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The future unmasked

Predicting the future of healthcare and life sciences in 2025

Deloitte Centre *for* Health Solutions

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Foreword

Welcome to our report, *The future unmasked: life sciences and healthcare predictions 2025.* These predictions 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.[1]

The unprecedented nature of the pandemic is having an indelible impact on our industry, with unimaginable human loss and lasting changes to the way people perceive healthcare risks. There is also a new appreciation of the contribution made by life sciences and healthcare organisations, and a new era of collaboration to identify and implement solutions. Moreover, all stakeholders across the health ecosystem have seen a dramatic acceleration in the pace and scale of technology-enabled transformation.

A legacy of the pandemic is likely to be new relationships based on partnerships, 'good will' and heightened levels of trust. Attitudes to both public and population health have changed, with a shift in emphasis to prevention, and an acknowledgement of the importance of the social determinants of health and the need to reduce health inequalities and improve healthy ageing for all. Traditional boundaries are becoming more porous, creating an opportunity for new healthcare behaviours, new business and funding models, and more effective collaborations among stakeholders, leading to new services from both incumbents and new entrants.

Crucial enablers include our improved knowledge of genomics AI and digital health; the emergence of new skills and talent; access to robust, interoperable data, analytics and insights; new approaches to regulation; and a value-based outcome approach to funding. These enablers can help deliver a future for healthcare that is more predictive, preventive, personalised and participatory.

Making predictions is never easy, especially given the disruption in the past year; nevertheless our vision of the world in 2025 is mostly optimistic and deliberately provocative. Each prediction is brought to life through a series of portraits of how patients, healthcare and life science organisations and their staff might behave and operate in this new world. We describe the major trends and the key constraints to be overcome; and identify the evidence today to predict what the future might look like tomorrow. As always we welcome your views ideas and questions as we continue to explore the future of health.

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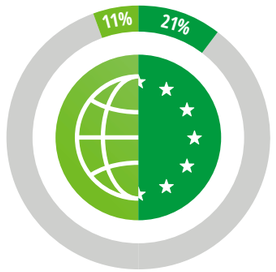
Trends in life sciences and healthcare

Demographic trends

By 2025, the over 65s will number some 840M – **11% of the global population (21% of the European population)**.



Ageing populations in both emerging and developed nations are increasing the demand for healthcare. The world's population is expected to increase by one billion people by 2025, 300M of whom will be aged 65 or older.

As population growth peaks and begins to decline, the financial and carer resources needed to care for the frail. Elderly population will be a huge challenge.[2,3]

The number of child deaths (younger than 5 years) from conditions for which vaccines are available fell from **5.5M in 1990** to **1.8M in 2017**.

Vaccination activities have been delayed or suspended in at least 27 countries to prevent the spread of COVID-19. Modelling suggests that for every COVID-19 death prevented by suspension of routine vaccination in order to reduce transmission, more than 100 children could die as a result.[4]

Economic trends

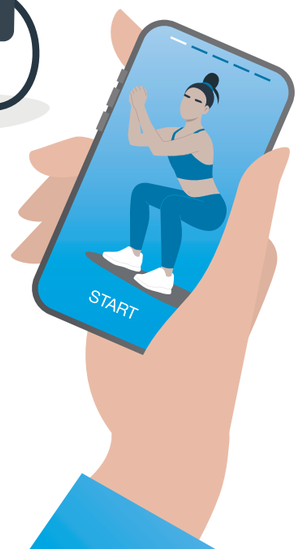
Global healthcare spending will fall by 1.1% in 2020 but will recover and rise by **5.5% in 2021** and by **5% annually till 2023**.[5]

GDP is expected to contract in most G20 markets, but healthcare spending as a share of GDP will rise sharply.[6]

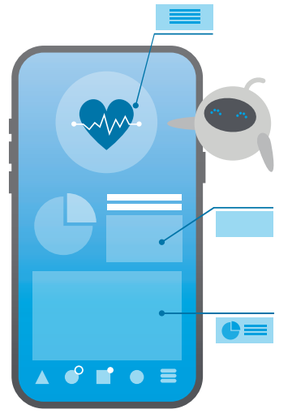
Pre-pandemic, the **global telemedicine industry** was expected to grow at 15% a year by 2025, this forecast is now 19.3% and $175.5B.

In the US, **virtual care visits** will soar to more than 1B this year, including 900M visits related to COVID-19.[7]

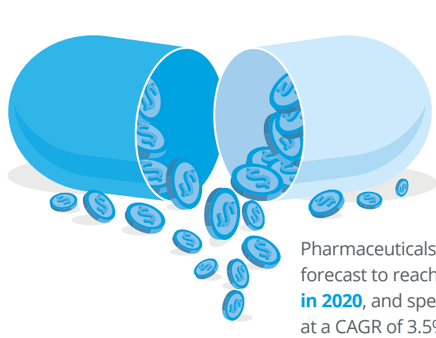
Globally, **1,249M health and fitness apps** were downloaded in Q1-Q2 2020 compared to 934M during same period a year earlier, a rise of around 34%.[8]



The **global virtual diagnostics** market is projected to grow annually by about 15.5% during 2019-2030, from US$425.6M in 2018.[9]

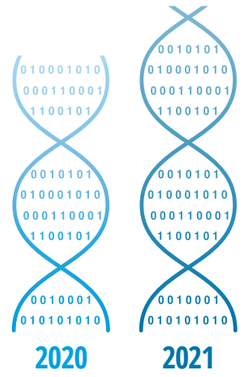


By 2023, annual spending in the global geriatric care market (home health, remote patient monitoring, etc.) will exceed US$1.4T.[10]



Pharmaceuticals sales are forecast to reach **US$1,366B in 2020**, and spending to rise at a CAGR of 3.5% in US dollar terms from 2020-24, up from 3% in 2015-19.[11]

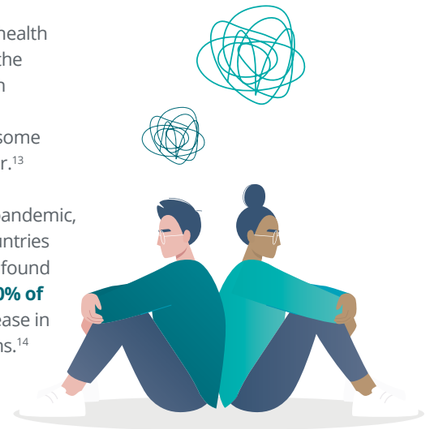
The global healthcare information technologies (HCIT) market size is projected to reach **US$270.3B by 2021** from **US$227.5B in 2020**, driven primarily by the rising incidence of COVID-19, government mandates, availability of big data, high returns on investment and the need to curtail escalating healthcare costs.[12]



Disease trends

Globally, poor mental health affects at least 10% of the world's population with 20% of children and adolescents suffering some type of mental disorder.[13]

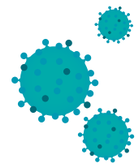
During the COVID-19 pandemic, research across 40 countries by CARE International, found **27% of women** and **10% of men** reported an increase in mental health problems.[14]



Worldwide, approximately **700,000 deaths per year** are attributed to **antimicrobial resistance (AMR)**. The number is expected to rise to 10M by 2050 at a cost of some US$100T.[15]

The number of people with diabetes globally is expected to rise from **463M to 578M by 2030** and **700M by 2045**. The estimated cost of treating diabetes is US$760B a year, and is projected to reach **US$825B by 2030 and US$845B by 2045**.[16]

In most countries a disproportionate death rate is seen among the over 70s, as well as in Black, Asian and Minority Ethnic (BAME) communities.[17]



The effects of **COVID-19** are more severe in people with underlying health conditions, ranging from diabetes and asthma, to cardiac disease and cancer.

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From health(care) to healthy ageing

Individuals are incentivised to take responsibility for their own health and lifestyle choices

Prediction: In 2025, many more people are fully informed about their health risks and take a proactive rather than reactive approach to prevention and treatment. They are well informed about their personal risks of developing chronic disease and have embraced prevention, based on hyper-personalised insights. Many individuals are focused on ageing well by maintaining their physical and mental health, including tailored levels of exercise and nutrition. There has been a shift in focus to preventative measures, including vaccines, genetic testing and therapies that boost vitality, wellness and immune health, encouraged by payer incentives, role models and many consumers sense for a longer, healthier life. Consumers also monitor their healthcare data through validated apps, wearables and other connected monitoring devices. For some individuals, data alone may not be enough to influence behaviour change and they may require further motivation for example, via a virtual health coach or a digital twin.

The world in 2025

- Consumers understand that they are largely responsible for their own health and how ageing, nutrition and exercise affect their immune health, resulting for many in healthier lifestyle choices.
- The biological science sector of the longevity industry, comprising geriatric science, regenerative and precision medicine, provides new insights to help our understanding of ageing.
- Individuals understand their genetic profile (and associated risks), and how this can be modified to improve their immune health.
- Individuals use supplements, prophylactic treatments and vaccinations to prevent disease and ensure healthy ageing.
- AgeTech provides customised digital solutions to support older people to live independently for longer.
- Individuals no longer request intermittent healthcare checks when feeling unwell: instead they deploy continuous health monitoring.
- Mental health needs are identified through a number of channels such as facial recognition technology and via apps on sleep patterns, mood and environmental factors.
- When healthcare is needed, AI chat-bots provide digital-first access to help navigate the health system, matching individuals with virtual or face-to-face services.
- Individuals have easy access to their own, portable and secure personal health information on their smartphone and decide who to share it with.

Conquered constraints

- **Skills and talent:** A coordinated set of health improvement initiatives have helped develop people's digital skills and health literacy, giving them a better understanding of their health risks and how digital technologies and therapies can improve their immune health and mitigate the risks of poor health. Numerous online health coaches, gamification and chat-bots are available to support, encourage and motivate people to maintain healthy lifestyles.
- **Funding:** As the cost of sensors and genetic testing has decreased significantly, individuals are prepared to invest their own money in therapies that will help them age well. Insurance companies and other payers give financial discounts and incentives in response to evidence of healthy lifestyles. Governments and the healthy ageing and longevity industry have become a major investor in the AgeTech industry.
- **Regulation:** Regulators have developed specialist teams focused on preventative health and fast-tracking regulatory approvals for health technology and medical devices that enable consumers to take more control of their own wellbeing. Regulators have modernised the oversight of consumer health products by developing an internationally agreed framework which segments products by their risk profiles to ensure they are safe and effective.
- **Data:** Enhanced data security and privacy settings have improved consumer confidence in using medical technologies. Connectivity in peoples' homes has been strengthened with the roll out of 5G technologies.

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Imagine the world in 2025

Next generation diabetic health management through a digital programme

Tom has obesity with insulin-dependent type 2 diabetes, and has been struggling to control his condition. He experiences frequent hyperglcaemia and difficulty in doing everyday tasks. Tom's doctor suggests switching his therapy to a new 800 calories-a-day diet and exercise programme, and that they should both monitor Tom's progress via a digital programme. Since the FDA provides a 20 per cent leeway for accuracy on food calorie labels, Tom's doctor also provides him with a food scanner so that he knows the exact amount of calories and sugar in his food, and the specific macronutrients he is eating. His scanned meals are logged in his app, and after meals Tom takes a breath test via a breath analyser connected to his app. Analysis of the volatile organic compounds in his exhaled breath helps him to understand exactly which foods spike his blood glucose, and which foods he can eat regularly and which to avoid. Changes to Tom's blood glucose are monitored through a continuous glucose monitor which Tom had fitted by his digital co-ordinator. Through the app, Tom joins a virtual patient group where he learns about the risk of diabetic foot disease (DFD). He has not noticed any of the symptoms of DFD but sees that he can book an annual check-in. At his check-in, he sends in a picture of his foot and learns how to reduce the risk of developing DFD.

Biomarkers and AgeTech reversing the risk of age-related chronic conditions

Mary, 45, is concerned about her risk of developing heart disease as she has a strong family history of the condition. Mary already uses a physician-recommended AgeTech device and has noticed a gradual rise in her heart rate and blood pressure over the past year. The device connects to her smartphone and feeds data into her electronic health record. She decides to have a genetic profile and longevity test, recommended by the patient support group that she joined six months ago. The longevity test assesses four metabolic biomarkers, including cholesterol, that are associated with cardiovascular disease. Her results indicate that she is at high risk of developing heart disease within the next five years. Mary therefore requests a virtual consultation with her doctor to discuss preventative measures. Her doctor prescribes a personalised smart pill that targets each of the biomarkers, and a diet and exercise regime. Mary continues to share her health data with her doctor through her AgeTech device linked to her electronic record. At six months, Mary has a scheduled bi-annual biomarker test which shows an improvement in her condition, which enables the doctor to readjust her medication. This encourages Mary to continue with her healthy lifestyle regime.

How the microbiome can improve the immune health of a new mother and her baby

Freyja is booked to have a caesarean section (C-section) due to complications she has experienced during pregnancy. Her doctor, Dr Ahmed, advises her how babies are born has a significant impact on their gut microbes, which influence many areas of the baby's development (including neurodevelopment, immune health and future health risks). Freyja consults a recommended chatbot which explains that babies born by C-section tend to lack strains of gut bacteria found in those born via the birth canal. Instead, their guts are more likely to harbour harmful microbes that are common in hospitals. To ensure her baby can develop a healthy gut microbiome, Freyja consults Dr Ahmed who takes a cervical and vaginal swab and sends it to the hospital's lab. At the lab, scientists uses an AI-enabled in-vitro diagnostic test to identify the helpful strains of bacteria from Freyja's swab that her baby may lack to create a personalised formula for Freyja to give to her baby when she is born. Dr Ahmed also mentions to Freyja that women who undergo C-sections are thought to be at increased risk of postnatal depression. Freyja arranges to speak to the clinic's dietician, Andi, who explains how the gut-brain axis impacts mental health, and how a person's microbiota can help the synthesis of serotonin and other mood influencing neurotransmitters. Andi formulates a personalised daily solution of pre – and pro-biotics to help keep Freyja's gut microbiota in balance, protect her mental health and improve her overall immune system.

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

Evidence in 2020

Apple Watch® Series 6: How the smartwatch has become a health watch

Initially providing a fitness tracker and featuring a health monitor that provides alerts, Series 4 introduced the electrocardiogram (ECG) and Series 5 added the always-on display. The new Series 6 health app measures blood oxygen levels, a key indicator of an individual's overall wellness. It uses a SpO2 sensor to measure oxygen levels for fitness and wellness purposes via red and infrared light. Apple Inc. is partnering with academics to study how this new metric can be used to help treat medical conditions.[18]

Invitae direct-to-consumer DNA testing

Invitae provides at-home DNA testing to help people understand their risk of developing certain conditions such as specific cancers, heart disease and neurological conditions. It provides actionable, personalised advice to help people manage their health. Invitae also partners with biopharma companies to offer sponsored genetic testing programmes which are provided free of charge to individuals with specific conditions who have been referred by their healthcare providers. In return the pharma companies receive de-identified patient data for research purposes.[19]

Zio by iRhythm – ambulatory cardiac monitoring service

Heart data are captured through a heart monitor with an uninterrupted signal that has minimal disruption to patients' lifestyle. The Zio service offers the potential to change the diagnostic pathway for patients with suspected arrhythmia in primary care. It offers a streamlined solution for capturing paroxysmal arrhythmias and can avoid significant downstream costs as well as significantly reduce the time to diagnosis or reassurance.[20, 21]

Amazon Halo – newest wearable tracking fitness and stress levels

Halo tracks fitness through steps, walking, running and climbing, as well as the quality and quantity of sleep, providing improvement advice where needed. Using the app, body scans are taken using a smartphone camera to give a better idea of BMI than just weight alone, and a personalised 3D model allows consumers to track progress over time. Halo also analyses the tone of the consumer's voice throughout the day to monitor stress levels.[22]

Digital therapeutics for sleep

Sleepio is a digital, sleep improvement programme that uses cognitive behavioural therapy (CBT) techniques to overcome poor sleep and improve mental health. The Sleepio programme (also available with a companion app) collects information about the user through a series of clinical questionnaires and daily sleep diary to personalise the programme to them. In March 2020, Sleepio was rolled out to 2.2 million workers in the US and UK in just one month in response to the COVID-19 crisis, including all 1.2 million NHS workers.[23,24,25,26]

Mobile health digital behaviour change programme to facilitate weight loss

Noom is an evidence-based app, digital behaviour change programme and health coaching platform for obesity and diabetes. The app enables users to adopt strategies for healthier lifestyles including daily food logging and access to a virtual support group. Noom has over 47 million users worldwide that typically lose 7.5 per cent body weight over four months. In October 2019, Noom partnered with the US National Diabetes Prevention Programme and NovoNordisk to enable patients participating in weight loss drug trials with free app access for 12 months.[27] Noom has shown reduced chances of pre-diabetic individuals developing type 2 diabetes by 58 per cent, and saved payers around $2,650 per patient over 15 months.[28]

DnaNudge: DNA analysis + wearable + phone app to encourage healthier food choices guided by the user's genetics

DnaNudge provides on the spot DNA testing in under an hour. The user's DNA is extracted from saliva taken from a cheek swab and analysed for nutrition-related health conditions using a portable 'lab in a box' PCR machine. The user's results are uploaded to their DnaNudge app and a wearable which monitors inactivity. The user receives personalised 'nudges' based on their DNA to increase their activity, choose foods that are more suited to them, and make healthier lifestyle choices.[29]

Deep Longevity's 'Biohorology' is helping address our understanding of age-related diseases and longevity

Some new tools are based on 'biohorology', the science of measuring the passage of time in living systems. These 'ageing clocks' use the biomarkers of ageing such as DNAm, gene expression and metabolomics. Today, DNAm clocks are the most popular, using deep learning to analyse data. Deep learning can also extend the functionality of ageing clocks beyond age prediction. Deep Longevity is developing user-friendly AI systems to track the rate of ageing at the molecular, cellular, tissue, organ, system, physiological and psychological levels, and developing systems for the emerging field of longevity medicine, enabling physicians to make better decisions on interventions that may slow down or reverse the ageing processes. Deep Longevity has integrated multiple deep biomarkers of ageing which provide a universal multifactorial measure of human biological age. During the past few years a number of Longevity therapies have entered human trials.[30]

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The COVID-19 impact

Deloitte view on the impact of COVID-19

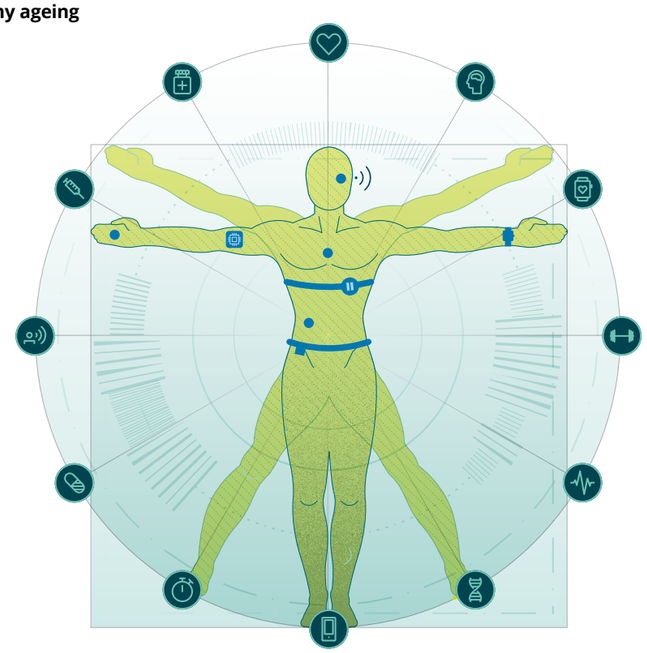
The COVID-19 pandemic has raised public awareness of the risks to their health of having a poor immune system and some of the actions they can take to improve their immune health and health outcomes. Evidence is also emerging on the increase in mental health risks. On a positive note COVID-19 has increased significantly the use of technology by individuals to monitor their own health and improve their activity levels and awareness of healthy lifestyles. It has also demonstrated the importance of improving digital literacy and establishing more local, meaningful public engagement that focuses on building trust and compassion with local communities. Importantly, COVID-19 has shone a spotlight on the role of vaccinations in protecting people's health. While many see a vaccine as a crucial step in return to a 'new normal', it will be 2021 before we know how quickly COVID-19 vaccines will be available for the general population or the extent to which people are willing to be vaccinated.

