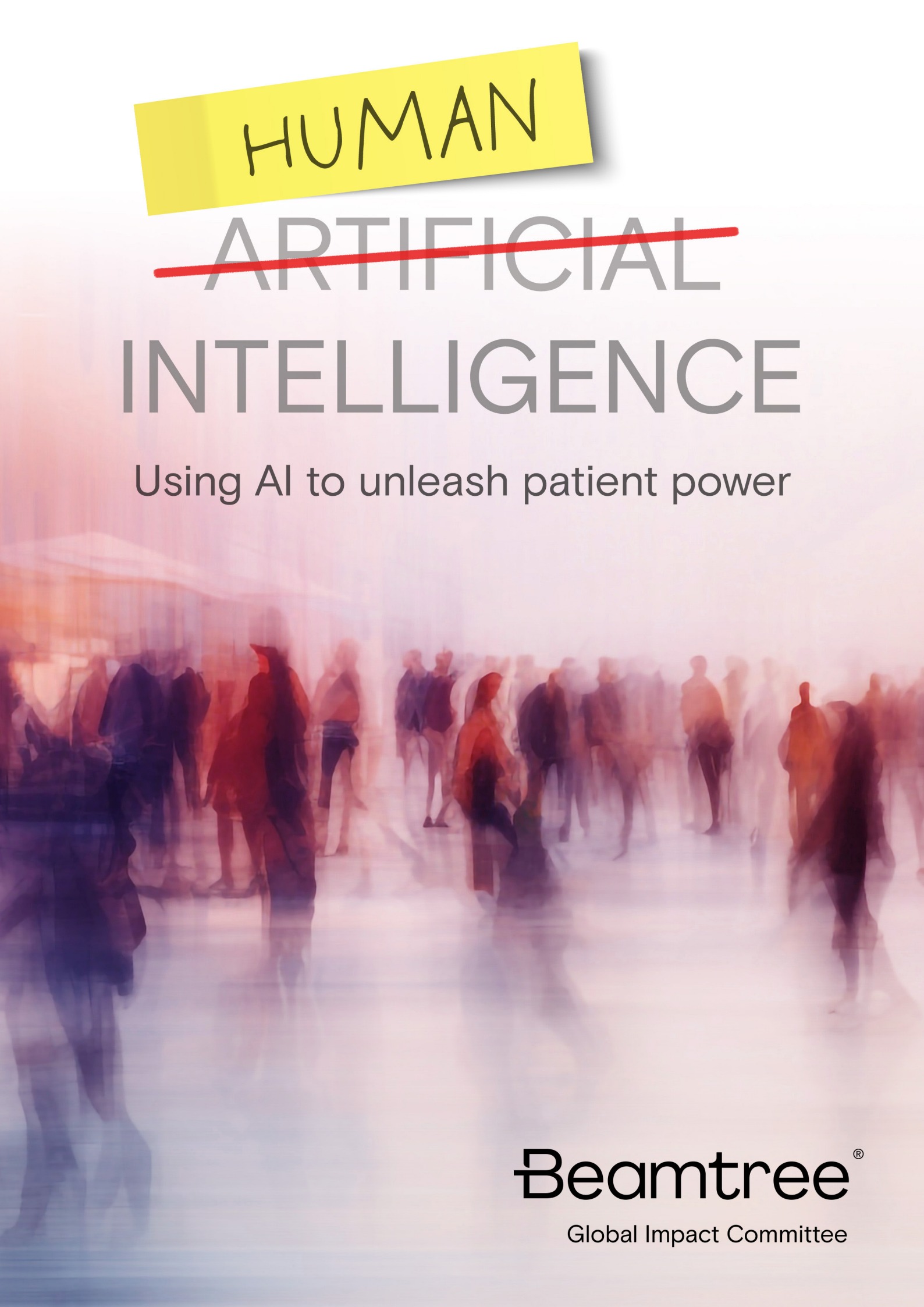
HUMAN ~~ARTIFICIAL~~ INTELLIGENCE

Using AI to unleash patient power



Beamtree®

Global Impact Committee

About Beamtree

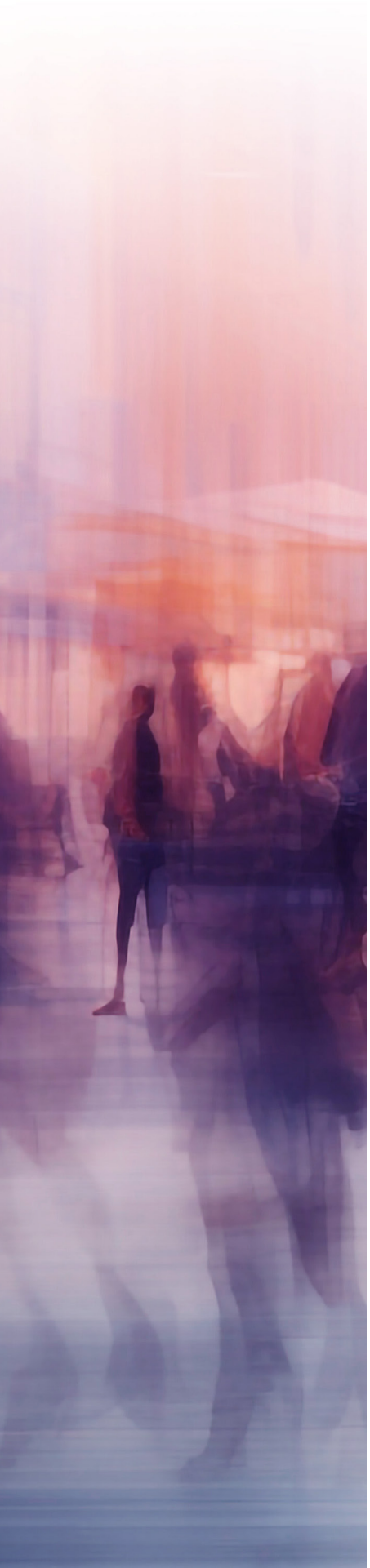
As a global AI health technology company, we empower organisations to deliver exceptional patient care. We strive to create a better future for health by turning data into insights and action through automation. Our innovative solutions and services aim to improve the delivery of care and solve real-world problems in healthcare.

About the Global Impact Committee

