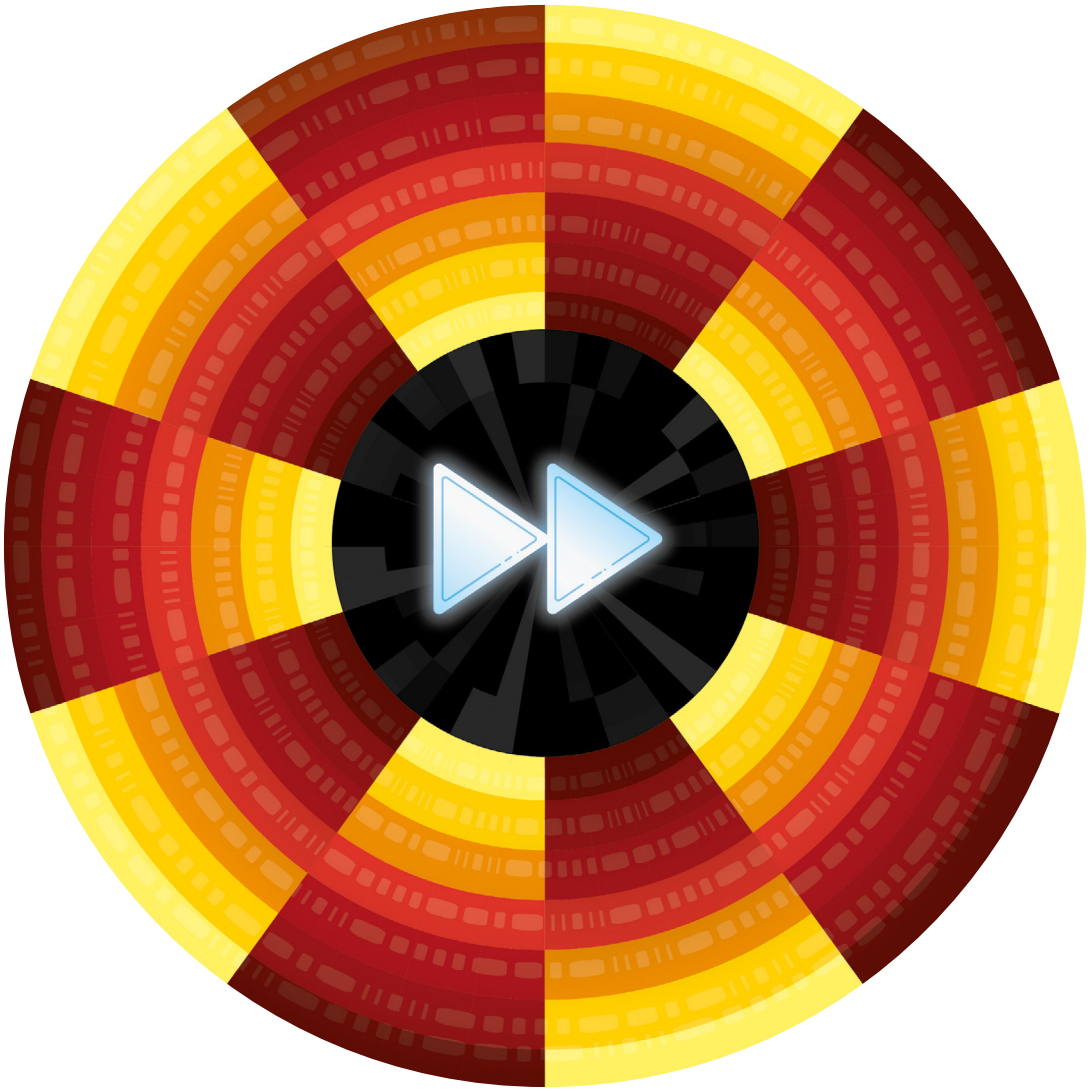

The future unmasked

Predicting the future of healthcare and life sciences in 2025

Prediction Three

Clinicians are empowered by new diagnostic and treatment paradigms

Deloitte Centre *for* Health Solutions

Foreword

Welcome to our third prediction, *Clinicians are empowered by new diagnostic and treatment paradigms*, from our report *The future unmasked: predicting the future of healthcare and life sciences in 2025*. This is the third of ten predictions all of which have been informed by emerging evidence of the impact of the COVID-19 pandemic on society and the health ecosystem. They have also been shaped by our research insights, including our global 2040 Future of Health campaign. This third prediction looks at what we expect the world in 2025 to be like for clinicians who are able to use digital technology, genomics and AI to drive a more predictive, preventative, personalised and participatory (4P) future for patients.