ChatBots

There has been a significant increase in the number of AI chat-bots that answer patient's questions about symptoms and other related factors to determine the individual probability of a coronavirus infection, and provide the patient with a clear risk assessment and advice based on the latest policies, including recommendations on telemedicine options, advice on isolation and nearby test centres.

For example, German start-up, **DOCYET**, has created an intelligent chat-application helping patients navigate the healthcare system, delivering decision support based on individual symptoms, and matching them with medical services both on – and off-line.[31,32]

From health(care) to healthy ageing



Source: Deloitte

Better public health drives better productivity

A resilient public health system protects the public, prevents disease and prolongs healthy life expectancy

Prediction: In 2025, public health is an established priority for governments everywhere, with a higher percentage of healthcare funding devoted to public health. National statutory public health organisations are accountable for building and maintaining a robust responsive public health infrastructure, including regionally coordinated public health agencies; a diverse and well-qualified public health workforce; and modern data and information systems. Non-traditional players, including public, non-profit and commercial enterprises, based around smart health communities work together with a focus on intelligent protection, prevention and promotion while prolonging longevity and improving the productivity of the nation. Digital inclusion and acceleration in the adoption of scientific and technological advancements have reduced health risks and improved prevention. The public health system is underpinned by intelligent national screening and vaccination programmes that focus on high – risk populations through better use of technology, genomics and AI. Empowered local authorities enabled by digital technology and behavioural science focus on tackling the social determinants of health.

The world in 2025

- Government investment has led to strong national public health systems using population data, behavioural science and digital technologies to protect the public, prevent disease, promote and prolong good health.
- A robust strategy for handling disease outbreaks is underpinned by real-time access to high quality data and strengthened health protection systems.
- AI and predictive modelling is applied to multiple data points including travel patterns, food habits, environmental parameters and global prevalence data, to detect signals to identify health risks.
- Public health authorities deploy a range of targeted preventative interventions in response to intelligent insights into the health of the population.
- Health promotion strategies have been co-created, based on strong public engagement and nudge interventions.
- Deep knowledge of local communities has reduced health inequalities such as infant mortality and childhood obesity with targeted application of evidence-based intervention strategies and measurable KPIs.
- Preventative public health digital interventions have dramatically lowered smoking rates, improved nutrition and reduced loneliness. They have also reduced premature mortality among people with chronic and mental health conditions.
- There is significant investment in infection control with financial incentives and penalties driving improvements.
- A focus on appropriate use of antibiotics has improved antimicrobial resistance.

Conquered constraints

- **Skills and talent:** Public health professionals have been upskilled to identify and tackle population health and social care needs, and prepare for and respond to emergency health threats, utilising data analytics and targeted evidence-based interventions. Digital inclusion initiatives have improved equity of access to digital technologies and resources targeted at reducing inequalities.
- **Funding:** A greater proportion of healthcare funding is devoted to public health as policymakers acknowledge the shift in focus from sickness and cure to wellness and disease prevention. Stakeholders have implemented payment reforms, including value-based payment models to optimise outcomes at the lowest cost.
- **Regulations:** Regulators across public health have aligned on core expectations, strengthening public health regulations with public health authorities proactively measuring and monitoring compliance using advanced analytics.
- **Data:** The authorities have created a robust public health IT infrastructure to identify and target reductions in health inequalities, with a national body accountable for progress. National and local authorities have established data-sharing agreements for collecting, analysing and sharing multiple sources of data, to address the social determinants health. Distributed ledgers (such as blockchain) have improved data integrity and transparency over access and use.

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Imagine the world in 2025

Gamification supports the mental health of children and young people

Funded as a government initiative, the 'Balance App' has digitalised the use of CBT to assist young people with mild to moderate depression. The app is available on prescription to all 13-19 year-olds and has dramatically improved access and reduced waiting times. The app was co-created alongside young people experiencing depression and anxiety, and applies gamification techniques to a series of proven CBT activities. Liam has struggled with depression and behavioural problems since the death of a close family member, and his therapist has prescribed the smartphone app. Balance uses avatars to explore a 3D world to complete quests, meet new characters, play mini-games and solve puzzles, all designed to help him self-manage his depression. Virtual guides provide him with instructions on how to apply the insights gained to help tackle his problems in real life. The app tracks Liam's progress using a validated mental health assessment questionnaire as he progresses through game levels. Early on in Liam's use of the app, the self-assessment results alerted his therapist to the fact that Liam needed further help and an app prompt encouraged him to seek face-to-face talking therapy. After two sessions Liam felt able to continue with the app, and ongoing assessments provided assurance that the intervention was working.

Smoking health literacy programmes are delivered through smartphone and wearable devices

Will has been smoking on and off for around 20 years. He has tried quitting seven times but generally relapses after a couple of months, usually due to work stress. His local healthcare authority is working alongside a social enterprise to reduce smoking rates across its communities, regardless of income, location, age, gender or ethnicity. He has received a SMS notification promoting an online smoking cessation initiative which includes impressive feedback from other users about the results achieved. Will downloads the app and the first step is to complete a form describing his previous history, motivations and cravings. The app uses an AI algorithm to derive a tailored education and support plan and deploys push notifications to help Will self-manage and modify his behaviours. Will is also monitored through daily questionnaires and data from a connected breath sensor. The app recommends nicotine-based products or facilitates a virtual consultation with a community pharmacist or physician to enable e-prescribing and therapy adherence tracking. Will can also access digital CBT and a virtual coach who supports him in his goal to quit smoking ahead of his 40th birthday. Will has also opted to join a peer support group. He is further incentivised by the app notifying him that he has saved nearly £500 in his first month of being smoke-free.

Introduction of a digital immunisation passport as a record

Mari's twin girls are about to start school and she is alerted to a new government-led initiative to provide people with a digital immunisation passport (DI-passport). Mari applies for a DI-passport for her children and is assured that all the relevant data from their electronic health records will be uploaded safely and securely, based on robust rules, information governance processes and FIHR interoperability standards. Her children's DI-passport is uploaded via the DI-passport app on to Mari's smartphone. Mari also opts to use an antibody test that has been made available to confirm her children's immunity status, which is also recorded in the DI – passport. If there are suboptimal levels of antibodies, an alert is sent to the individual's primary care provider for further intervention. Mari can keep track of her children's vaccinations: this is particularly useful as her children's new school requires proof of their vaccination status before either can start. Mari is also able to use the app to alert their family doctor if there are any adverse reactions to new vaccines. Her children's anonymised 'real world' data is used to help monitor responses to the vaccine and spot trends earlier.

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

Evidence in 2020

Portugal: Health literacy Serviço Nacional de Saúde 24 (SNS 24)

The Directorate General of Health (DGS) launched the Serviço Nacional de Saúde 24 (SNS 24) in 2017, as part of the government's 2020 strategies and healthcare system reforms, with a specific focus on strengthening digital health literacy across the population. The main objective of SNS 24 is to serve as the single access point for health information. It is a free online and telephone service that provides first-hand health information and responds to enquiries 24/7. SNS 24 provides advice and guidance on a range of health behaviours as well as enabling users to book vaccinations. It offers services that allow people to solve health-related issues without having to visit a primary care service or hospital. The platform is accessible across a range of devices and aims to support users in plain and simple language.[33]

Italy: Vaccines are compulsory for children enrolling in state-run schools

In 2017 the Italian government's National Plan for Vaccine Prevention (NPVP), followed by the National Law 119/2017, increased the number of mandatory vaccinations from four to ten (vaccination for polio, diphtheria, tetanus, pertussis, hepatitis B, haemophilus influenzae B, measles, mumps, rubella and chickenpox). The vaccines are compulsory for children enrolling in state-run schools, and fines were introduced for parents/guardians refusing vaccination. Partially or unvaccinated children under the age of 6 years were not permitted to attend pre-school.[34] Data from 2018 shows an increase in vaccine uptake at the national level and in almost all regional and autonomous provinces.[35]

England: The PrescQIPP Antimicrobial Stewardship Hub initiative supports better antibiotic prescribing in primary care

A joint initiative between NHS England and NHS Improvement, the PrescQIPP Hub offers online access to ready-to-use antibiotic prescribing data sets for all Clinical Commissioning Groups and GP practices in England, shares successful practice, and links to other AMR-related resources, including those published by TARGET, Health Education England and the Antibiotic Guardian campaign. Data in the PrescQIPP Hub is offered in multiple formats to allow comparisons across time and organisations.[36]

The US: Grapevine Health – community health literacy project

Grapevine Health is a non-profit start-up in the US that designs culturally appropriate health information campaigns targeted at underserved populations. Grapevine Health leverages storytelling, short educational videos, community-based support and digital communication to improve health literacy and health care engagement. Grapevine Health has joined the Health Equity and Access Leadership (HEAL) Coalition, along with 16 other health tech organisations including Google and Microsoft, to use technology to tackle health disparities exacerbated by COVID-19.[37,38]

Australia's approach to tackling childhood obesity

Approximately 17 per cent of Australian children are overweight, and 7 per cent are obese. The Australian government and Healthy Australia have created *feedAustralia*, an early obesity intervention, childhood nutrition and health education programme. Over 6,000 early childhood education and care (ECEC) services currently use feedAustralia's tools, which include a menu planning tool and app, which connects to existing child care management systems, and includes a nutritional database of more than 200 healthy recipes and snack suggestions with established energy, macronutrient profiles and food group breakdowns. The feedAustralia programme also saves each service an average of $3,500 in groceries every year.[39,40]

The COVID-19 impact

Deloitte view on the impact of COVID-19

The COVID-19 pandemic has highlighted the critical importance of having a robust public health system underpinned by a comprehensive epidemiologically-relevant data infrastructure including demographic and mobility data. A consensus is emerging on the elements of the wider infrastructure needed to protect public health, enable recovery and mitigate subsequent surges in infection. Specifically:

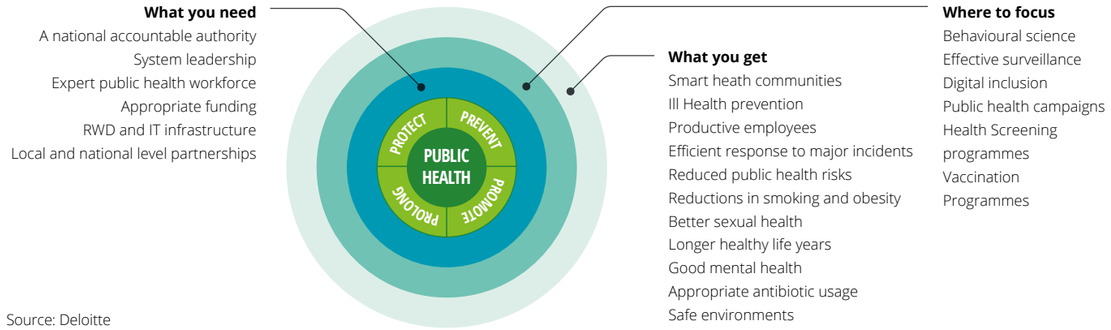
- test, track and trace – for new cases and levels of immunity, to improve the confidence of decision-makers in reducing restrictions without undue risk to health
- evidence-based mitigation strategies (social distancing, face masks, hand and environmental hygiene and good ventilation) together with segmentation based on an understanding of how and where transmission occurs
- consistent and clear communication strategies to encourage compliance with mitigations and address complacency and dissent
- sustained investment in an adequate supply of personal protective equipment (PPE) and other infection control resource requirements including new supply chain solutions.

Digital technologies using disparate data sets to support the public health response to COVID-19

Digital technology can enhance public health education and communication messages. In the United States, the COVID-19 Task Force partnered with Apple, Inc. to develop an app that provides CDC recommendations, including guidance on social distancing and self-isolation, how to monitor symptoms, recommendations on testing, and when to contact a medical provider.

The COVID-19 Mobility Data Network is a network of infectious disease epidemiologists from universities around the world, working with technology companies to use aggregated mobility data to support the COVID-19 response. Their goal is to provide daily updates to decision-makers at the state and local levels on how well social distancing interventions are working, using anonymized, aggregated data sets from mobile devices, along with analytical support for interpretation. The participants in the Network share a deep commitment to personal privacy and data protection.[41]

Better public health drives better productivity



Source: Deloitte

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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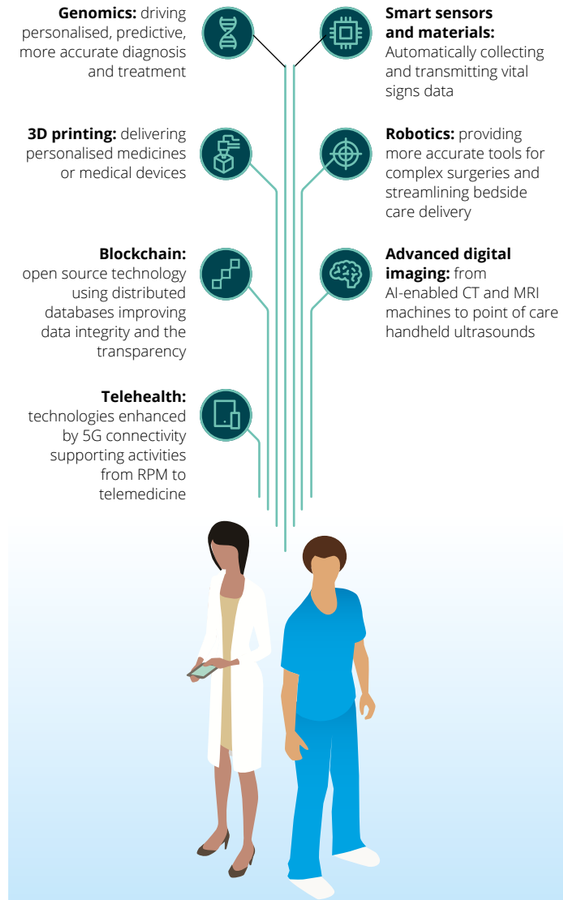
The COVID-19 impact

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



Source: Deloitte LLP, 2018

The who, what and where of work rearchitechted

Healthcare professionals, augmented by technology and life-long learning, have transformed their ways of working

Prediction: In 2025, advances in AI-enabled robotics, cognitive automation and digitalisation are helping HCPs to work more productively, including rearchitecting the who, what, where and how work is done. There is more focus on cognitive, emotional and analytical skills and less on repetitive, administrative tasks. These changes enable all HCPs to practice at the top of their professional license, enriching career development opportunities, improving the attractiveness of the profession and creating new specialisms. Task shifting is commonplace leading to a diverse, multi-professional, blended, workforce that is employed across permeable boundaries providing care wherever needed. All HCPs participate in multi-professional training to enable more adaptive, agile ways of working. This training uses simulation and virtual reality to equip HCPs to use technological innovation. This enables staff to adapt their skills to work where and when needed. Staff are also trained in understanding the application and ethics of genomics, digital health and AI in determining treatments and are able to convey this to patients.