The Global Impact Committee provides advice on strategies and policies, promotes best practice and innovation in health data, and advances the Beamtree mission to create a better future for health. It leads thought leadership programmes to promote the priority of quality in healthcare and oversees schemes to empower global comparison of health outcomes. The Committee has previously released two reports: More Time to Care (2023) and Quality in Retreat (2022).

Disclaimer

The report is the collective view of the Global Impact Committee and not necessarily the views of organisations where members are employed or represent.



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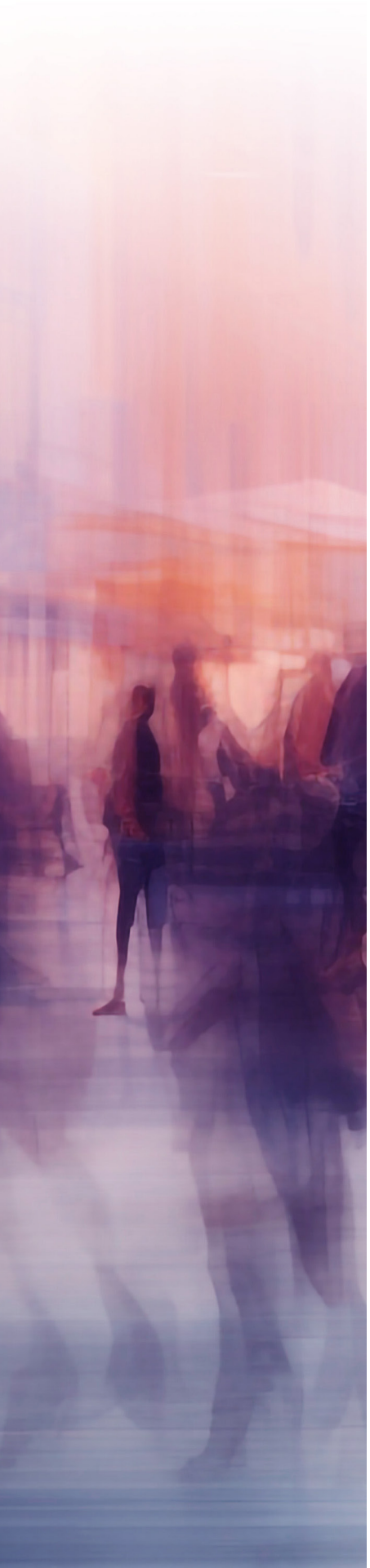