The COVID-19 pandemic has drawn attention to the fact that a 'one size fits all' method of treating the disease is unlikely to work. Consequently, researchers across the world have doubled down on their precision medicine efforts to understand the genetic factors influencing COVID-19 susceptibility and to determine the clinical efficacy of potential treatments. Potential treatments are emerging as clinicians and scientists share their increased understanding of diagnosing and treating the disease and use predictive analytics to evaluate how specific groups of people might respond, improving the evidence base and approach to the management and control of COVID-19 or any future infectious diseases.

In 2025, we predict that medicine has undergone a paradigm shift with clinicians using technological and scientific advancements including: digital therapeutics, genomics, epigenetics, and understanding the role of the microbiome. They also have access to massive amounts of health data and information to determine more precise diagnoses and treatments that are most likely to benefit individual patients.

This prediction, like all our predictions, is brought to life through a series of portraits imagining what the experience of individuals might be like in 2025, with reference to the evidence today to predict what the future might look like tomorrow.

Stay tuned for the subsequent predictions in our series of ten.

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Clinicians are empowered by new diagnostic and treatment paradigms

Genomics and AI are driving more predictive, preventative, personalised and participatory (4P) medicine

Prediction: In 2025, medicine has undergone a paradigm shift with clinicians basing their diagnoses and treatment decisions on predictive, preventative, personalised and participatory (4Ps) medicine. This shift has been driven by technological and scientific advancements including: digital therapeutics, epigenetics, and AI; massive amounts of health data and information; and increased expectations of the quality of care provided. Technological breakthroughs in AI, nanotechnology, quantum computing and fifth-generation wireless technologies, have enabled the development of faster, customised diagnostic pathways. Clinicians are also supported by AI-enabled clinical decision tools that incorporate data on biomarkers and genetic information, as well as clinical and behavioural health data, to deliver hyper-personalised evidence-based prevention and treatment interventions. Clinicians also use point-of-care diagnostics and knowledge about the genetic markers of a disease and Health Technology Assessment (HTA) guidelines to determine the treatment that it most likely to benefit the patient with minimal side effects; ultimately lowering care costs.

The world in 2025

- Clinicians have access to data from multiple sources to help understand changes in patients' health, including vital signs (blood glucose, heart rate and blood pressure); physiological biometrics (sleep and voice patterns) and environmental metrics (weather conditions and pollutant levels).
- Molecular biology, computational analysis and mathematical modelling identify what properties, at cellular, tissue or organism levels, are responsible for health conditions.
- Clinicians have access to fast, reliable AI-enabled diagnostic technologies, including radiology and pathology, as well as new point-of-care diagnostics, including liquid biopsies, to help detect and analyse molecular biomarkers.
- Treatments are based on hyper-personalised, data-driven insights and interventions through multiple real-time data insights. A new value chain is emerging, driven by the explosion in health data to generate highly personalised therapies in the form of tailored nanoparticles, 3D bioengineering of transplantable organs and skin grafts, gene editing, and implantable microchips to control pain.
- Clinicians are supported by clinical decision aids and medication management technology to co-create proactive prevention strategies involving patient's as active participants in care decisions.
- Clinicians share the complete records of a patients previous interventions, medication prescriptions, physical therapy recommendations, and outcomes, to co-create 4P care plans.

Conquered constraints

- **Skills:** The education and training of all clinicians now includes an understanding of medical research, statistical analysis and data science, and the ability to interpret and convey to patients diagnoses derived from genomic, digital and AI applications. Clinicians are also trained in using virtual technologies and conducting virtual consultations. New clinical specialisms have evolved.
- **Funding:** Providers have invested in data and analytics capabilities, and use of real world evidence (RWE) to inform disease stratification, tailor dosing, and provide tailored drug regimens. Organisations collaborate in designing new payment models that reward providers for health outcomes and better management of health and wellness. Value-based care models are used to re-allocate resources to where they can be most effective.
- **Regulations:** Organisations have adopted rigorous nationally-agreed standards of ethics and safety for the use of AI and genomics medicine in healthcare, within a technical infrastructure that supports SNOMED-CT medication terminology and HL7 FHIR application programming interfaces.
- **Data and interoperability:** Healthcare providers have built a new and open multi-omics data ecosystem, underpinned by blockchain open source technology, and use distributed databases for secure transcription to address most privacy and security concerns. Data is of low latency and high bandwidth, with unlimited continuous internet connectivity.

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Imagine the world in 2025

Nanotechnology used as a drug delivery model for cancer

Oni is clinical director of a research centre transforming the way cancer therapies are delivered. Her research team has been using AI and nanotechnologies for drug development and precision therapy; and have discovered several new targets for cancer therapies and a new drug delivery model consisting of nanoparticles. The nanoparticles are loaded with cancer drugs, and can target specific areas of cancer cells, delivering high doses of treatment without damaging other body cells (as in typical cancer treatments). The nanoparticles are also infused with a non-toxic dye so that they can be visualised and scanned to make sure the drugs have been delivered to the correct cells. This highly targeted, hyper-personalised therapy minimises the patient's risk of adverse reaction. Oni's new technology opens the way to many exciting therapeutic approaches for targeted high concentration drug delivery to cancer cells with reduced injury to normal cells.