The world in 2025

- New ways of working, augmented by automation and robotics, have helped providers with task-shifting and role enrichment to create a sustainable and flexible workforce.
- Employers refine the working culture and working conditions including enabling HCPs to practice at the top of their license as part of a blended workforce, augmented by AI-enabled clinical decision aids, robotics and other digitally enabled insights.
- Training is focused on developing cognitive, digital, emotional and analytical skills to enable HCPs to communicate effectively with each other and with patients, whether face-to-face or remotely.
- HCPs are confident in discussing the results of AI-enabled diagnostics and genomics testing with staff and patients.
- HCPs proactively respond to intelligent alerts from continuous vital signs monitoring or from digital telehealth coordinators, providing effective advice and real-time interventions.
- The provider infrastructure is configured to assist HCPs with data sharing across organisational boundaries.
- Pharmacists' have a greater role as caregivers and provide online and video consultations and monitor and track medication adherence remotely through smart pill dispensing devices.
- Some health tasks are conducted by physical robots delivering and administering medication, taking and documenting vital signs and conducting minor procedures. Remote and robot-assisted surgeries for several major procedures are commonplace.

Conquered constraints

- **Skills and talent:** Recruitment strategies have encouraged a wide range of more diverse individuals from more varied backgrounds to become HCPs. All HCPs receive core training, using blended learning methods, including classroom and on-line digital training and VR to increase expertise. There is an emphasis on continuous development of core human traits such as problem solving, communication and engagement. Professional competencies in genomics, digital health, data analytics and ethics have become part of the curricula. All HCPs are also expected to have an understanding of how the health system works, with an increased focus on agile, adaptable and collaborative working across the health ecosystem.
- **Funding:** National and local governments help determine and allocate training budgets and align incentives and funding models to create a flexible and sustainable workforce. Employers provide opportunities for staff to develop their skills, underpinned by consistently applied remuneration packages.
- **Regulations:** Regulators and professional bodies collaborate to ensure compliance with safe staffing models. They also partner with academia to design education curricula, to align learning needs with the evolving roles and responsibilities of the technology-enabled healthcare workforce.
- **Data and interoperability:** Staff understand data provenance, curation, integration and governance, and the ethical, data privacy and security considerations associated with technology. They obtain the benefits of data sharing while complying with robust information governance and data security standards.

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Imagine the world in 2025

A community pharmacist supporting patients virtually in 2025

Olivia is a community pharmacist who oversees the care of Ayesha, a 60 year-old patient with Parkinson's disease alongside other comorbidities. Because of Ayesha's complex medication regime, Olivia provides her with a monthly supply of medication to be taken via a smart medication dispenser. Olivia loads the dispenser at the pharmacy using an automated robot and programmes it to release medication for Ayesha at set times, and to sound an alert when medication is released. The device is registered to Ayesha's smartphone app, and if the medication is not taken at the correct time Olivia is alerted since Ayesha's medications are time-critical. One day, Olivia is alerted via a SMS to the community pharmacy's smartphone that Ayesha has not taken two scheduled doses of her Parkinson's disease medication. She calls Ayesha via an online consultation platform and carries out a structured medication review to check if Ayesha is okay, and asks whether she requires any counselling or advice relating to her medication or condition. Ayesha explains that she had taken her smart dispenser to dinner with a friend the previous evening and had misplaced it. Olivia arranges for a new smart dispenser to be delivered to Ayesha on the same day, to ensure that she does not miss any further doses.

A smart hospital enabling healthcare professionals to work differently

Dr Patel is the Chief Clinical Information Officer of a brand new 'hospital' which opened its doors in 2022, following a $2.4 billion investment and a decade of planning and construction. The hospital has 400 patient rooms and a robot-enabled infrastructure with consumables and medical equipment delivered to each room via a fleet of 23 self-driving robots, each the size of a large office printer. The robots have their own infrastructure and a dedicated elevator, and they move through corridors at two miles per hour, transporting heavy items such as rubbish, bedding and food. There is also a machine for dispensing pills in sealed-box packs (which is connected to a medication distribution and electronic health registration system). Each room is equipped with a smart TV (which also enables daily menu selection and translation facilities), IoMT-connected medical devices, and a bed and chair with in-built sensors to detect when the patient gets in or out. Patients download a smartphone app to enable them to navigate the hospital. Dr Patel's philosophy is that it's not about the technology but is about a hospital change management programme with AI-enabled technology supporting staff to work differently. He believes they will see a positive return on the investment and improved patient outcomes.

Expediting a patient's safe diagnosis and treatment

Tony, 80, is experiencing a chesty cough with sputum and has been feeling increasingly unwell. Tony uses his general practice's AI-enabled clinical assessment tool which suggests a possible diagnosis of pneumonia and recommends that he should speak with his doctor immediately. Dr Jones receives an urgent electronic alert to call Tony. Dr Jones reviews Tony's medical notes and can see that Tony is generally fit and healthy, but wellness data fed through in real time from wearable devices show that he has a low temperature of 35.5^{0}C, an increased heart rate of 91 beats per minute and a breathing rate of 22 breaths per minute. These results, coupled with Tony's symptoms, suggest he may be at risk of developing sepsis related to pneumonia and so requires immediate medical attention. Dr Jones arranges to speak with Tony in an online consultation and arranges a zero emissions e-ambulance that has a video and voice collaboration platform. Dr Jones is able to communicate virtually with the paramedics and send through Tony's results via an API integrated platform. This ensures that the e-ambulance is equipped with an appropriate sepsis biomarker test kit and the specific antibiotic medication to treat the infection at the point-of-care without delay.

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Evidence in 2020

Area9 has developed a blended education platform to customise healthcare learning experience

Area9 have partnered with the New England Journal of Medicine (NEJM) Group to create the first-of-its-kind medical education platform, NEJM Knowledge+, which uses smart technology that adapts to clinicians' learning goals, pace of learning and knowledge gaps to deliver customised information and training. Research from 2020 shows physicians who used NEJM Knowledge+ performed better on their board exams by a statistically significant margin than a well-matched control group. Area9, has collaborated with the American Heart Association and Laerdal Medical to deliver a more adaptive streamlined, personal and tailored resuscitation learning experience for healthcare professionals. Area9's Rhapsode™ learning and publishing platform uses AI to deliver a personalised and efficient approach that measures time-to-completion, confidence and self-awareness to more accurately assess and respond to each learner's individual competence and performance.[52,53]

RITA: Referral and Intelligent Triage Analytics

RITA uses the latest AI and robotics technology to automatically triage incoming cancer referrals and assign patients to appropriate pathways. Deloitte initially completed a proof-of-concept with a gastroenterology department in a Scottish hospital, with promising results. In the proof-of-concept, RITA developed an algorithm based on analysing over 24,000 incoming referrals, using natural language processing to identify patterns in the referral letters and assign them to a specific pathway. RITA displayed a high level of accuracy in triaging patients with suspected cancer. The project has now been extended to two other cancer referral processes and is following the necessary regulatory processes.[54]

CMR Surgical Ltd, widening adoption of robotic surgery

Robot-assisted minimal access surgery (MAS) reduces blood loss, recovery time, intraoperative and postoperative complications and pain when compared to open surgery, yet uptake remains low. To increase adoption and improve outcomes, CMR Surgical Ltd, by working collaboratively with surgical teams, developed the Versius® Surgical Robotic System, for use in MAS. The system aims to empower surgeons to transform how surgery is performed across the world. The system has a novel, mobile design with independent arm carts and surgical console, with wristed instrument tips providing seven degrees of freedom and a 'game controller' handgrip design. It is approved for use across Europe with CMR Surgical partnering with surgeons and hospitals. In bio-mimicking the human arm, Versius® has the ability to improve team communication, the surgeons' work environment and career longevity.[55,56]

Patient first: how Karolinska University Hospital is transforming to meet future demands of healthcare

At Karolinska University Hospital in Stockholm, Solna, new operating models are designed around patient care flows, instead of traditional clinical departments. For example, patients with heart and vascular conditions are treated in an integrated manner, with specialists from functions such as emergency medicine, imaging and cardiology working together – often in the same building or corridor. This new operating model is strengthening cooperation between different functions, improving patient care, and delivering better outcomes.[57]

Virtual reality is reshaping training of healthcare professionals

Virtual reality is being used for medical education. Embodied Labs has created a programme called We Are Alfred that simulates elderly patients' real-life experiences and trains healthcare workers to understand a patient's fears.[58,59]

Wireless StethoMe rolls out AI medical device following major deals with European telemedicine providers

Polish telemedicine innovations company StethoMe has announced that it will be rolling out an AI wireless stethoscope following recent collaborations with major telemedicine providers MaQuestionMedicale and HomeDoctor. The company is also in talks with other providers across Europe and hopes to expand operations.[60]

Liverpool University chooses 'Better' way to teach e-prescribing

Liverpool John Moores University has teamed up with Better to teach nursing and pharmacy students' about digital prescribing practices. The university will use Better's OPENeP electronic prescribing and medicines administration (EPMA) solution as part of student's learning. It's aimed at enabling students to learn about the prescribing, dispensing and administering medicines electronically.[61]

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The COVID-19 impact

Deloitte view on the impact of COVID-19

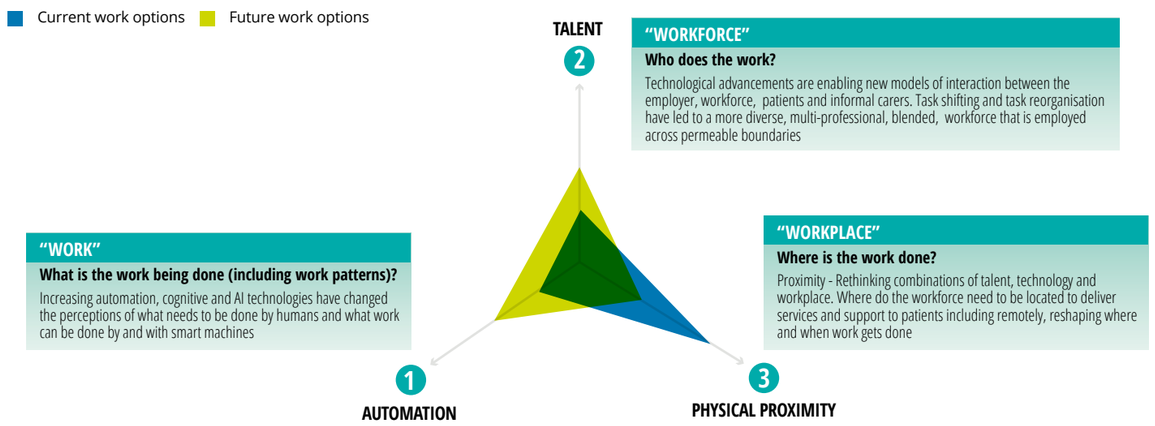
COVID-19 has had an unprecedented impact on healthcare services across the world. Health systems had little time to prepare and in the shortest of time frames had to reorganise services, train staff to work in new ways in unfamiliar teams, and develop effective ways of supporting the wellbeing of the workforce and deliver safe care to patients. All in the absence of suitable treatments and a real risk of staff acquiring an infection themselves. The response was an unprecedented transformation programme implemented in weeks that might otherwise have taken years. One notable outcome is an accelerated adoption of digital technologies including adopting new robotic processes to help support service delivery. Hospitals are using data analytics and automated dashboards to ensure staff are working in the most optimal and efficient manner. A crucial enabler has been the growing use of connected care solutions, such as telehealth and remote patient monitoring, technology-enabled ways of diagnosing, monitoring and treating patients, eTriage systems and simulation models for emergency departments and outpatient and primary care consultations pivoting to become telehealth services. New approaches to delivering care have also emerged, from drive-through testing centres to pop-up walk-in centres and vaccination clinics.

AI-enabled platform REiLI, supporting radiologists in assessing the impact of COVID-19 on patients' lungs

During the COVID-19 pandemic, hospitals in the Italian Lombardy region faced unparalleled pressures, and had to reorganise services swiftly to tackle the influx of patients with serious breathing difficulties.

Vimercate Hospital, a HIMSS 6 hospital leading in digital transformation, collaborated with Fujifilm to implement an AI platform, REiLI, to help reduce the impact caused by the rapid spread of COVID-19 and to deliver a timely response to the evolving pandemic. REiLI's processing of CT scans and chest X-rays (CXR) provides important support for radiologists, giving them a rapid, objective assessment of zones of the lungs for evaluating the presence of the pulmonary parenchymal consolidation caused by the virus. The AI data supports reporting on daily examinations aimed at monitoring the development of the disease, and also supports clinical analysis and decision making. REiLI was installed at the hospital in just two weeks. During the first few months of the pandemic more than 900 cases of COVID-19 lung disease were identified using this more precise and timely approach to diagnosis.[62]

The who, what and where of work rearchitechted



Source: Deloitte

Care is designed around people not place

Fully integrated care models are delivering more accessible, efficient and cost-effective patient-centred care

Prediction: In 2025, the integrated healthcare delivery model is adaptive based on digital-first triaging and signposting patients to the most appropriate care setting. Networks of primary care providers manage population health needs in a patient-centric healthcare model. Advanced technologies and data interoperability provide continuous connected care. Digital tools support HCPs in co-developing personalised care plans with their patients. AI-enabled RPM and point-of-care diagnostics collect and interpret real-time data on vital signs, whether in hospital or at home, so HCPs can intervene early. Enhanced HCP-to-HCP communication provides more coordinated, efficient and cost-effective care. Advanced network connectivity provides an array of opportunities around real time monitoring, combining data from biosensors, health applications and personal health records. This includes the use of digital twins to predict and monitor responses to disease and treatments.

The world in 2025

- Healthcare services and clinical pathways have been redesigned with and around the needs of specific patient groups to deliver seamless integrated care.
- HCPs in primary care act as care navigators and co-create patient care plans.
- Widespread use of AI-enabled technologies have enhanced care delivery including pharmacy dispensing, smart ambulance services and radiology and pathology services. Virtual command centres manage customer relationships, including RPM.
- Telehealth services involving continuous RPM at home and in hospitals, transmitted via the cloud and displayed through real-time dashboards alert HCPs to deterioration in a patient's condition.
- Digital hospitals cater to patients requiring urgent or more complex interventions, including robotic critical care and complex surgical procedures.
- Community health hubs in partnership with voluntary, private, health and social care sectors provide a hybrid (virtual and face-to-face) one-stop shop. They deliver high quality preventative clinical services (such as ophthalmology and dentistry), rehabilitation, phlebotomy, diagnostics and minor urgent care.
- Automation and AI algorithms have enhanced pharmacists' responsibilities, including diagnosing and prescribing approved medications and managing chronic diseases.
- Retail pharmacies enhance the consumer experience using 3D printing, self-check kiosks, telehealth, 5G-enabled telehealth, and same-day delivery.

Conquered constraints

- **Skills and talent:** Multidisciplinary teams facilitate collaboration amongst the different professional groups and functions working successfully across organisational boundaries to deliver care in the most appropriate settings. New models of education and training have equipped staff to use digital technologies, AI and genomics to design services around the patient.
- **Funding:** Budgeting in silos has been replaced with integrated care budgets to support population health management. Funding extends to telehealth services and social prescribing to support equality of access to digital solutions. Data-driven funding models have attracted new stakeholders, driving innovation across the health ecosystem.
- **Regulation:** Regulators help support innovation while promoting public and provider safety. They work with provider organisations to develop products and solutions based on a security-by-design mind-set and a trustworthy framework for data exchange. Compliance with robust cyber security standards has reduced risks, despite the increased use of connected medical devices.
- **Data and interoperability:** Data science and cloud technologies have improved the security, completeness and quality of health and behavioural data. Agreed interoperability standards have accelerated data sharing between all stakeholders, enabling insights from these data to inform shared decision-making, and enable real-time diagnosis. The emergence of 5G, cloud and edge computing together with AI algorithms has provided the analytical scale and speed to drive the new virtual healthcare ecosystem, including data simulation and visualisation, with strict protection of patients' data.

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Imagine the world in 2025

Virtual wards and digital command centres optimise hospitals' clinical and operational services

As part of a new partnership, some 50-plus hospitals have aggregated care delivery monitoring into a single digital command centre. Mohammad is the centre director, managing a team of 200 medical professionals on-site and 400 team members off-site who monitor and manage patients remotely using cloud-based, interoperable electronic health records. On their health record, patients have a dashboard showing information on their Health ID, hospital location and vital signs trend line. The patient's risk status is symbolised as a simple green dot for low risk and red for high risk – that beeps intermittently. The team monitors red dots closely and alerts the hospital's own staff or the field force about possible interventions if a patient's risk escalates. Digital real-time monitors track a patient's health in the hospital and at home, and the command centre uses AI and predictive analytics to help with diagnosis and treatment plans. Patient-facing virtual assistants also make direct requests to the command centre (using natural language processing) which the team reviews, allocating support accordingly. Mohammad obtains real-time data on operational efficiency, and his statisticians use predictive analytics on hospital (clinical and operational) and community health data to forecast needs for clinician and nursing staffing, supply chain operations and logistics to ensure efficient use of resources.

Streamlining the patient's experience of care, from home to hospital discharge

Kate's heart disease has worsened, and in two weeks she will be undergoing a coronary angioplasty at her local hospital to improve blood flow through her coronary arteries. To learn about her condition and what to expect from the surgery, she is using an app prescribed by her physician during her pre-operative assessment. The app includes directions to the catheterisation laboratory where the surgery will take place, parking information, and where her partner can wait during her surgery. Ahead of the appointment, the app prompts Kate to complete pre-operative forms about her health, and when she arrives at the hospital, she is given a smartwatch that monitors her vital signs. This information is fed directly into her electronic health records. Kate's surgeon can access her vital signs data, consent forms and history via her electronic record which he reviews in advance. Before and after the surgery, Kate is provided with real-time information on the progress of her health via an iPad that connects to her wearable. A monitor above her bed also displays the information in real-time for her care team to view. She has access to a health-bot hologram which answers her queries. Once Kates electronic discharge plan is activated, the pharmacy is automatically notified to dispense her prescription, and her smartphone app notifies her partner she is ready to be picked up. The app provides information about her medication, what to expect throughout recovery, diet and lifestyle advice, wound management advice and tracks her progress to support Kate's speedy recovery.