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Foreword – Professor Mark Britnell

Chair, Beamtree Global Impact Committee

Disintermediation – the reduction in intermediaries between producers and consumers – is powering ahead in every aspect of life, bringing greater quality, speed, personalisation, accessibility and efficiency to the provision of goods and services. But in healthcare it remains slothful.

This report highlights the success of healthcare organisations around the world that have found a way to develop new patient-facing digital services at speed and, critically, scale. Every country has something to be proud of when showcasing new digital capabilities, but this can be beguiling because these policy cherries often mask a failure to drive progress at scale. And scale matters if we are to sustainably deliver the Quadruple Aim of better care, better population health, better value and a better work life for healthcare staff.

In this report we illustrate how big health systems in mature and emerging economies have made the leap towards digital disintermediation. In doing so they have put more power in the hands of patients, improved access, reduced costs, enhanced the patient experience, become more transparent about their performance and saved time for hard-pressed clinicians. Their stories are impressive and empowering, particularly case studies such as Apollo in India, Clalit in Israel, Dr Sulaiman Al-Habib Medical Group (HMG) and Seha Virtual Hospital in Saudi Arabia and British Columbia, Canada.

Professor Mark Britnell with Apollo family leadership

These systems have embraced the concept of the intelligent health system or hospital. They have demystified and democratised healthcare by looking carefully at the patient process, disrupting conventional models of care and staff attitudes and leveraging their technological and digital capabilities to transform what is possible. We know there are many things that get in the way of progress – ageing infrastructure, stop-start funding, bureaucracy, education and skills – but the health systems we have identified have a powerful antidote: unswerving vision and leadership over the long term.

Developments in the East are moving at greater pace and scale. Whether it is China, South Korea, Japan, Singapore, the Middle East or India, new public/private partnerships are harnessing the best all parties have to offer. Their success flows from a steadfast commitment to alliances between industry, government, healthcare, universities and digital disruptors. Increasingly, no single agency can command and control. It requires a new leadership mindset which is more entrepreneurial than traditional healthcare management.

The Covid-19 pandemic has revealed a pernicious paradox. It forced healthcare to become more digitally savvy, yet the extra healthcare costs during the pandemic have now become fossilised in old ways of working which have lowered already modest healthcare productivity. Governments increasingly lack a credible Plan B to reverse this phenomenon. We hope this report illustrates some ways in which it can be changed.