Developing a 3D printed heart with remote imaging

Dr Klein identified that his patient Paul, who has cardiovascular disease, requires a heart transplant. Cardiovascular disease is the leading cause of death globally. Heart transplants are the only way to treat end-stage heart failure. There are over 100,000 people on the organ transplant waiting list. Dr Klein is concerned that a long wait would have potentially fatal effects on his patient's health. Knowing that the hospital has a partnership with the academic science and engineering department at his local university who have been pioneering the development of 3D printed organs, he contacts them to discuss Paul's situation. They agree to develop a 3D printed heart using Paul's tissues including blood vessels, collagen and other biological components. Paul is scheduled for his heart transplant, bypassing the waiting list for organ donors. Following Paul's operation, he is fitted with a FHIR-compliant remote monitoring system that holds his biometric data in a secure, self-tracking cloud-based platform via a smart patch. The patch monitors Paul's vital signs including heart rate, blood pressure and oxygen saturation levels which links to his electronic record. Dr Klein then monitors Paul's data remotely, and is able to offer timely interventions.

CAR-T therapy, a type of immunotherapy, providing a unique approach to cancer treatments accelerating the shift to product as a service

Most healthcare authorities have established funding and treatment sites for Chimeric antigen receptor (CAR-T) T-cell therapy, a type of individualised immunotherapy that involves reprogramming the patient's own immune cells which are then used to target their cancer. Hans, who has been diagnosed with relapsed/refractory lymphoma, has been referred by his clinician to be assessed as a potential candidate for the treatment. As access to CAR-T is controlled via an enrolment process, Hans is referred to the nearest CAR-T cell therapy centre. The specialist at the centre establishes that Hans meets the clinical eligibility criteria and says that the centre can begin his treatment within a week. Hans is informed of the risks of the treatment but because evidence suggests that response rates are as high as 80-90 per cent, he elects to go ahead. At the clinic, his immune cells (T-cells) are isolated from his blood, engineered and genetically modified, grown and then expanded *in vitro*, producing millions of cells which are infused back into the patient. Because the cells go on to multiply in the body and continue fighting the cancer, Hans needs just one CAR-T cell infusion. His prognosis is very positive and he is supported in his recovery through a virtual rehabilitation coach who can answer any concerns. At the last follow-up visit he celebrated his one-year remission.

Note: All elements on this page are from a perspective of 2025 and are fictional

Evidence in 2020

Bioelectric technologies – implant to mitigate chronic pain

Traditionally, pain management involves non-personalised treatment with multiple medications (including opioids) that may be ineffective. A novel development that involves imbedded devices like a spinal cord-stimulating unit with a battery-powered magnetic transmitter on a wearable belt. More generally, bioelectric therapy is effective in providing temporary pain control, but it should only be a part of a total pain management program. When used along with conventional pain-relieving medications, bioelectric treatment may reduce the dose of some pain medications by up to 50%.[42,43]

Nanomedicine's potential in treating disease

NaNotics, a nanomedicine company, builds subtractive nanoparticles that remove specific disease-causing molecules from the human body. NaNots do not target diseased cells or stimulate immune cells: they modulate cellular behavior by depleting specific signal molecules or their inhibitors from blood – without disturbing normal cell signaling. Different NaNots can be biochemically programmed to deplete specific targets driving different diseases. NaNots are injected into the body like a drug, and can potentially treat any disease enabled by soluble molecules, including cancer, autoimmune disease – even infectious diseases like COVID-19. In a mouse model of triple negative breast cancer, NaNots depleted more than 90% of their targets in less than five minutes, blocking metastasis and significantly outperforming checkpoint inhibitors.[44]

Tel Aviv University scientists print a 3D heart using the patient's own cells

Tel Aviv University researchers have 'printed' a 3D vascularised engineered heart using a patient's own cells and patient-specific biological materials. They used 3D-printed thick, vascularized and perfusable cardiac tissues that completely matched the immunological, cellular, biochemical and anatomical properties of the patient.[45]

FabRx: 3D printing of medicines

3D printing technologies aim to deliver unique personalised medicines that can be tailored to individual patient requirements. In an academic study, FabRx 3D printed six different drugs into a multi-layered polypill, demonstrating the potential to improve personalisation for patients. These polypills aim to help patients adhere to their regimen and better manage their medications.[46]