Remote monitoring and delivery of personalised antimicrobial therapy

Sally is experiencing symptoms of a urinary tract infection (UTI). She has a history of recurrent UTIs and her electronic health record includes a history of the antibiotics she has received and found to be effective in the past. She uses her smartphone app to book a virtual appointment with a medical professional. Her doctor, Dr Richards, asks her to use a home testing kit to confirm her diagnosis. The kit is delivered to Sally via her local pharmacy on the same day. The results are immediate: the test is positive, showing that Sally has a UTI caused by Escherichia coli (E. coli), a type of bacteria commonly found in the gastrointestinal (GI) tract. The result is uploaded instantly to her electronic health record, and Dr Richards is notified. Through an AI-enabled clinical support tool that looks at Sally's history and pharmacogenetic profile, Dr Richards sees which antibiotics are most suitable for her, to provide the correct therapy at the correct dosage. Through the smartphone app, Dr Richards arranges for Sally's antibiotics to be delivered to her home via her local pharmacy. She requests that Sally uses a wearable device to assess remotely any signs of intolerance to the antibiotics. Through continuous remote monitoring, Dr Richards can see that she does not have any signs of an inadvertent reaction and Sally reported that her symptoms have cleared.

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

Evidence in 2020

Freenome: Artificial Intelligence Cancer Diagnostic

The Longevity Vision Fund has invested in Freenome, which has developed early detection blood-based diagnostic tests for cancer. In a recent study, Freenome's diagnostic test demonstrated a 94% specificity (patients who do not have the disease) and a 94% sensitivity (patients who do have the condition) for early-stage colorectal adenocarcinoma. The standard genetic diagnostic rate is in a range of 33% to 98% sensitivity and a range of 72% to 99% specificity.[63,64]

Bradford Teaching Hospitals NHS Foundation Trust (BTH) opens a digital command center

In November 2019 the Bradford Teaching Hospitals NHS Foundation Trust (BTH) opened a digital command centre to help a centralised 'control' team see the full picture of hospital activity in real time. The team monitors a 'wall of analytics'– multiple digital screens on the wall–that pulls streams of data from various sources such as BTH's EHR system, patients' vitals sensors, and other scheduling systems to make a real-time impact on all operational, clinical and financial decisions.
With over 96% utilisation and a 40% increase in ER visits in the past ten years, the command centre will help optimise the resources and improve how patients move in and out of the hospital. The 'wall' enables faster ambulance transfer times, faster intra-hospital patient movements, getting home quicker, and even fewer surgery cancellations due to winter pressures.[65]

Israel-based Sheba Medical Center launched the ARC innovation center in 2019

To promote open innovation in the medical arena, the Israel-based Sheba Medical Center launched the ARC innovation center in 2019. ARC (accelerate, redesign, collaborate) is as an incubation hub for start-ups to work with hospital executives in identifying unmet clinical needs through breakthrough solutions. It currently focuses on innovation in six areas – precision medicine, telemedicine, virtual reality (VR), big data and AI, surgical innovation, rehabilitation, each headed by Sheba's senior physicians, along with the start-ups. A major feature of the ARC is the fully digital reality-based departments in the medical centres. Sheba is working with extended reality start-up XRHealth to use a digital reality platform for cognitive therapy, physical therapy, pain relief and other applications throughout the hospital. XRHealth's platforms are particularly useful in helping medical professionals analyse patient data in real time to track their recovery both physically and remotely.[66]

Ohio State University's (OSU) Wexner Medical Center uses bedside tablets that act as virtual care assistants for patients and relatives

The tablet, with the OSUMyChart application, allows patients to see their EHRs, ask questions, view test results, and schedule appointments. Patients can set medication alarms, schedule visits by physicians and relatives, view test results, or read educational material about their diagnosis. Patients can also make minor requests for water, snacks, and even for help going to the toilet, without using a nurse call button.[67]

A digital biomarker for diabetes

Given the multifactorial vascular effects of diabetes, researchers hypothesised that smartphone-based photoplethysmography, ((PPG) a simple optical technique used to detect volumetric changes in blood in peripheral circulation) could provide a widely accessible digital biomarker for diabetes. Researchers developed a deep neural network (DNN) to detect prevalent diabetes using smartphone-based PPG from an initial cohort of 53,870 individuals (the 'primary cohort'). Their findings demonstrate that smartphone-based PPG provides a readily attainable, non-invasive digital biomarker of prevalent diabetes.[68]

HBKiCare, home monitoring solution jointly marketed by the UAE and Israel

The first product to be jointly marketed from the United Arab Emirates (UAE) and Israel is HBKiCare a "universal remote healthcare IoT platform" and home-care kit, soon to be released by Dubai's Hamad Bin Khalifa Department of Projects HBK DOP and the Ramat Gan-headquarted healthcare IoT software developer, Sure Universal. The solution enables "continuous patient monitoring with maximum flexibility and affordability," recording electrocardiogram (ECG), temperature, pulse, blood oxygen and pressure measurements.[69]

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The COVID-19 impact

Deloitte view on the impact of COVID-19

Since the start of the COVID-19 pandemic, healthcare providers have implemented a major transformation, reorganising services and training staff to work in new ways in unfamiliar teams. Moreover, the rate of the adoption of virtual healthcare technology has accelerated across the world. Healthcare teams have developed and implemented new ways of working while keeping patients in a safe, remote environment. This includes the use of virtual consultations, RPM, and the use of apps and wearable devices for disease surveillance and interventions. New business models have been developed at speed with medical leaders, including hospital boards collaborating with private providers to create the right infrastructure including the tools and training to enable a digital-first health ecosystem. As healthcare providers attempt to recover and restore normal activity levels, infection control measures and social distancing rules are being used where possible to help minimise unnecessary interactions between patients and HCPs to help mitigate the spread of COVID-19. Digital working is becoming the 'new normal'.

Rapid deployment of emergency and outpatient ophthalmology video consultation services at Moorfields Eye Hospital NHS Foundation Trust

Moorfields Eye Hospital NHS Foundation Trust is one of the largest providers of ophthalmology services in Europe. Between 2018 and 2019, the Trust handled nearly 800,000 patient encounters, and about 100,000 patients attended the main accident and emergency (A&E) department or an emergency satellite clinic. The COVID-19 pandemic and subsequent UK lockdown in March 2020 created two immediate challenges for the Trust: how to identify and manage the most critical emergencies while minimising hospital visits, and how to provide care to those patients for whom prolonged care disruption could lead to significant harm or loss of vision. The national roll out of video consultations in Trusts across England, led by NHS England and NHS Improvement, enabled rapid roll out of multiple services across the Moorfields network, covering both drop-in and scheduled appointments.[70]

Care is designed around people not place

MedTech and the IoMT are crucial drivers of value-based care

Data from connected medical devices is enabling population health management

Prediction: In 2025, MedTech companies are actively driving the future of health, focusing on the use of transformative technology to enhance products and services and enable 4P medicine. Companies have access to sophisticated data analytics capabilities through in-house skills development and partnering, working closely with end-users and leveraging new cognitive and robotic technologies to improve outcomes. MedTech companies have also partnered with consumer-focused technology companies to benefit from their experience of brand development, customer engagement and advanced analytics. Where once MedTech companies were traditionally focused on developing hardware (surgical equipment, joint replacements, diagnostic equipment, etc.) many more now use software and sensors and deploy advanced analytics, to become Software as a Service (SaaS) providers, targeting preventative care at specific patient populations. Companion diagnostics have become a crucial tool for personalising patient therapy with MedTech playing a major role in driving VBHC, helping reduce medical costs, optimise surgical performance, and improve patient outcomes. Connected medical devices have helped close the loop between patients and HCPs by augmenting HCP skills.

The world in 2025

- Government and other funding models have expanded to provide wide-scale telehealth coverage including telemedicine and other breakthrough technologies to deliver efficiencies and proactive care.
- Most MedTech companies have robust strategies and transparent policies for generating and publishing peer-reviewed evidence on efficacy of outcomes including HTA cost-effectiveness analyses.
- Providers, clinicians and patients use connected medical devices at scale to monitor health, improve efficiency and patient outcomes. Business models use RWE from connected medical devices, to enable companies to transition from a provider of products to an insightful partner, delivering evidence-based value for stakeholders across the clinical pathway.
- Companies developing services use the generation and transmission of patient data and FAIR data sharing principles to help increase the trust of patients and confidence in using devices.
- MedTech companies have entered into long-term VBHC arrangements that differentiate products which offer protection from price erosion, create stickier relationships with customers, and increase market share and revenue by being a preferred product.
- Established collaborations between stakeholders have enabled the transmission, aggregation, analysis and management of data, improving their understanding of patient needs.
- MedTech companies have developed a better understanding of the clinical context in which their devices are used, creating VBHC solutions to deliver preventative wellness solutions.

Conquered constraints

- **Skills and talent:** MedTech companies recruit talent with advanced digital, cognitive and analytical skills and have established partnerships with academia, tech companies and innovative start-ups, to obtain access to data scientists and bioengineers. Six new MedTech roles have emerged (see figure) with leaders acquiring new skills and capabilities.
- **Funding:** Companies' new payment models use innovative contracting and value-based arrangements such as risk sharing. Payment pathways encourage adoption of VBHC payments at scale, as data quality has improved. Payer funding has been extended to remunerate RPM, digital therapeutics etc. using flexible models such as 'per-patient per use'. A new evaluation framework has been agreed for the reimbursement of *in vitro* diagnostics (IVD) aimed at improving health outcomes in a sustainable way.
- **Regulations:** Regulatory teams use a 'Regulation by Design' approach from design to manufacturing to after care, including validated software updates. Companies have robust systems for compliance with the raft of regulatory changes introduced over the past five years, including MDR, IVDR and GDPR. They also collect and publish RWE on outcomes to satisfy safety and efficacy requirements and expedite approval of innovative medical devices.
- **Data and interoperability:** MedTech has adopted FAIR data principles and protocols for the exchange and use of data, a governance framework and eConsent systems. Manufacturers have adopted a 'security by design' approach (adopting key data encryption and authentication mechanisms), working with providers to manage AI-ethics, data privacy and cyber security, enabled by cloud, edge computing and blockchain technologies.

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Imagine the world in 2025

The use of RWE to smooth regulatory medical device submission and expedite approval

Amen is the market access lead for a new medical device aimed at transforming the management of diabetes. In gathering the information needed for regulatory approval, he first piloted its use in a small patient pool to refine the technology and collect efficacy data. He then partnered with the university hospital and research institute to run a clinical trial. In this second phase, Amen collected efficacy and safety data from early adopters to qualify the solution for certification as a medical product. He also worked with the university to develop a health economic model to support reimbursement discussions with payers. The platform collected a large amount of RWE, increasing confidence in the validity of the results, which Amen used to start early dialogue with the regulator and payers about a reimbursement model. He decided to follow the centralised approval process which has stricter technical and efficiency criteria than local agreements; and once the the device is approved for use on a countrywide basis, it is likely to be recommended as a standard part of the diabetes care pathway with an agreed nationwide reimbursement model. This ensures patients will be able to get access to the device across the country more quickly. This is a win-win for the company, for patients and for Amen's own performance evaluation.

Recent technology developments streamlining stroke care and dramatically improving outcomes

Mike is at high risk of having a stroke, having had two mini strokes. Knowing that stroke was the third main cause of death and disability, he and his wife Mary had recently attended an online support group training session on recognising the signs of a stroke. Mike was in the kitchen making a cup of tea when his wife noticed he was slurring his speech and one side of his face had sagged. She knew that if this was a stroke, 'time lost was brain lost', so she called immediately for an ambulance. The ambulance call centre reviewed Mike's EHR and despatched their specialised stroke ambulance fitted with 5G-enabled video communication, monitoring and consultation technology. Mike was moved quickly into the ambulance and using a new smart camera ML-algorithm, the paramedic Alex confirmed the likelihood of a stroke. Using the video Alex shared the results and a mobile CT scan (taken in transit to the hospital) with the stroke consultant, who confirmed an ischaemic stroke (a blocked blood vessel). Under supervision, Alex, administered a clot-busting intravenous thrombolytic drug as Mike was well within the 3-4 hour window from the onset of the stroke. A cerebral angiogram at the hospital confirmed that there was no evidence of further clots stroke. Mike was discharged from hospital two days later with only minor after-effects and a set of RPM tools to support his rehabilitation.

Digital therapeutics successfully treating chronic back pain

SBTech has a reputation for its strong innovation and product development (I&PD) strategy which has helped it to develop and deliver the right products to market at the right time using agile development methodologies and advanced IT tools that support engineering and clinical development. SBTech has recently launched a new digital therapeutic solution to treat back pain which includes an AI-enabled triaging and monitoring tool, an education and training app about back pain, mindfulness practices, and a range of physiotherapy developed physical exercises. SBTech's solution was initially developed through a partnership between the company and a neighbouring Technical University to demonstrate how such a digital therapy can provide effective, cost-effective standard care for back pain. An independent review of SBTech's digital tool provided compelling evidence of improved outcomes and this led to a number of partnerships with payers to trial a way of paying for the therapy in the same way as for conventional treatments. This resulted in inclusion of the technology in the standard patient pathway. A recent randomised control trial demonstrated that SBTech's technology was more efficacious than physiotherapy and online education, the current standard of care.

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Evidence in 2020

NICE Evidence framework for MedTech products

The UK's National Institute of Health and Care Excellence (NICE) Evidence launched a standards framework in 2019, HealthTech Connect to make it easier for innovators and commissioners to identify the evidence that should be available, or developed, for digital health technologies in order to demonstrate their value. This includes evidence of effectiveness relevant to the intended use(s) of the technology and evidence of economic impact relative to the financial risk. This initiative aims to help companies develop health technologies to identify routes to national evaluation programmes, as they seek to move from inception to adoption in the health and care system.[71,72]

Digital therapeutics for the treatment of Substance Abuse in the US

Pear Therapeutics is a leading prescription digital therapeutics (PDTs) company with the first three FDA-authorised PDTs. Pear's products are clinically validated software-based therapeutics that directly treat diseases. Its lead product, reSET®, treats Substance Use Disorder (SUD), the first PDT to receive FDA marketing authorisation to treat SUD. It's second, reSET-O®, for the treatment of Opioid Use Disorder, was the first PDT to receive Breakthrough Designation. Pear's third product, Somryst™, for the treatment of chronic insomnia, was the first PDT submitted through FDA's traditional 510(k) pathway while simultaneously reviewed through FDA's Software Precertification Pilot Program. Its products collect RWE, have been tested in RCTs with results published in peer-reviewed journals. The products, are adjuncts to outpatient counselling, providing patients with algorithm-driven CBT, fluency training, and contingency management, while clinicians receive access to clinical dashboards to inform in-office and tele visits.[73,74]

Launch of a Digital Health Centre of Excellence by the FDA to advance digital health technology

In September 2020, the FDA announced the launch of the Digital Health Centre of Excellence within the Centre for Devices and Radiological Health (CDHR). Its aim is to boost the advancement of mobile devices, software-as-medical-device (SaMD), wearables when used as a medical device, and other technologies. The Centre is responsible for providing advice and coordinating and supporting the work being done across the FDA in advancing best practices and reimagining digital health device oversight. Through the Center, the FDA intends to modernise digital health policies and regulatory approaches to ensure access to 'the most cutting edge, digital technologies are rapidly developed and reviewed'.[75]

Deloitte crowdsourcing simulation with MedTech stakeholders

Deloitte conducted a crowdsourcing simulation, to understand what the MedTech company of the future might look like. It found that companies that traditionally focused on developing hardware (e.g. surgical equipment, joint replacements, diagnostic equipment, infusion pumps, pacemakers, etc.) are shifting their focus to software, data collection, and advanced data analytics. MedTech companies that focus on developing acquiring or partnering to access sophisticated data analytics capabilities can better address changing patient and clinician needs. The top technologies cited were AI (80%), robotics (53%) and nanotechnology (47%). The research noted that the MedTech company of the future will face intense competition from consumer technology companies. Beyond product offerings, MedTech companies are also positioned to help hospitals and health systems make the transition to the future of health through services.[76]

Evidence of new payment models in MedTech

Medtronic-Tyrx antibacterial sleeve has 1,000 contracts that require the company to reimburse hospitals for certain costs if its antibacterial sleeve fails to prevent infection in patients receiving cardiac implants.

J&Js has developed a 'Thermocool' catheter ablation procedure whereby if a repeat procedure is needed within a year of treatment the company guarantees a discount on the cost of its device for the second procedure.

Bruin Biometrics has developed a hand-held wireless scanner that detects pressure ulcers (bed sores) and helps caregivers or providers prevent the formation of pressure ulcers. The company has been developing a variety of risk sharing agreements with providers in the UK which may involve payment tied to early detection and prevention of ulcers.