Executive summary

- Unleashing the power of patients and citizens through digital technology is essential to ensure the long-term sustainability of healthcare systems and better outcomes for individuals and populations.
- The mature healthcare systems of Western nations risk being left behind by the ambition and digital innovation of countries such as Singapore, Saudi Arabia and India. With innovation cycles getting shorter, systems and providers who embrace innovation and change as their default will pull further ahead.
- Established healthcare systems are failing to keep pace with rising consumer expectations that digital technology will give them a better experience and greater control over their health and healthcare.
- The disruption that digital technology is bringing to healthcare offers a unique opportunity to reverse its polarity so that it is oriented around the needs of service users rather than doctors and institutions.
- Global leaders in empowering citizens and patients through technology use behavioural insights to get close to patient and professional needs, use the necessity of meeting future demand to drive innovation, are tenacious, curious and forward-thinking and are driven by competition while working in partnership.
- Healthcare's borders are breaking down, with cross-border online consultations and other forms of telemedicine testing providers, payers and regulators.
- The ideal is for healthcare systems to deliver a seamless, personalised, integrated experience across in-person and digital channels.
- Providers need to understand that, as well as patients, we are customers and coproducers. Always thinking of us as patients is anachronistic in a world where digital technology is enabling citizens to take more responsibility for their health and care.
- Artifical Intelligence (AI) will become the bedrock of population health management. Its ability to integrate and analyse vast datasets makes it perfectly suited to investigating the social, behavioural and environmental determinants of health, identifying and predicting trends and developing targeted interventions. This will usher in the era of 'precision public health'.
- The biggest impact of AI on population health may prove to be its ability to identify health problems long before symptoms become apparent.
- Large language models such as ChatGPT can make health information more personalised, understandable and actionable by explaining it in ways which match the literacy, numeracy and circumstances of the user.
- Digital access is far from universal even in the wealthiest countries.
- Building an unbiased dataset on which to train AI is hard. Steps to mitigate the risk include standardising data, actively engaging with the risk of bias, being transparent about data sources and contents, retraining the technology as knowledge changes and listening to patients and clinicians.
- Regulation needs to facilitate safe, ethical development of AI without discouraging innovation.
- Winning clinician trust is vital if AI and digital technology are to put power in the hands of service users. Neither clinicians nor the public want technology to undermine the fundamental human nature of care.

Chapter 1:

Introduction

Unleashing the power of patients and citizens through digital technology is for health what decarbonisation is for climate change – it is not an optional extra, but an essential development to enable people to stay as healthy as possible, to get the care they need and to ensure the long-term sustainability of healthcare systems through better outcomes for individuals and populations.

The power of digital healthcare is threefold: exploiting data and artificial intelligence (AI) to improve the quality, speed and cost effectiveness of diagnosis and treatment; empowering individuals to gain greater control over decisions and actions affecting their health; and combining AI with patient power to improve population health.[1]

The aims of digital health are the same as the Quadruple Aim for healthcare: improving the experience of care, improving the health of populations, reducing per capita costs and improving the work life of healthcare staff.[2] [3]

"Precision public health is one of the most exciting developments for modern healthcare. Trusted digital solutions will be the way to achieve this ambition."

Professor Andy Hardy, UK

The West risks getting left behind

Many of the most striking examples of the digital transformation of healthcare are found not in the major Western economies but in countries such as Singapore, Israel, Saudi Arabia and India. While progress in many of the more mature health systems is patchy and slow, those at the cutting-edge are putting this technology at the heart of their development.

There is a serious risk that some of the most mature systems will get left behind, held back by outdated ways of thinking and working. With innovation cycles getting shorter, systems and providers who embrace innovation and change as their default will pull further ahead.

Empowering the healthcare consumer

With rare exceptions, healthcare is paternalistic and disempowering. Despite much talk, many promises and attempts to make medical training more 'patient-focused', healthcare systems have been slow to the point of negligence when it comes to empowering the people it is there to serve. Doctors who become patients are shocked at how little agency they have in their care, and how impersonal and disempowering the experience feels.[4]

The disruption that digital technology is bringing to every part of healthcare offers a unique opportunity to reverse its polarity so that it is oriented around the needs of the service users rather than the doctor and institution. To maximise the benefits it must be used to transform many aspects of care rather than simply rebuilding old systems with a new medium. Both the disruption itself and the innovation that digital healthcare is unleashing provide the best chance to finally give individuals meaningful control over their health and care.

Chapter 1:

Introduction

Population health – the biggest win?

While much of the public excitement about technological advances in healthcare centres around gains in areas such as diagnoses from medical imaging, in the long term the biggest impact may be felt in population health. The ability of AI to integrate and analyse vast and disparate sources of data is creating the prospect of 'precision public health' – delivering precision targeted, high impact population health interventions at scale.