PatientsLikeMe (PLM) DigitalMe

PLM, a US based company has created an open online community that is designed to give a voice to a patient's story, and turn that story into data. The company is developing DigitalMe, a virtual avatar of the patient, based on a standardised profile, qualitative and clinical data. The data combine to create a comprehensive digital picture of an individual patient, designed to predict the outcomes of various therapies. DigitalMe allows patients in partnership with their HCPs to 'try' alternative interventions, such as a new drug, on the digital avatar first before identifying the one likeliest to succeed.[47]

Gene therapies breakthrough: ZYNTEGLO treats rare genetic disease

In June 2019, ZYNTEGLO® gained approval from the European Medicines Agency (EMA) for the treatment of patients (aged 12 years and older) with transfusion-dependent β-thalassemia (TDT). Patients with this rare genetic disease, which is caused by mutations in the β-globin gene, have reduced or absent levels of haemoglobin, and require lifelong regular blood transfusions to lessen the chronic anaemia and, ultimately, survive. ZYNTEGLO's therapeutic approach makes use of autologous CD34+ stem cells that have been genetically modified to contain the working β-globin gene. This authorisation for European marketing was the fastest assessment of an advanced therapy medicinal product (ATMP) to date, having also benefited from the EMA's Priority Medicines (PRIME) programme.[48,49]

Kheiron Medical Technologies

A UK-based deep learning company which has developed Mia (mammography intelligent assessment), an AI solution for breast cancer screening. The AI algorithm has been developed on over three million real-world screening mammography images and the initial retrospective evaluation of the system indicated that it compares favourably with established performance benchmarks for modern screening digital mammography. Kheiron has recently completed a second clinical study which tested the solution on over 250,000 cases - making it one of the most ambitious studies in radiology AI to date. This study showed a level of performance that strongly indicates practical utility and a level of generalisability that strongly indicates safety. The results of this second study will be published shortly.[50]

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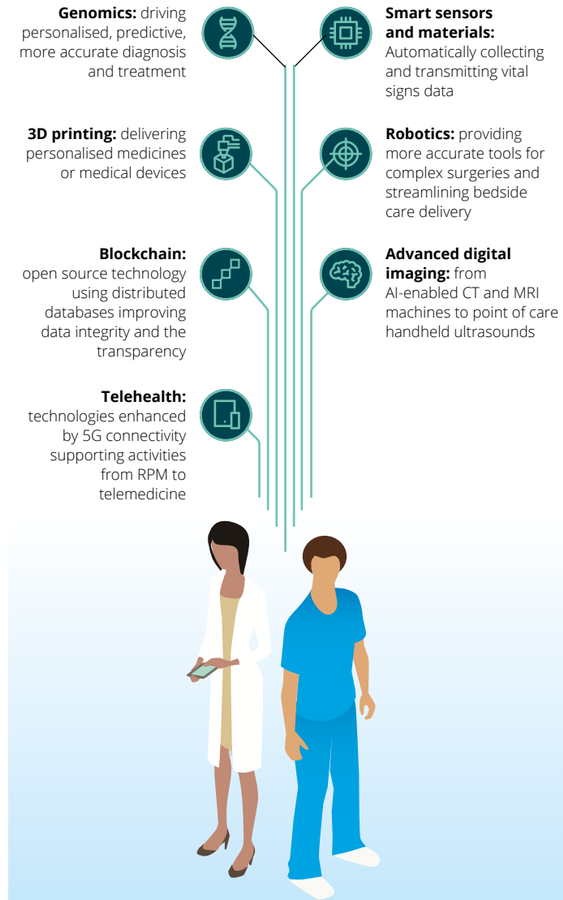
The COVID-19 impact

Deloitte view on the impact of COVID-19
Researchers across the world have openly shared their findings, including the genetic sequencing of the virus to establish its phylogenetic tree. Many have explored the potential for repurposing existing drugs as an efficient and cost-effective approach to developing prevention and treatment strategies. Potential treatments are emerging as clinicians and scientists share their increased understanding of diagnosing and treating the disease and use predictive analytics to evaluate how specific groups of people might respond. This increased understanding is expected to pave the way for precision medicine and personalised treatment strategies for COVID-19 and improve the evidence base and approach to the management and control of other infectious diseases.

CovidNudge: rapid, lab-free COVID-19 test
DnaNudge's, CovidNudge test is a rapid, accurate, portable and lab-free RT-PCR test that delivers results at the point of need and in just over an hour. The test is authorised by the MHRA for clinical use and has subsequently obtained its CE mark. An average sensitivity, compared against numerous NHS lab-based tests, is around 95% and specificity around 100%. These results satisfied the MHRA's performance criteria. The test is now being rolled-out UK wide in urgent NHS patient care and elective surgery settings, plus out-of-hospital locations.[51]

Clinicians are empowered by new diagnostic and treatment paradigms



Advanced technologies can improve:
- patient outcomes
- health care related costs
- access to health care
- accuracy of diagnosis and treatment
- customisation of products
- privacy and security of patient data

Source: Deloitte LLP, 2018

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