Philips and the Jackson Health System have entered into an 11-year enterprise-monitoring-as-a-service (EMaaS) partnership. Under the terms of the agreement, Jackson Health will use remote patient monitoring systems, such as wearable biosensors, for a per-patient fee and adopt standardised patient monitoring for each care setting across its network. Philips own the hardware, software, and networking solutions to patient monitoring technologies, Jackson pays only for hours of monitoring usage.[77]

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The COVID-19 impact

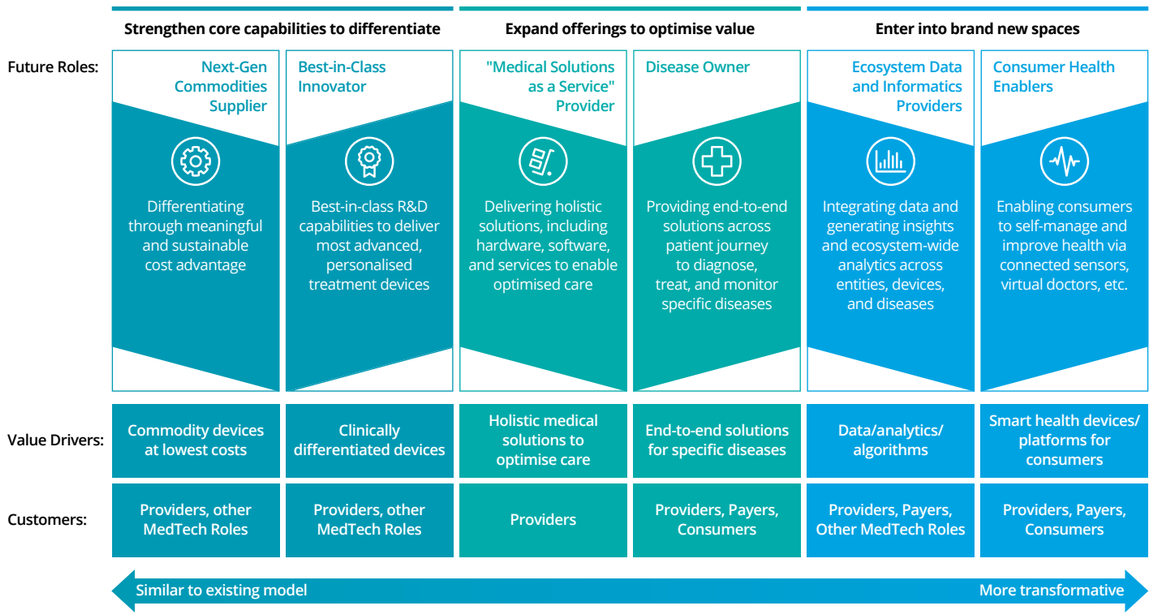
Deloitte view on the impact of COVID-19

The COVID-19 pandemic has accelerated the use of MedTech devices enabling individuals to record their behaviour, get an online diagnosis and manage their health more efficiently, without having to leave their homes. Virtual consultation technologies have been scaled dramatically to help HCPs diagnose, monitor and care for patients remotely while reducing the risk of infection. Wearable technology has magnified the added value provided by IoMT technology, giving patients, carers and HCPs with numerous real-time data points about the patient's activity and vital signs. The IoMT has also played a crucial role in 'test, track and trace' to curb the spread of COVID-19 by creating a virtual perimeter using GPS, RFID, Wi-Fi, Bluetooth signal, and cellular network. AI-enabled MRI and CT scanners and IVD tests have also increased the accuracy and speed of diagnoses. The pandemic has highlighted the importance of large-scale partnerships to mobilise and coordinate public and private efforts to tackle global public health threats.

Philips' IoMT solution for critical care patient monitoring

Philips has a comprehensive portfolio of solutions to help support the care of COVID-19 patients. Solutions include secure, connected and intelligent approaches to diagnosis, treatment and predictive monitoring in hospitals, plus screening, RPM and care at home. Philips' telehealth and AI-enabled data analytics help support HCP's workflows, facilitate remote collaboration and help optimise the use of resources, being designed for rapid deployment and scalability. In June 2020, Philips received Emergency Use Authorisation (EUA) from the FDA for it's IntelliVue Patient Monitors and Active Displays, for use during the COVID-19 health emergency. These solutions support infection-control protocols and provide critical patient information remotely when caring for hospitalised COVID-19 patients. Updated features, include enhancements to monitor and assess clinical and network device performance, and additional functionalities to strengthen cybersecurity.[78]

MedTech and the IoMT are crucial drivers of value-based care (six new MedTech roles have emerged)



Companies have reversed the decline in the returns from pharma R&D

Advanced AI-enabled technologies have accelerated drug discovery and clinical trials improving efficiency and reducing costs

Prediction: In 2025, Pharma R&D processes are augmented through digital platforms and large-scale access to FAIR data and research partnerships with academia and digital tech companies, driven by leaders with digital skills and a fail-fast mind-set. This is improving success rates and reducing the time to market. AI for drug discovery companies are using DL to derive crucial insights from multiple datasets, improving the speed and accuracy of drug discovery, and delivering more precise therapeutic candidates. Innovative clinical trials, using digital technologies, AI and RWE have helped define new patient-centric digital end-points, refine indications and improve trial enrichment strategies. Pharma companies now employ data-rich visualisation tools across the study lifecycle and deploy hub-and-spoke command centres to operate virtual clinical trials, enabling faster recruitment, enrolment and monitoring of more diverse groups of patients. Apps, wearables, eConsent platforms and telehealth help reduce the time commitment and financial costs that hindered recruitment and retention. All these changes are reversing the previous upward trend in R&D costs.

The world in 2025

- Pharma companies use DL algorithms in their drug discovery processes, deploying in-house data analysts and partnering with AI for drug discovery start-ups and government-supported genomic teams.
- Novel biomarkers and drugs identified using AI have increased alongside better knowledge on disease mechanisms. As a result, a greater proportion of pipelines comprise candidates for more precise pathologies.
- Increasingly, early-stage research uses *de novo* design and/*or in silico* clinical trials. Many Phase I trials also use quantum computer simulations to accelerate decision making at key milestones.
- Advanced techniques such as DL are embedded in clinical trials improving the diversity of trial participants and the development of precise treatments, such as for rare diseases.
- New platform technologies have changed the development of next gen therapies, such as CRISPR and mRNA, leveraging the experience of cell and gene therapies, to create new treatment paradigms.
- Liquid biopsies, combined with improved use of bio-sample libraries, have accelerated the development of precision medicine.
- An AI-enabled digital infrastructure, has improved approval rates, lowered development costs, and is delivering medications to patients faster.
- An enhanced hybrid clinical trial experience has embedded patient-centricity across R&D, with patient groups and their unique 360-degree perspective, inputting to the design and management of clinical trials.
- Biopharma companies use digital twins to simulate clinical trials including costs, patient selection, and the likelihood of success.

Conquered constraints

- **Skills and talent:** recruiters target data science, bioinformatics, computational biology and biochemical specialists. R&D scientists are increasingly a blend of clinician, natural scientist and computer data scientist. Companies are also partnering with academia, AI for drug discovery companies and tech giants to bring people with proficiency in data science and data ethics into the R&D team. Skilled interdisciplinary leaders with AI-friendly, tech-savvy boards create new businesses and operating models.
- **Funding:** biopharma companies have increased investment in data, analytics, technologies and research collaborations. Faster drug discovery, use of synthetic control arms and improved recruitment and retention of patients in clinical trials have reduced R&D costs and helped reverse the previous decline in ROI, attracting high levels of investment. Reimbursement discussions with payers begin at Phase I, with new funding models, for example for cell and gene therapies.
- **Regulations:** rapid changes to regulatory requirements in response to the growing use of technologies (including experience during COVID-19) have created new relationship paradigms. Regulators readily accept RWE in support of new drug applications, label expansions and revisions. New regulatory pathways have increased flexibility, transparency and speed of approval. Regulators have also collaborated globally to develop new evidence frameworks and enhance their own skill-sets to use the vast data stored on cloud platforms.
- **Data and interoperability:** HIPAA and GDPR compliant cloud, quantum computing, blockchain and AI-enabled services and tools facilitate global FAIR data management and sharing. Blockchain technology is also used to verify the origin and veracity of dossier submissions.

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Imagine the world in 2025

Using AI algorithms to match patients to clinical trials

Susan has been diagnosed with a rare cancer for which there is no available treatment. Her doctor, Dr Nemo, used her clinical data (including EHRs and genomic data) to find a suitable clinical trial through an AI-enabled search tool. By mining numerous datasets, the AI algorithm matched Susan with a Phase II study and Dr Nemo helped Susan enrol. The pharma company provided Susan with comprehensive information about the study and addressed her anxieties, so that she was happy to sign the eConsent form. Susan received a smart watch, digital diagnostic tools and an app, all of which fit seamlessly into her daily routines providing real-world remote two-way communication while continually monitoring her health. AI algorithms capture and analyse data to provide insights, including precise digital biomarkers that monitor Susan's response to her treatment and whether there is need for dose adjustments or any indications of adverse reactions. Susan receives automated reminders throughout the study to ensure that she follows the treatment and personalised messages that keep her informed about the progress of the trial. Home monitoring means that Susan visits the trial site much less frequently than she would otherwise have done. When she does visit, she uses her app to arrange her appointments and transportations. Susan adheres to the trial protocol throughout and responds so well that she is invited to join the next stages of the study providing her with continued access to the treatment.

The regulatory function of a biopharma company is fully integrated across clinical development

Luis is the regulatory affairs director of MJ Biopharma (MJBP) and is accountable directly to the Board for ensuring that the use of next generation technologies helps drive regulatory compliance. Luis has automated the company's dossier compilation to reduce the time and cost of the marketing authorisation application process. He also uses AI to identify any anomalies in dossier compilation and rectify them before submission, with NLP used to translate dossiers for multiple applications. Automation has been implemented across the clinical development process to improve regulatory compliance with enriched recruitment and retention strategies. The custody and serialisation of blockchain capabilities are used for real-time tracking of the control, transfer and distribution of medicines to trial participants. Automation has also made it easier to create an audit trail to review compliance and decision-making. Overall, Luis has transformed pre-authorisation information management by leveraging AI and BI capabilities, based on his understanding of the regulators own use of advanced analytics to detect patterns and trends to ensure products' safety and efficacy.

Technological advances that herald a renaissance in peptide drug discovery

Nina is currently working as a Chief Business Officer at an AI-enabled, peptide-focused drug discovery company founded in 2019 by a renowned scientist who has received numerous awards for her business leadership and scientific work in AI. Her team includes some 60 employees, composed of 'drug hunters' working in partnership with a number of major pharma companies. Last month Nina was part of the team that identified and accelerated clinical development to launch a novel anti-inflammatory product identified by the AI platform and developed in the record time of 420 days. The company has since entered into seven further corporate partnerships and a joint venture and are actively deploying the AI platform in developing new therapeutics that target novel pathways in oncology and cardio-metabolic diseases. Nina and her team have published over 20 peer-reviewed papers, applied for a dozen patents and received a number of industry awards for their innovative drug discovery work.

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Evidence in 2020

Medidata's Acorn AI gives researchers a 360-degree view of the patient

Medidata, a Dassault Systèmes company, is helping drive the digital transformation of the life sciences industry through its world leading platform for clinical development, commercial, and real-world data. Medidata established Acorn AI in early 2019 to develop new insights across all phases of drug development and make data 'liquid' across the end-to-end lifecycle of a biopharma company (from research to development and into post-market surveillance). In building linkages between clinical trials, genomics, RWE, translational health and other datasets, it aims to help biopharma make quick 'go/no go' decisions, accelerate clinical trials and demonstrate value. Acorn AI is built on the Medidata platform, which comprises more than 20,000 clinical trials with structured, standardised clinical data repositories from over 6.3 million patients. Acorn AI is focusing on addressing precision medicine with CAR-T therapy, tissue engineering, gene and cell therapy, while leveraging the advancement of AI and new sources of data to give researchers a 360-degree view of the patient, including clinical, genomic, molecular, as well as socio-economic, behavioural and environmental data. They help sponsors make critical decisions on how to create better-integrated evidence, including clinical as well as RWE to demonstrate the products' value to regulators, patients, payers and providers.[79,80]

Japan's National Cancer Center Hospital East using circulating tumour DNA analysis for trial selection

Japan's National Cancer Center Hospital East compared circulating tumour DNA (ctDNA) analysis to tissue genotyping for enrolling gastrointestinal patients into two large trials. One trial, SCRUM-Japan GOZILA, used the Guardant360 liquid biopsy to identify patients, while the other one, GI-SCREEN, relied on tissue genotyping. Researchers more quickly enrolled a higher number of patients into a trial using the ctDNA approach. They further noted that liquid biopsy-based profiling uncovered a greater number of actionable mutations demonstrating that genomic profiling by ctDNA analysis using the Guardant360 liquid biopsy has the advantage of shorter turnaround times and improved patient enrolment compared to tissue biopsy for clinical trials, without compromising treatment efficacy.[81]

Flatiron Health uses machine learning (ML) to identify patients eligible for oncology clinical trials and to generate important RWE from the experiences of the 95% of cancer patients who aren't represented in trials

The complexities of identifying and screening patients for trials are consistently cited as causing study delays, unexpected costs and study failure. EHRs are a valuable source of the real-world data key to a solution. Leveraging data from the EHRs of cancer patients, Flatiron has developed an approach that employs ML to provide real-time notifications of potential patient-trial matches to site staff and research coordinators at the point of care, integrated into their daily workflows. The functionality is one feature of Flatiron's OncoTrials® software, which continuously runs ML models trained on tens of thousands of structured and unstructured real-world data points to infer key trial eligibility criteria such as metastatic status and biomarker results.[82,83]

Exscientia and the use of AI for drug discovery

Exscientia is a leading global pharmatech company and was the originator of the first AI-designed molecule to enter clinical trials. Exscientia has developed a full-stack AI-driven drug discovery platform from target identification to drug design and optimisation of novel drug candidates. Fusing the power of the original AI-design with the experience of seasoned drug hunters, Exscientia's Centaur Chemist™ platform enables the discovery of exquisitely optimised molecules with breakthrough productivity. In tandem, Exscientia's Centaur Biologist™ platform drives the flexible analysis and prioritisation of discovery targets across all pharmaceutically relevant disease space. Five assets have been delivered in around 8 to 14 months (compared to the five-year industry benchmark), with drug discovery cost savings of more than 80% (30% achieved for the entire drug development process). Over 20 AI-Driven drug discovery projects are currently active with further growth scheduled throughout 2021. The company plans to develop its own portfolio as well as continue to partner with pharma and biotech companies.[84,85]

Trials.ai uses its proprietary database to derive insights and recommendations for trial sponsors

Trials.ai uses AI to analyse large sets of data including past clinical studies, medical journals, regulatory guidance, standards of care, trial complexity information, amendment information and other forms of trial-related documentation to improve study design. Using its proprietary codified clinical trials database, the system is able to unlock information, derive insights and make recommendations to trial sponsors on how to best design and optimise their trial protocols, as well-designed protocol limits improves recruitment, retention, and reduces burden on patients and trial sites by bringing in cost and time efficiency. For one of its clients Trials.ai shortened study timelines by 33% and reduced data errors by 20%.[86]

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The COVID-19 impact

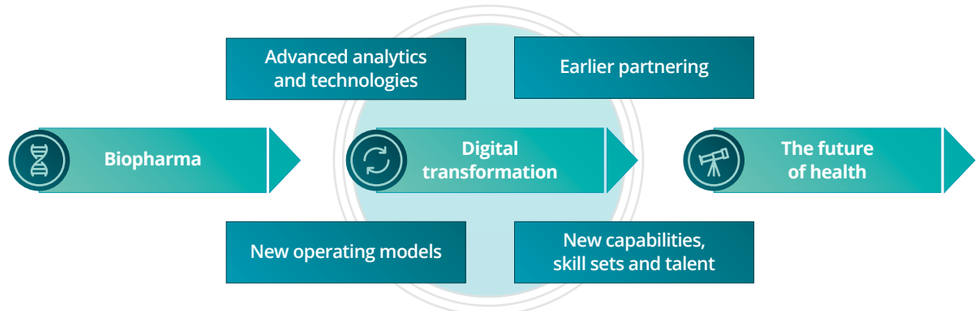
Deloitte view on the impact of COVID-19

In response to the COVID-19 pandemic, the pharma industry, academia, biotech, and hospitals, embarked on unprecedented scientific endeavours funded by governments, multilateral agencies, not-for-profit institutions, and the private sector. Trade secrets and intellectual property have been more widely shared than ever before as collaborations and partnerships formed to expedite the search for new treatments and vaccines. Regulators entered into immediate dialogue aimed at supporting the most promising innovations, discussing cost-plus pricing strategies and improving the diversity of participants in clinical trials. However, pivoting R&D activities towards COVID-19, while necessary, has impacted the progress of other clinical trials. By the beginning of November, ten vaccine candidates were in Phase III trials and developers of three of these vaccines are hoping to obtain regulatory approval before the end of 2020. This is faster than any other vaccine in history. In response to concerns about the speed of development, the CEOs of nine leading developers signed a pledge committing to uphold the integrity of the scientific process and provide robust evidence of safety and effectiveness. While initially any approved vaccines are expected to be targeted at healthcare staff and more vulnerable populations, their ultimate impact globally will depend on the disease's epidemiology and transmission and the duration of immunity from infection. Nevertheless, vaccines will play a crucial role in most response scenarios and will serve as an insurance policy against continued health societal and economic impacts of the pandemic.

23andMe: from genetic testing, to discovery, to drug development

23andMe is a direct-to-consumer online genetic-testing company providing users with insights into their health, genealogy and ancestry, while furthering research into the genetic basis of diseases and leveraging genetic data to help develop new treatments. Since 2007, 23andMe customers have submitted saliva samples, self-reported information and, for those who opt-in to the 23andMe research program, separate consent documents for biobanking and research. 23andMe has sold more than 12 million kits and over 80% of its customers elect to participate in research. In 2018, GSK took a $300 million stake in 23andMe signing a four-year collaboration agreement to work together to discover new drugs. To date around 30 therapeutic targets have been identified with majority of pre-clinical programmes in the target validation phase, and the remainder are in early drug discovery programs. In January 2020, 23andMe licensed the rights to a drug targeting multiple inflammatory diseases (including various dermatological conditions) it developed in-house to a Spanish pharma company, Almirall, who plans to take the drug through clinical trials. During the COVID-19 pandemic, 23andMe has used its research platform to identify a number of genetic and non-genetic associations for susceptibility and severity to COVID-19. In under four months, more than a million 23andMe customers consented to participate in the research, more than 15,000 had tested positive for COVID-19, with 1,100 of them requiring hospitalisation. Through their participation, 23andMe has been able to make new findings, replicate others, and contribute to the larger effort by other researchers who are searching for treatments.[87, 88, 89,90]

Biopharma companies need to pursue a fundamental shift in their R&D model



Next generation supply chains are integrated into healthcare and the patient experience

The convergence of clinical, commercial and manufacturing processes, networked through data-driven value chains

Prediction: In 2025, the adoption of advanced digital technologies has improved the visibility and efficiency of the supply chain. Many companies have shifted from a linear supply chain to an interconnected digital supply network (DSN), which utilises interoperable data to provide a foundation for companies to compete more effectively. Track and trace is no longer a vision, but a blockchain-enabled reality from manufacturing to the patient and HCP. AI technologies have transformed the supply chain and manufacturing through real-time data processing and decision-making, reducing the risks of human subjectivity and bias. Commercial, regulatory and operational data have been unlocked by AI tools to identify non-linear and complex relationships and provide strategic insights for improving the supply chain. Advanced analytics have helped deliver significant improvements in productivity and costs. This has enabled more efficient demand forecasting, inventory management, logistics optimisation, procurement, and workforce planning. Biopharma companies have streamlined their regulatory compliance functions across the supply chain to overcome functional siloes and improve efficiency across the product lifecycle.

The world in 2025

- Advanced data analytics have transformed the operating models of the pharma supply chain enabling a fundamental shift from linear to dynamic, interconnected DSNs.
- Control towers provide end-to-end visibility across the supply chain with AI tools applied to real-time data to generate actionable insights and improve decision-making and regulatory compliance.
- Companies have adopted robust Third Party Risk Management (TPRM) solutions to manage global risks.
- Data analytics are used to interpret data from multiple sources to detect patterns and anomalies, including creating a digital twin of the supply chain to produce better demand forecasts.
- Companies have revaluated their overall value chain, manufacturing and transport to meet the overall companies' sustainability goals. Smart transport vehicles provide real-time insights about delivery and product status.
- Responsible supply chains enabled by advanced automation and open data management have improved transparency while supporting biopharma companies to collaborate more effectively with regulators, improving compliance.
- Companies improve operational effectiveness by adopting a resilience-by-design mind-set (such as financial and reputational resilience) and deploy predictive maintenance, including optimising machine uptime.
- Sensors and actuators within facilities, connected securely to the cloud or data centre, provide companies with BI across the supply chain.

Conquered constraints

- **Skills and talent:** Collaborations with experts in other industries have improved the skill-set of in-house staff and helped to establish a more diverse workforce, including experts on AI design-thinking. Manufacturing and distribution staff are more flexible, digitally-literate and open to continuous learning.
- **Funding:** The return on investment in DSNs has improved across the supply chain. Earnings before interest, tax, depreciation and amortisation (EBITA) have increased substantially over the past five years. This has convinced companies of the benefits to be gained by investing in advanced technologies, including investing in robotic applications and intelligent real-time monitoring systems to track operational performance.
- **Regulations:** Regulators use accelerators and 'sandboxes' to test products, services and business models. RPA risk management tools ensure regulatory requirements are met. International agreements have reduced the risk of individual governments resorting to trade protectionism. Compliance with the EU's Falsified Medicines Directive and FDA's Drug Supply Chain Security Act (DSCSA) has improved product traceability and visibility. TPRM across the life sciences industry helps clients make a positive ethical impact, reduce regulatory risk and manage supply chains faster and more efficiently.
- **Data and interoperability:** Data integrity has improved by establishing a robust IT infrastructure and adopting FAIR standards, reliable connectivity and robust cloud-enabled data security across the DSN. Blockchain technologies provide transparency in tracking systems (through visibility of the chain of custody and chain of identified risks), especially in multi-nodal hand-offs.

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Imagine the world in 2025

Real-time, end-to-end tracking to deliver cell and gene therapies

In biopharma's hyper-connected, globally complex supply chain, companies need to respond rapidly to any event that impacts outcomes, which is particularly challenging when distributing therapies derived from living organisms. IPTherapeutics (IPT) is a leading clinical stage biotech company that develops cell and gene therapies. Through a partnership with Olaf Logistics, an AI-enabled cold chain logistics company, IPT can have end-to-end visibility across its supply chain. Olaf Logistics' advanced cold chain technology integrates a real-time tracking software from packaging and storage to transportation and distribution, ensuring the effectiveness and safety of IPT's temperature-sensitive cell and gene therapies when they reach individual patients. This advanced logistics system links patients and clinicians and the manufacturing site with complete visibility to produce therapies for individual patients. Through continuous collection and aggregation of data on temperature, conditions and packaging across all supply chain functions, IPT and Olaf Logistics are able to use AI-based predictive analytics to generate actionable data and take proactive and timely interventions when any issue arises.

Deploying digital twins to drive efficiencies and reduce costs for manufacturers

'Spear' is an optimisation and simulation engine that helps manufacturers find better ways to balance their production and inventory. In order to understand the best way to meet the demand, Spear analyses entire product portfolios and builds digital twins of production lines. It also optimises costs involved in production and storage to determine the right production frequency and optimal production pattern for each product. It also optimises inventory by defining exactly how much stock should be held in each warehouse. In the final step of the simulation, Spear models millions of possible permutations to validate findings and arrive at a new operational model. LJPharma, a large global pharma company, wanted to make its complex production processes more efficient, and contracted Spear to develop a digital twin across its five main production lines. In under a year, LJPharma realised a reduction in its working capital and additional operational savings. Spear has also shown the potential to cut manufacturers' changeover times by up to 22% and reduce inventories by up to 25%.

How AI is driving integration of planning and operations across the pharma supply chain

RST Solutions, is a decision management software company that uses an AI platform to power integrated planning and operations across pharma manufacturing companies. RST's platform provides demand forecasting, commercial and supply chain planning, and integrated business planning. It brings together graph modelling, big data analytics and advanced algorithms to provide demand forecasting and scenario planning. It also provides a digital engagement portal and easy-to-use interfaces for customers, suppliers, internal operations, on one cloud-based platform. Jamie is a data analysts who is leading a project with one of RST Solutions' key clients, PharmaKF, and is leveraging the RST platform to integrate PharmaKF's business and operational planning and model the effect of demand and supply challenges across its complex supply chain. The supply modelling identified a number of potential disruptions in the transport infrastructure and ran a number of simulations to identify workarounds. PharmaKF was able to intervene early and address the transportation problem ensuring that its products were delivered in a safe and timely manner.

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

Evidence in 2020

GSK is accelerating technology adoption in manufacturing

GSK is building a 'pharmaceutical factory of the future'. In 2016, the company used knowledge gained by other industries using Industry 4.0 technologies, to develop its own project in Stevenage, UK: the IIM Digitisation Lab. GSK built this unit to be used as a proof-of-concept facility to demonstrate what a 'data-based strategy' for manufacturing within the company might look like. To build the IIM Digitisation Lab, GSK reached out to different partners, including Siemens, which has experience on transformative technological innovations in its own industry. Siemens' role in the partnership was key to integrating data acquisition and use, as well as workflow execution, including the elimination of paper records.[91,92]

Merck KGaA uses ML to optimise demand forecasting

Merck, headquartered in Darmstadt, Germany, has embarked on a multi-year project to create a data-driven supply chain operation to optimise demand forecasting. It is using a combination of tools (SAP Integrated Business Planning, ML Statistical Forecast and home-made ML engines) to provide an Automated Demand Forecast, helping to increase efficiency across its supply chain. This Automated Demand Forecast is proving to be better than the standard judgmental forecast for 75% of the products for which a statistical forecast can be generated. A better forecast is helping to optimise the Service level production plan, and reduce costs by optimising inventory levels. The Automated Demand Forecast is also reducing the time spent on forecasting, allowing this time to be allocated to more value-added tasks.[93]

Gartner forecasts that the supply chain and manufacturing solutions market will exceed $19 billion by the end of 2021

This is driven largely by software as a service (SaaS), which will enable new revenue opportunities (estimated value $6 billion).[94]

RxAll and FarmaTrust are using AI-enabled digital solutions to fight fake medicines across the world

RxAll, a US start-up, has developed an AI-based technology to provide patients with access to authentic, high-quality drugs. Its platform combines a proprietary molecular sensor (a spectrometer) and a cloud-based DL algorithm, and uses a database of spectral signatures of drugs, to perform non-destructive verification of drugs authenticity. Its newest device, the RxScanner II, can identify the authenticity and quality of prescription drugs – in tablet, powder or liquid forms – in 20 seconds and with an accuracy of 99.9%. This technology is used by hospitals, pharmacies, biopharma and regulatory bodies around the world. Their ML system continuously learns from the spectral reads to inform pharmaceutical manufacturers about counterfeiting.[95]

FarmaTrust is a company that offers digital solutions that combine blockchain and AI tools to create a system that is immutable, secure and transparent, supporting data-driven decisions. The company's solution provides end-to-end traceability of biopharma products to safeguard the supply chain against counterfeit or substandard medicines. In addition, clients can use FarmaTrust's Consumer Confidence App for authentication of medicinal products.[96]

BlueDot Insights – infectious disease tracking

BlueDot Insights sends tailored, near real-time smart-alerts about infectious diseases with global visibility. The alerts can be used by biopharma companies to adjust their operations accordingly, and is vital for biopharma companies to optimise the manufacturing and distribution of specific drugs to affected areas.[97]

Maintaining temperature stability of biologics is a key supply chain requirement

Biologics are difficult to keep stable with temperature fluctuations and contamination affecting batch quality and yield, especially during transportation. Given that regulations require end-to-end, rigorous temperature control, cold-chain transportation technology needs to be integrated with tracking software to ensure the effectiveness and safety of therapeutics when they reach patients. By 2022, an estimated 30 of the 50 top global biopharma products will require cold chain handling and specialised, temperature-controlled logistics. Advanced, intelligent technologies that allow for real-time end-to-end visibility can enable biopharma and logistics companies to track the state of the drugs and take proactive and timely interventions when any issue arises. For example, companies like Vineti Inc and Cryoport Inc integrate IT systems, track shipments and maintain chain of custody and temperature logs in gene therapy patient cycles.[98]

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The COVID-19 impact

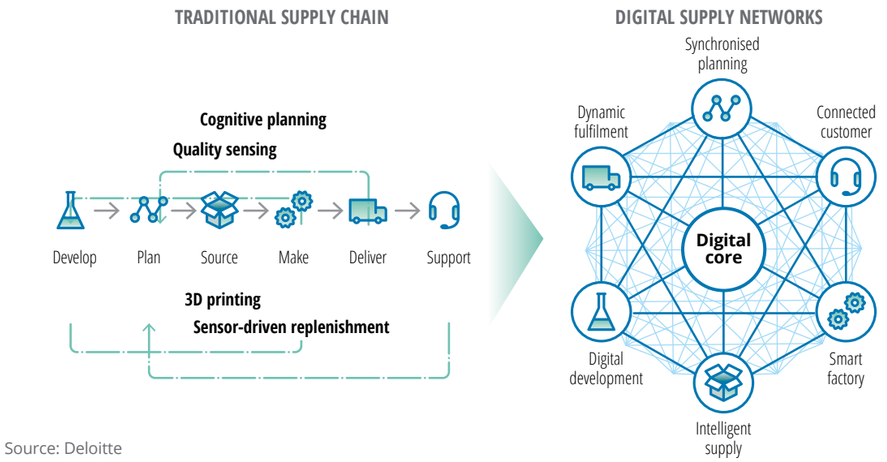
Deloitte view on the impact of COVID-19

The COVID-19 pandemic has highlighted the critical importance of an operational global biopharma supply chain, but has also exposed its vulnerability to global shocks. Companies affected most are those that rely largely on a single geography or a single supplier for key products. From the outset, countries across the world have used export bans, price caps and supply chain diversions to shore up supplies for COVID-19 patients within their own populations. Consequently, many biopharma companies are considering the location of their manufacturing facilities. Experience with COVID-19 highlights the need for companies to accelerate the digitalisation of their manufacturing and supply chain operations. Companies and governments are actively reevaluating the resilience and integrity of their sourcing strategies and considering diversifying through 'Near Sourcing', 'Localisation', and 'Moving closer to the customer'. A major challenge now is the development, manufacturing and equitable distribution of safe and effective vaccines; requiring the world's largest ever supply chain infrastructure. Manufacturers have taken a risk by standing up facilities and preparing a resilient and scalable supply chain in anticipation of regulatory approval. Functionalities such as identification of recipients (vaccine passports) and cold-chain transportation technology integrated with real-time, end-to-end tracking software, will be important in ensuring safe, equitable and efficient distribution. Governments, regulators and pharma companies will have to work together to establish trust in the vaccines.

Moderna Therapeutics has digitalisation as a core element of their business strategy

Moderna is a clinical stage biotechnology company pioneering the development of messenger RNA (mRNA) therapeutics and vaccines that have a therapeutic or preventive effect on a broad spectrum of diseases. Moderna is also a front-runner in the development of a COVID-19 vaccine. Its digitalisation strategy has six key building blocks: AI – analytics and predictive modelling; Cloud – to provide computational power, agility, cost-effectiveness and processing of data; Integration – to bring data and processes together; IoMT – based on smart, interconnected devices to improve compliance and traceability in the supply chain, control inventory, and optimise energy consumption; Automation and robotics – to increase operational accuracy, repeatability and throughput, while reducing human errors and improving quality and compliance; Analytics – to generate insights for informed decision-making. The Moderna Technology Center (MTC) manufacturing facility, designed to Current Good Manufacturing Practices specifications, has three core functions: Pre-clinical production – to develop materials for pre-toxicology studies using integrated robotics; Clinical production – to run Phase I and II clinical development programmes driven by real-time data and a fully integrated manufacturing execution system; and a Personalised cancer vaccine (PCV) unit – to ensure fast manufacturing and supply of individualised batches.[99,100]

The evolution towards the Digital Supply Network: from linear to network thinking



A DSN integrates data and information from different sources by leveraging advanced digital technologies, and enables greater product visibility, traceability and inventory control.

Source: Deloitte

Healthcare and life sciences companies have prioritised decarbonisation

Organisations are focused on being sustainable and responsible businesses

Prediction: In 2025, healthcare and life science organisations have adopted mitigation strategies to reduce their carbon footprint and improve sustainability by improving waste management and water usage, adopting renewable energy, greener procurement policies and adapting low-carbon transport delivery systems. Resilient pharma companies have implemented these and other carbon neutral solutions across their clinical development and supply chain functions. Digital transformation is improving carbon efficiency such as RPA and virtual clinical trials. Organisations prioritise suppliers that have zero-carbon landfill policies, recycle waste and water, and use sustainable materials in packaging and parts. Healthcare providers have also switched from disposable to reusable instruments wherever possible, reducing use of landfill sites and transportation costs (for example, 'near-shoring'), ultimately saving costs whilst improving sustainability. Payers are seeking evidence that suppliers are becoming carbon neutral, choosing medical supplies and equipment with low carbon footprints. Providers have reduced patient journeys through the shift to virtual models and widespread use of remote monitoring and electronic prescriptions.

The world in 2025

- Healthcare and life sciences organisations are phasing out their use of fossil fuels and have reduced their carbon footprints by switching to renewable 'green' energy. Natural gas needs are replaced by bio-gas.
- Pharma companies have adopted the principles of circularity (reduce, reuse, recycle) by developing closed-loop product life cycles and reducing the use of raw materials and associated emissions.
- Most pharma companies have amended their packaging, using 100% recyclable, reusable or compostable clear plastic packaging and certified recycled paper and pulp-based packaging.
- Healthcare organisations have increased 'out-of-hospital' care and focus on prevention and population health. Digital-first primary and outpatient care are reducing travel and protecting local communities from emissions and pollutants.
- Switching from disposable to reusable instruments wherever possible has improved hospital handling and transportation costs, reduced use of landfill sites, saving costs and improving sustainability. Healthcare procurement teams consider sustainable goals when purchasing medicines and medical equipment and prioritise companies with shared values.
- Life sciences and healthcare organisations have developed a system level set of common metrics and disclosures, including independent audits to engender confidence and trust in their progress towards sustainable environmental goals.
- New reimbursement schemes for zero emission inhalers, anaesthetic gases and 3D printed products, broaden access to affordable, quality products.

Conquered constraints

- **Skills and talent:** Life sciences and healthcare staff are upskilled to drive and implement sustainable actions across the health ecosystem. Companies whose leaders champion sustainability goals have had the most success in reducing their carbon footprint. Training on climate change, health and sustainability has been introduced across all staff training courses.
- **Funding:** Most countries have established a 'Green Bank' prioritising industry investment in infrastructure projects that deliver net zero goals, including carbon capture and storage, waste management, 'building decarbonisation' digitalisation and green transportation systems. Private investors prioritise companies that openly report their progress towards environmental sustainability goals.
- **Regulations:** Regulatory standards have been introduced on measuring and reporting carbon emissions across the health ecosystem with regulators evaluating progress on a regular basis. Organisations track their emissions and disclose their results annually. 'Eco-labelling' of products and supplies with details of their carbon footprints has also been introduced to inform consumer choice and drive industry practices.
- **Data and interoperability:** Stakeholders across the health ecosystem have developed a set of new decarbonisation targets based on agreed data-reporting standards and metrics. A new global predictive simulation model is used to forecast the impact of different carbon reduction strategies on each company's carbon footprint and the extent to which their environmental sustainability goals are being met. Sustainability indicators are audited and reported nationally against aligned industry goals of a net zero impact on climate.

The future unmasked | Predicting the future of healthcare and life sciences in 2025

Imagine the world in 2025

Smart hospital infrastructures creating 'greener' sustainable environments

In 2021, in response to a government mandate, Jupiter Hospital Trust, a new four-hospital building project, appointed Nick Weber to the board as Head of Sustainability. Nick has been working with the executive team for four years to embed climate-smart features in the design of hospital operations and real estate. Energy for the hospital buildings is obtained from an energy efficiency and conservation scheme, using clean renewable energy. The hospitals use various forms of renewable energy: solar, wind, geothermal, biomass, landfill gas and anaerobic digestion. The buildings contain water recycling plants and have extensive garden areas and bio-diverse external spaces. Nick introduced procurement policies to ensure that the hospital reduces its use of single-use plastic, and instead uses bioplastic and biodegradable packaging. The hospital has also reduced its reliance on single-use equipment, and where possible buys only mercury-free and sustainable medical devices. A key initiative by Nick in 2021 was to work with clinicians to shift all non-essential physical services to virtual healthcare models, reducing resource waste. Patients, physical products and services are now connected via cloud-based digital offerings. The hospital's food supply comes from local distributors that have zero landfill policies and the hospital's ambulance fleet consists of electric vehicles powered by rechargeable lithium batteries. Jupiter was certified as carbon neutral in April 2025.

How pharma companies have developed new strategies to minimise waste

Anna works as the Digital Strategy Lead for a forward-thinking pharma company. She has been tasked with developing a strategy to digitise workflows and audit trails to provide transparency over the sustainability of the supply chain. The company aims to achieve carbon neutrality. Anna's strategy is to implement AI-powered supply chain and manufacturing functions, with performance monitored through interconnected equipment units that continually provide data and analytics. There is also greater oversight through real-time inventory management, or monitoring of processes to prevent, reduce or recycle waste, or ensure safe disposal. A closed-loop manufacturing system is implemented to convert waste into energy and to avoid wastage of materials that can be reused or sold. Anna reports waste data on a quarterly basis, and contractors are routinely audited to ensure compliance with waste management standards. Gainsford Pharma chooses to commit to longer term relationships with a selection of critical suppliers, who in turn invest in new technology to deliver exceptionally recyclable products. The company has established metrics and targets for waste: for example, 85% of all non-hazardous waste and 70% of all hazardous waste should be reused or recycled. It has also committed to longer term relationships with a selection of critical suppliers, that have invested in technology to deliver exceptionally recyclable products. the company also use sustainable design principles and to eliminate the use of polyvinyl chloride (PVC) in packaging. Digital twins are used to predict which products can be reused and which should be disposed of, and how. Hospital procurement teams support recycling schemes by returning products or packaging to the pharma company that supplied them, for reuse in the supply chain.

Collaboration between a healthcare organisation and pharmaceutical company to reduce carbon emissions from transportation

Verde Pharma and Seacole Hospital Trust have collaborated to reduce emissions from transportation. This remodelling of logistics arrangements aims to reduce emissions by reducing distances travelled by vehicles. They use zero-emission lorries to transport pharmaceutical products and medical devices from the hospital's local distribution centre. By centralising operations they have introduced multiple-stop deliveries; and via a digital command platform, Verde Pharma and Seacole Hospital Trust track the multi-stop deliveries and monitor polluting emissions. Data analytics show how operating facilities might be relocated to reduce distances travelled. Pathways are remodelled through the use of a digital twin for the supply chain, which uses machine learning to enhance in real time the accuracy, speed and efficiency of responses to the procurement needs of the hospitals.

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

Evidence in 2020

Johnson & Johnson Consumer Health (J&JCH) Healthy Lives Mission

J&JCH is investing $800 million over the next ten years to improve the health of people and the planet. It expects to provide transparency for all the ingredients used in its brands, inform consumer choice, and to use 100% recyclable, reusable or compostable plastic packaging and certified/post-consumer recycled paper- and pulp-based packaging by 2025. Other initiatives include removing pumps from products, and making disposable wipes made from plant-based, home-compostable fibres and bottles made with at least 30% recycled material and recycled plastic in its packaging. It also aims to source and process natural ingredients in an environmentally responsible manner.[101]

US hospitals and health systems sign up to Practice Greenhealth and Global Green and Healthy Hospitals, a global network committed to sustainable operations

Across the US healthcare sector, more than 43,000 hospitals and health systems are part of a global network, Practice Greenhealth and Global Green and Healthy Hospitals that is committed to sustainable operations. Practice Greenhealth is a healthcare membership organisation that provides sustainability solutions to benefit patients, health and care workers, communities and the environment. Member hospitals aim to minimise their own environmental impact and encourage suppliers to do the same through sustainable procurement policies. Practice Greenhealth operates an annual Top 25 Environmental Excellence Awards system, and all award winners are seen as leaders in the US in addressing the links between the environment and human health. From serving less meat to reducing toxic chemicals to installing life-saving renewable energy sources, these hospitals demonstrate leadership and performance that set an example for others in the health sector to follow.[102]

Automedi device aims to make NHS supply chain more sustainable

Automedi has created an intelligent, on-site machine that makes and assembles healthcare equipment at the point-of-care. Automedi's on-site 'FabLab' combines 3D printing, a live catalogue, and a user interface with fleet support, all consumables and software and hardware upgrades into a simple managed service. The 'FabLab' device enables healthcare organisations to reduce delivery emissions, produce equipment faster and minimise equipment shortages.[103] Fleet support is available through the Automedi service, where users can access a cloud-based fleet management platform, supported by a management team that responds to calls from devices, delivers consumables and hardware upgrades, and recycles surplus material.[104] The Axelisys team plans to extend the Automedi device fleet to the entire Greater Manchester Health and Social Care network. A UK-wide alternative supply chain will be launched early in 2021.[105]

Pharma companies develop next-generation inhalers to reduce carbon emissions

Respimat®, Boehringer Ingelheim's propellant-free soft mist inhaler has carbon emissions approximately 20 times lower than that of an ipratropium pressured metered dose inhaler (pMDI). A recently-developed reusable model has the potential to reduce emissions by an additional 71%, when used with six cartridges.[106]

AstraZeneca expects the propellant used in the next generation pressurised metered-dose inhalers (pMDI) to have a GWP that is 90-99% lower than propellants used in older pMDIs.[107]

Novo Nordisk is the first global company to have assessed its performance against the Future-Fit Business Benchmark, and have the results independently assured

Novo Nordisk used the Future-Fit Progress Indicators to define real progress, identifying its strengths and weaknesses and thus the areas where improvement was needed e.g. before the assessment the company didn't know that 7% its water use is occurring in water-stressed area; now it can work with local experts to reduce the footprint.[108] Novo Nordisk has also announced targets to ensure all its direct suppliers supply the company based on 100% renewable power by 2030. Novo Nordisk will work with all existing and new suppliers to meet the target. The commitment is the next step in Novo Nordisk's 'Circular for Zero' environmental strategy.[109]

Kaiser Permanente reaches a carbon neutral health system

In September, Kaiser Permanente became the first health system in the US to achieve carbon neutrality by making its buildings more energy- efficient, investing in sustainable business practices and purchasing carbon offsets. The milestone was certified in accordance with The Carbon Neutral Protocol. The company improved energy efficiency in its buildings, installing on-site solar power and making long-term purchases of new renewable energy. In 2018, it reached a power purchase agreement to acquire enough clean energy to power 27 of its 39 hospitals. The agreement helped establish new solar and wind farms and one of the largest battery energy storage facilities in the US. The health system also targeted reductions in waste and water use, and 100% sustainable or local food consumption. Kaiser Permanente said it plans to address its supply chain in future projects aimed at reducing emissions.[110,111]

The future unmasked | Predicting the future of healthcare and life sciences in 2025

The COVID-19 impact

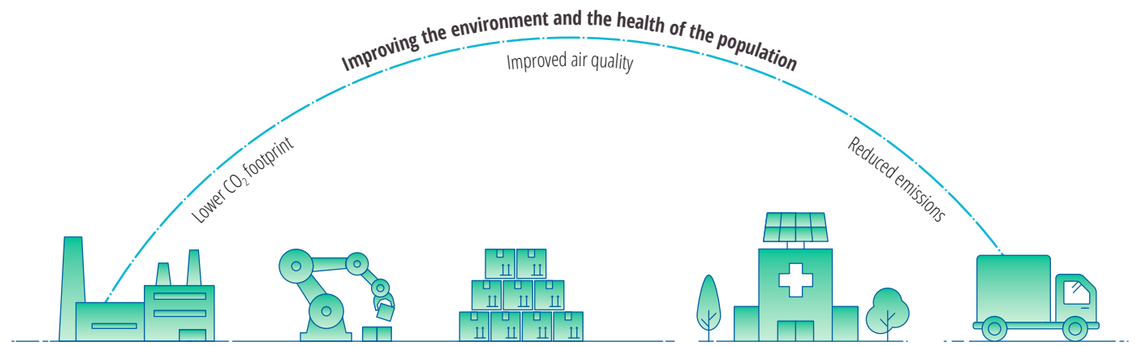
Deloitte view on the impact of COVID-19

The COVID-19 pandemic has demonstrated quite clearly the interrelationship between health and the environment. During the pandemic many healthcare and life sciences organisations have had to transform their operating models almost overnight and seen an acceleration in digitalisation across their supply chains. They have also had to adopt new ways of engaging with clinicians and patients, including virtual consultations and virtual clinical trials which, in reducing the need to travel, have the potential to deliver long-term reductions in carbon emissions. Conversely, other responses to the pandemic such as an increased need for cold-chain transportation and demand for single-use technology and personal protective equipment (PPE) could undermine decarbonisation goals. Nevertheless, health stakeholders continue to acknowledge their responsibility to take action in response to the threat to health from climate change. Moreover, although the pandemic has not changed the fundamentals of the climate crisis it has helped galvanise global action, at government and organisational level, with some healthcare systems and large global life sciences companies adopting more ambitious sustainable, decarbonisation goals.

Reducing the environmental impact of PPE in the UK

During the first wave of COVID-19, the global demand for PPE rose to unprecedented levels, putting a huge strain on supply chains. The NHS procured exceptionally large volumes of PPE to maintain service delivery and sustain high quality care. However, there were growing concerns about the environmental impact due to increases in the demand for single-use items, which are made predominately from plastics. Work is already underway in the NHS to reduce the environmental impact of PPE. A part of the UK Make initiative is for the UK to establish domestic PPE manufacturing, and to develop a resilient supply chain with high quality, innovative and environmentally-friendly products for end users. Examples of this are measures to procure made-for-reuse PPE items, including masks and gowns.[112]

Healthcare and life sciences companies are focused on being sustainable and responsible businesses



Source: Deloitte analysis

Clusters of trusted partnerships have accelerated innovation

Collaborative working has redefined traditional operating models for a more cost-effective health ecosystem

Prediction: In 2025, multiple types of trusted partnerships between industry, academia and providers, with shared views on value exchange, are a central feature of the successful health clusters that have emerged over the past five years. These clusters are backed by a creative and reputable financial services sector, supported by governments and a new regulatory paradigm, creating optimal conditions for the development of new VBHC business models, with savings delivered to the broader health system. By working collaboratively clusters have also accelerated the pace of innovation and driven the adoption of revolutionary new medicines and technology, faster than ever before. Digital transformation, enabled by new standards and radically interoperable data, advanced technology and analytics, and secure, open platforms, have driven much of this change. New standards for data sharing, analysis and transparency have emerged improving trust, driving efficiencies, expanding access and reducing costs. Clusters are also uniquely placed to draw on technological advances and play a major role in the move towards sustainable models of care.

The world in 2025

- Government support and incentives have helped concentrate innovation in clusters across health ecosystems based on a shared commitment to improve the health and wealth of local communities.
- Enhanced and new standards have encouraged life science companies of all sizes congregate in clusters of excellence, supporting faster, easier and more enduring ways of working between stakeholders.
- All stakeholders recognise the importance of investing in and nurturing a high degree of trust within and between clusters and across different types of partnerships, including with patients and the public.
- Stakeholders are focused on forming values-based, high-performance/ high-trust partnerships and have signed up to a code of ethical business practices.
- These trust-based, VBHC partnerships deliver clinical and economic value through product and service innovation, including subscription services.
- Healthcare providers work with industry to take well thought through risks and willingly accept revolutionary change.
- Academic institutions, comprising both research academics and specialisms in key areas of science, have established enduring industry collaborations.
- Product developers have formed strong R&D partnerships with leading universities and tap into patient and HCP groups to inform research, evaluate outcomes and provide continuous customer feedback on the effectiveness of products and services.
- Healthcare providers have partnered with MedTech and telecom companies to apply low latency of 5G, edge computing and IoMT in areas such as critical care on-demand and remote robotic surgery.

Conquered constraints

- **Skills and talent:** Sustainable trusted partnerships are based on shared mind-sets and ability to listen, learn and act on feedback from all stakeholders. Partner organisations have clear strategies to manage conflicts of interest between partners and leaders have the digital and technical skills needed to enable them to understand business needs and 'speak data science' to experts. Patient groups have a pivotal educational role across the health ecosystem.
- **Funding:** National and local governments have established favourable economic environments to drive investment in life sciences R&D such as 'enterprise zones' or direct investment. This includes IP, trade and tax credits, grants and other incentives that support the commercialisation of innovation. There is a systematic approach to funding based on public-private partnerships, cross-industry collaborations and venture funding, encouraging innovation at scale. New innovative contracts allow reimbursement over longer timeframes, not just budget cycles.
- **Regulations:** The use of RWD and aligned objectives have helped industry comply with regulatory legislation and respond in a coordinated and timely manner. Greater alignment of regulators at a national and international level has provided a framework to optimise commercial objectives and patient outcomes.
- **Data and interoperability:** Data provides the currency on which VBHC partnerships are designed and executed with patients willingly sharing health data as part of a value exchange. There is a consensus among partners on the use of HL7 interoperability standards and a framework to enable shared access to high-quality RWE. Open data sharing is the common 'truth' on which partnerships have been formed, and healthcare transactions are undertaken.

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Imagine the world in 2025

Medscan and IVDiagnostics driving clinical insights in oncology

Medscan and IVDiagnostics entered into a strategic ten-year partnership in January 2020 to develop and co-market digital clinical decision support solutions, with an initial focus on products that improve personalised treatment options for cancer and critical care patients. By 2025 their dashboards are bringing together data generated by IVDiagnostics tissue pathology biomarkers and next generation AI-enabled endoscopes and genomics data to aid decision-making by oncology and critical care teams. Oncology team specialists have a comprehensive data dashboard for reviewing and collaborating on precision treatment decisions for individual cancer patients at each stage of the disease. Technology-enabled support systems have increased the productivity of the multi-disciplinary teams. Additionally, within critical care, the integration of data from a patient's hospital monitoring equipment with biomarker, tissue pathology, genomic and sequencing data enables clinicians to identify complications, and even predict them before they arise.

Building trust by putting patient centricity at the heart of everything we do

In 2020, NWPharma appointed Jordan James as its Chief Patient Officer to champion patient centricity and engage with more diverse representative groups. His first action was to implement an engagement strategy with global patient advocacy groups across the company's therapy area to help improve patient involvement, trust and adherence to existing therapies and recruit more diverse clinical trial candidates. In 2021 Jordan launched a new patient-centric online platform for all patient-related information and activities across the company. He also commissioned a regular online survey of each advocacy group to collect regular feedback on the perceived culture of the company and trust in its products. Every quarter patients attend a virtual 'Town Hall' meeting to discuss how the company is responding to feedback and hear about the latest innovations including launches and progress in trials. In 2022, an innovative partnership between the advocacy groups and NWPharma with AGBT24 technologies to roll out clinical trials in patients' homes. Patients also helped design and implement new value-based contracting and pricing models, aligning payments to differentiated improvements in patient outcomes. An AI-enabled adherence tracking tool was also introduced to provide differentiated support and motivate patient adherence to medication regimens.

An innovative alliance between two life sciences and healthcare clusters building a secure cloud research platform to advance R&D into rare diseases

In the search for treatments for rare diseases, a leading healthcare cluster in Western Europe formed an 'Alliance' with another cluster in the Nordic countries, to combine their research and innovation capabilities and drive progress in the search for treatments for rare diseases. Each cluster comprises a leading university, several teaching hospitals, a Research Biobank, and National Disease Registries. The Nordic cluster received funding from a non-departmental government innovation agency, and the Western Europe cluster received government funding and additional investment from a private research consortium. The IT and digital infrastructure for the project, based on open interoperability standards, is provided by a large tech company and a leading AI for drug discovery company. The alliance has been transparent about its use of patient data and the role of each partner organisation, helping to build and maintain public trust in it. Using a secure cloud-based research platform to combine datasets, within 12 months the Alliance had achieved its first objective of moving drug candidates for two potential treatments into a Phase I trial.

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

Evidence in 2020

Medtronic and Lehigh Valley Health Network (LVHN) building an infrastructure for new VBHC programmes

Medtronic and LVHN are transforming healthcare using a VBHC model, with shared financial accountability for outcomes. Since 2018 they have pursued value-focused business models to achieve outcomes that matter to patients and lower the overall cost of care. They built a new VBHC model requiring everyone to shift their mind-set and an 'Advantaged Ecosystem™' designed to enable both organisations to: establish trust in the technology; apply well-defined rules and governance; design and deploy the programme to scale adoption and avoid staff burnout; and build a data-rich IT infrastructure to measure value and inform objective decision making. LVHN and Medtronic agreed initially to focus on reducing respiratory compromise in patients receiving opioids for pain management using a new, data-driven Enhanced Respiratory Monitoring programme. The aim is to create efficiencies and reduce healthcare costs to patients, payers, and the health system.[113]

Innovative partnerships involving Genomics England

As part of the UK's Genomics Healthcare Strategy, Genome UK was launched in September 2020, setting out plans to use genomics to drive improvements in diagnosis and personalised medicine; disease prevention; and research. Genome UK builds on existing major institutions, funding streams and infrastructure such as: the NHS Genomics Medicine Service, the Accelerating Detection of Diseases challenge and research resource provided by the UKBiobank and NIHR BioResource. Its aim is to offer a predictive, preventative and personalised health and care service for the whole population and 'make the UK the global leader in genomic healthcare'.[114]

During the COVID-19 pandemic, Genomics England has partnered with the GenOMICC consortium (Illumina, the University of Edinburgh and several NHS hospitals) to derive insights into the role of genomics in the spread of the disease and severity of symptoms. Illumina's technology is being used to sequence the genomes of 35,000 people with either mild or severe symptoms to develop an understanding of the different responses and identify treatments that have the best chance of success, and people at extreme risk if they develop COVID-19.[115,116,117]

Big tech partnerships

Google's Verily teamed up with Novartis, Otsuka, Pfizer and Sanofi to improve patient recruitment and retention, and speed-up clinical trials. Using Verily's AI-powered research tools, including wearable devices and sensors, EHRs, biometrics and patient-reported data, they plan to launch studies across multiple therapeutic areas, including cardiovascular disease, dermatology, diabetes, mental health and oncology.[118]

Comprehend Medical is an AWS Cloud NLP service that decodes and mines structured and unstructured data to extract information about medical conditions and medication regimens from clinical trial reports, doctors' notes and EHRs. It is being used by Roche Diagnostics to enable its NAVIFY Clinical Trial Match platform to extract and structure information from medical documents to match patients to independent clinical trials.[119,120]

Microsoft has entered a five-year collaboration with Novartis to explore how to combine Microsoft's advanced AI technology with Novartis' deep life sciences expertise.[121]

Vodafone is investing in new technologies and partnering with health systems

Technologies like 5G, Mobile Private Network (MPN) and Multi-access Edge Computing (MEC) are part of Vodafone's strategy to revolutionise healthcare. It has established a novel 5G clinic, providing the foundation to test new, more efficient approaches to healthcare services such as surgery rehearsal, remote access to expertise and enabling rural clinics to provide access to expert treatment without patients or clinicians needing to travel. The University Hospital Düsseldorf is the first German hospital to create a 5G campus to enable new medical procedures that have proved extremely challenging previously. Examples include 3D visualisation of brain tumours so experts from other parts of the country can work together on surgery in real time.[122,123,124]

The Corona Accelerated R&D in Europe (CARE) public-private partnership

CARE, supported by Europe's Innovative Medicines Initiative (IMI), is dedicated to discovering and developing treatment options for COVID-19 and future coronavirus threats. The CARE consortium brings together leading expertise and projects from 37 academic and non-profit research institutions and pharma companies in a comprehensive drug discovery engine. With a grant totalling €77.7 million, CARE is funded by cash contributions from the EU, 11 EFPIA companies and three IMI-Associated Partners. The consortium builds on: drug repositioning, small-molecule drug discovery and virus neutralising antibody discovery. Exscientia, an AI for drug discovery company, is leading the small molecule drug design activities and Boehringer Ingelheim the work on virus neutralizing antibodies. CARE also aims to maximise synergies and complementarities with other initiatives such as the Gates Foundation.[125, 126, 127]

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The COVID-19 impact

Deloitte view on the impact of COVID-19

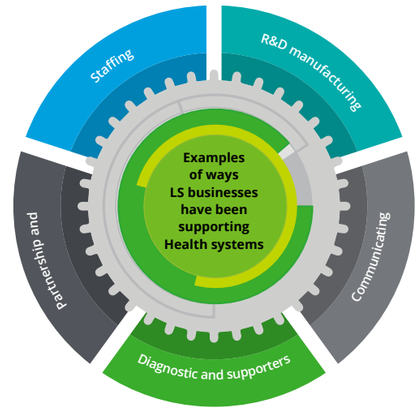
The level of national and international collaboration triggered by COVID-19 has surpassed all expectations and historical precedents. A raft of public-private partnerships between regulators governments, healthcare providers, the life science industry and tech and consumer health businesses have brought stakeholders together to tackle the pandemic, improve population health, and help economies to survive and ultimately thrive. During this extraordinary time, cross-industry collaborations quickly refocused efforts and resources to support clinical trials, test new equipment and develop new test, track and trace systems. They also developed innovative digital and virtual care solutions to enable HCPs to work differently in providing patient access to virtual healthcare services. These collaborations are also tackling challenges in the medical equipment supply chain, including the manufacture, transportation and distribution of testing kits, PPE and ventilators. There has been a previously unseen level of partnering that has led to a wave of innovations and the sharing of knowledge and IP across value chains. The unparalleled speed of development of the leading vaccine candidates and potential treatments is due largely to the level of collaboration between stakeholders, including regulators. Funding and support from government and NGOs have also been a key to this success. Importantly, established life sciences clusters were well positioned to face up to the challenge and drive global excellence.

How COVAX is building and upscaling vaccine manufacturing and supply capabilities to provide equitable access

At the start of November 2020, ten candidates had reached the last phase of clinical development prior to seeking regulatory approval. These candidates have been developed by international collaborations, some of which involve existing life science clusters such as Cambridge and Oxford in the UK. One of the most challenging tasks now facing the industry is how to get the life-saving COVID-19 vaccines to people around the world, in record time, to halt the spread of this virus. In anticipation of this challenge, in the summer of 2020, the WHO, together with Gavi, and the Coalition for Epidemic Preparedness Innovations (CEPI), launched the COVAX initiative to help build and upscale vaccine manufacturing and supply capabilities and provide countries worldwide with equitable access to two billion doses by the end of 2021. COVAX is one of three pillars of the Access to COVID-19 Tools (ACT) Accelerator, bringing together governments, global health organisations, manufacturers, scientists, private sector, civil society and philanthropy, with the aim of providing innovative and equitable access to COVID-19 diagnostics, treatments and vaccines. Importantly, the power of procurement now lies with countries that make vaccines and drugs, not just those that can afford them.[128]

How health ecosystems responded to the COVID-19 pandemic highlights the power of collaboration in healthcare

- **Provided staff** to backfill programmes where health staff have been moved
- New partnerships between **pharma and academia**, including social enterprises, to help vaccine and treatment development
- Helped the **supply chain** to manage the disruption and high demand for services and products
- Leveraged telephone lines or support programmes to support patients, or clinicians



- **Open sourced IP** to increase production, including resource diverting to make equipment and consumables
- **Pivoted their R&D capabilities** to accelerate the development of vaccines and treatments for COVID
- **Leveraged their marketing and communication** skills to support the dissemination of public health messages
- Supported **seroprevalence studies** and provided antibody screening

Conclusion

A future accelerated by COVID-19

The methodology for this report included a range of discussions and debate with colleagues across our healthcare and life sciences practices, extensive literature review and insights from clients. The report also draws on recent primary and secondary research undertaken by both our UK and US Centres for Health Solutions, as well as insights derived from our Future of Health 2040 campaign.

Our research was also undertaken at a pivotal time for the healthcare and life sciences industry. At the beginning of 2020, healthcare and life sciences companies were on a steady, albeit relatively slow, path towards digital transformation. Since March 2020, however, with the declaration of the COVID-19 pandemic, we have seen the future of digital healthcare accelerate, achieving advances in nine months that would have previously taken many years. Importantly, the pandemic has changed the mind-sets of clinicians, patients, governments and industry on the 'who', 'what' and 'where' of care delivery. We have also seen the establishment of new innovative, cross-industry collaborations and partnerships based on shared values and purpose. The disruption wrought by the pandemic has transformed the world as we know it, and neither life sciences nor healthcare organisations are likely to want to or be able to revert back to their previous ways of working.

Our 2025 predictions report focuses on the major changes we have seen in the past few years and especially the acceleration of change seen during 2020. Our ten predictions identify a world in five years' time when countries have benefited from insights derived from multiple open-data sources, and use advanced imaging and other diagnostic and telehealth technologies to deliver more precise targeted treatments.

We consider that in 2025 people will have a better understanding of how their immune system and behaviours affect their health risks and chances of ageing well. Importantly, we identify innovative examples today that allow us to predict tomorrow and the prospect of a more predictive, precise proactive and participatory health system.

Each of our ten predictions feature four sets of constraints that have been overcome, to accelerate in the pace of change and enable us to predict the world in 2025. These are:

- new skills and talent
- new funding and business models
- a new regulatory paradigm
- solutions to data interoperability, privacy and security concerns.

New skills and talent

Across all ten predictions, efficient and effective service delivery requires organisations to have access to specialist and generalist skills and talent, including digital, analytical and behavioural science skills. Deloitte's 2020 report, *'Global Human Capital Trends'*, has identified paradigm-shifting forces such as cognitive technologies and the open talent economy that will reshape the future workforce. The extent to which the healthcare and life sciences industry responds and acquires the right skills and talent will determine how well the predictions are realised. While the technology is available today to automate many of the more repetitive tasks and enable new ways of working, adoption at scale requires leaders with a digital-first mind-set and robust change management skills. Furthermore, the 'essentially human' parts of work such as empathy, communication, persuasion, problem solving, judgement and strategic decision making are more valuable than ever.

By 2025, the public's digital skills and health literacy have been improved and so has their confidence in using digital technologies to monitor and manage their health. Digital inclusion initiatives have improved equity of access to digital-first healthcare and have reduced health inequalities. Public health professionals have been upskilled enabling them to understand how best to tackle population health needs, and prepare them to respond to health threats, utilising data analytics and targeted evidence-based interventions. Employers recruit staff from more diverse educational and social backgrounds. These staff have more enriched career paths based on new ways of continuous learning, with task shifting and task reorganisation being commonplace, leading to a blended workforce that provides care where and when needed. HCP education includes an understanding of medical research and data science, as well as how to understand and communicate more effectively with patients and explain diagnoses derived from genomic, digital and AI applications.

New funding and business models

A greater proportion of healthcare funding is devoted to public health as policymakers shift the focus from sickness and cure to wellness and disease prevention. By 2025, the cost of sensors and genetic testing has decreased significantly, with individuals being prepared to invest their own money in therapies that will help them age well. Governments and the emerging longevity financial industry are major investors in 'AgeTech'. Moreover, aligned incentives and data-driven funding models are driving innovation across the health ecosystem, including flexible funding models such as 'per patient use' remunerating RPM and digital therapeutics, also social prescribing to support equality of access to digital solutions. Integrated care budgets help ensure value-based healthcare is delivered at the right time, in the right place, by the right HCPs.

In 2025, innovative contracting and value-based funding models are deployed at scale. Healthcare and life sciences companies have invested in advanced data analytics, research collaborations and AI companies to inform these models. These developments have helped deliver efficiencies and financial benefits across the whole value chain.

A new regulatory paradigm

Traditionally, life sciences and healthcare companies have adopted a risk-averse approach to regulation which has impeded the adoption of innovation at scale. The evidence today and predictions for tomorrow illustrate that while changes aimed at supporting innovation were happening across the regulatory environment, these changes have accelerated, shaped by the experience during the pandemic. In 2025, regulators are focused on balancing the need to foster innovation, protect patients and address the consequences of innovation. Governments have worked with regulators to increase their internal efficiency, enabling them to keep pace with scientific and technological advancements and accept RWE to improve the effectiveness of the regulatory process.

By 2025, regulators have adopted more common and interconnected regulatory frameworks, and established alliances among regulators. Regulatory convergence and a more collaborative approach to driving quality and transparency has improved public trust. Regulators now work with provider organisations to develop products and solutions based on a security-by-design mind-set and a trusted framework for data exchange is underpinned by robust cyber security standards. New regulatory pathways have increased flexibility, transparency and speed of approval, RPA has improved risk management, making it easier for companies to optimise their commercial objectives and deliver improved patient outcomes.

Solutions for data, interoperability, privacy and security concerns

Current data challenges include a fragmented data landscape, a lack of interoperability, and problems with data quality, data privacy, protection, and cybersecurity. Data being the 'new oil' and a source of revenue for owners is replaced by data being the 'currency of exchange' in the digital future. In 2025, we expect that data, in the words of IDC, will be "treated more like water - an essential element that is fluid across boundaries, readily accessible and cleaned for use". Moreover patients will own their own health data and decide who to share it with and for what purposes, democratising health data as part of a value exchange.

By 2025, data science and cloud technologies will have improved the security, completeness and quality of health and behavioural data with internationally agreed interoperability standards, supporting data sharing across all stakeholders. Companies have adopted HIPAA and GDPR compliant cloud, quantum computing and AI-enabled services and tools alongside FAIR data principles and protocols for the exchange and use of data. Open data sharing is the common 'truth' on which partnerships have been formed, and healthcare transactions are undertaken.

Providers have built an open multi-omics data ecosystem (underpinned by blockchain open source technology) and use distributed databases and secure transcription to address privacy and security concerns. Staff understand data provenance, curation, integration and governance, and the ethical, data privacy and security considerations with technology. Manufacturers work with providers to manage AI-ethics, data privacy and cyber security challenges.

What next

In 2025, building on their experience during the pandemic, healthcare and life sciences organisations are actively sharing data, creating stronger linkages between the public and private sectors and a resilient health ecosystem. Data has fuelled a wave of new AI-enabled, intelligent automation opportunities, with data scientists, business analysts and knowledge workers optimising the use of data and insights at speed and scale. Technologies like RPA, AI and advanced analytics and 5G, cloud and edge computing provide the scale and speed to drive the new virtual health ecosystem. Enterprises have re-architected the way they work, creating solutions that break down barriers, transform productivity and performance and insights, becoming truly intelligence-led organisations.

Data is the unifying force driving our predictions for 2025; enabling more proactive, preventative, personalised and participatory care, changing care delivery models, and revolutionising the discovery of new medical interventions, whether drugs or devices or services. Most people are digitally and health literate and more informed about their health risks and take a proactive approach to prevention and treatment. Clinicians are supported by AI-enabled clinical decision tools and are confident in using genomics and digital technologies to help them deliver hyper-personalised evidence-based prevention and treatment interventions. Public health is a priority for governments everywhere, with a higher priority given to maintaining a robust and responsive public health infrastructure. Our predictions are unashamedly positive as we believe that the future for the health ecosystem is bright, very bright.

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Abbreviations

3D printing	Three dimensional printing, also known as additive manufacturing
5G	Fifth generation cellular network
4Ps	Predictive, preventative, personalised and participatory (healthcare)
A&E	Accident and emergency
AgeTech	Ageing technology
AI	Artificial intelligence
AMR	Antimicrobial resistance
API	Application programming interface
Apps	Mobile applications
AR	Augmented reality
BAME	Black, Asian and Minority Ethnic
BI	Business intelligence
CAR-T	Chimeric antigen receptor (cell therapy)
CBT	Cognitive Behavioural Therapy
CDC	Centers for Disease Control and Prevention
CE	European Conformity
CEO	Chief executive officer
CT	Computerised Tomography
ctDNA	Circulating tumour DNA
COPD	Chronic obstructive pulmonary disease
CPD	Continuing professional developmen
CRISPR	Clustered regularly interspaced short palindromic repeats (used in gene editing therapy)
CRO	Clinical research organisation
CXR	Chest X-ray (radiograph)
DFD	Diabetic foot disease
DI-passport	Digital immunisation passport
DL	Deep learning (algorithms)
DNAm	DNA methylation
DSN	Digital Supply Network
DSCSA	Drug Supply Chain Security Act
EBITA	Earnings before interest, tax, depreciation and amortisation
ECEC	Early childhood education and care services
ECG	Electrocardiogram
eConsent	Electronic informed consent
EHR	Electronic health record
ePMA	Electronic Prescribing and Medicines Administration
ER	Emergency room
eTriage	Electronic triage
EUA	Emergency Use Authorisation
European EU	European Union
FAIR	Findability, Accessibility, Interoperability, and Reuse (of data)
FDA	US Food and Drug Administration
FHIR	Fast Healthcare Interoperability Resources (data formats and elements)
GANRL	Generative adversarial networks and reinforcement learning
GDPR	General Data Protection Regulation
GPS	Global Positioning Service
GWP	Global warming potential
HC	Health care
HCIT	Healthcare information technologies
HCP	Health care professional
HEAL	Health Equity and Access Leadership
HIMSS	Healthcare Information and Management Systems Society
HIPAA	Health Insurance Portability and Accountability Act
HL7	Health Level Seven International (healthcare standards organisation)
HTA	Health technology assessment
IOMT	Internet of Medical Things
IP	Intellectual property
I&PD	Innovation and product development
IT	Information technology
IVD	In-vitro diagnostics
IVDR	IVD Regulation
KPI	Key performance indicators
NLP	Neuro-linguistic programming
NPVP	National Plan for Vaccine Prevention
MACS	Model-Assisted Cohort Selection
MAS	Minimal access surgery
MBC	Metastatic breast cancer
MDR	Medical Device Regulations
MedTech	Medical technology
MIA	Mammography intelligent assessment
ML	Machine learning
MRI	Magnetic Resonance Imaging
mRNA	Messenger RNA
PET	Positron Emission Tomography
PHM	Population Health Management
pMDI	Pressurised Metered Dose Inhaler
PPE	Personal protective equipment
PREM	Patient-reported experience measures
PROM	Patient-reported outcome measures
PVC	Personalised cancer vaccine
Q&A	Questions and answers
qPCR	Quantitative Polymerase Chain Reaction
R&D	Research and development
RFID	Radio-frequency identification
RITA	Referral & Intelligent Triage Analytics
ROI	Return on investment
RPA	Robotic process automation
RPM	Remote patient monitoring
RWD	Real world data
RWE	Real world evidence
SaaS	Software as a service
SaaMD	Software as a medical device
SDOH	Social determinants of health
SNOMED-CT	Systematised Nomenclature of Medicine Clinical Terms
SMS	Short Message Service
SpO2	Oxygen saturation
T-cell	Thymus cell (immune cell)
TDT	Transfusiondependent β-thalassemia
TPRM	Third party risk management
VBHC	Value-based health care
VR	Virtual reality

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