"The preconditions are now aligned to refocus the healthcare industry into a digitally enabled knowledge transfer business to harmonise the different needs and aspirations of patients, professionals and policymakers."

Professor Sir Bruce Keogh, UK

Defining the future

Empowerment is a process through which people gain greater control over decisions and actions affecting their health.

Digital health technologies include apps, software and online platforms intended to benefit individuals or the wider health and care system. They may be standalone or combined with products such as medical devices or diagnostic tests.[5]

Digitisation is the process of converting analogue records to digital data.[6]

Digitalisation is the integration of digital technologies into healthcare systems.[7]

Digital transformation describes the cultural shift in reorganising healthcare systems and care pathways around digital technologies to improve care quality, outcomes, productivity and value for money.[8]

Chapter 2:

Digitally empowered care in action

Across the world hospitals and healthcare systems are demonstrating the transformative power of digital technology to give service users more control, improve safety and outcomes, and improve the experience of giving and receiving care.

Apollo, India – AI powered healthcare

Empowerment, behaviour change, clinician support, telemedicine

One of the outstanding examples globally of using AI to empower patients and drive quality and productivity is the Apollo Hospitals group in India. Founded in 1983 in Chennai, Apollo is a network of 71 hospitals along with pharmacies, primary care clinics, diagnostic centres, telehealth clinics and digital healthcare services.

Apollo's approach to medical technology is long term, comprehensive and integrated. It has five key objectives:

- **Empower patients** to manage their own wellbeing and healthcare and access and interrogate their records.
- **Meet public health needs** by creating solutions which help people manage their health.
- **Support clinicians** with decision support tools, interpretation of patient data and access to comprehensive, standardised, coded patient records including images, videos, diagnostic results, prescriptions and discharge summaries.
- **Optimise healthcare productivity** by improving the speed and quality of throughput, enhancing patient safety and reducing costs.
- **Provide digital health platforms** which deliver value for patients, physicians, payers and providers.

At its core is 40 years of data from Apollo's standardised and coded records, alongside vast amounts of information from peer-reviewed journals.[9] Apollo claims it is one of the largest health data lakes in the world.

One of the most powerful parts of the system is the Clinical Intelligence Engine (CIE), a self-learning clinical decision support tool designed for medical care in South Asia, used by Apollo's 4000 doctors and available to all physicians in India for free on smartphones via the Apollo247 platform.[10] Built with Google Cloud AI and machine learning technology,[11] it uses probabilistic algorithms to form clinical diagnoses for over 1300 conditions, covering 95% of the case mix of outpatient clinics.

The CIE was set up by parsing two million records using natural language processing (NLP), text analytics and deep learning to provide around two billion data points. Uses include optimising patient throughput, developing more sensitive risk scores for cardiovascular disease, diabetes, liver fibrosis and chronic kidney diseases, generating alerts for physicians and nurses managing drug regimes, reducing hospital-acquired infections and cutting the time to diagnose and treat stroke patients.

The AI-based risk scores for cardiovascular disease are supported by integration with Fitbit exercise trackers using the Singapore-based ConnectedLife platform. After medical assessment the patient is given recommendations for action and receives nudges through their device. Regular reassessments enable the patient to understand how their lifestyle changes modify their risk. Pooling the data from more than 500,000 wearable users in eight countries allows Apollo to continually recalibrate its cardiovascular disease risk tool.

"Digital is our best way to find disease prevalence earlier than ever before in its life cycle. By spotting and preventing this early we will reduce the burden of ill health."

Dr Don Rucker, US

Chapter 2:

Digitally empowered care in action

Empowering patients with AI

As well as supporting clinicians in diagnosis, treatment, management and research, the CIE uses large language model technology to enable patients to check symptoms and interrogate their records via a chatbot, with questions and answers in non-technical language.

Apollo's ProHealth is a personalised health programme bringing together AI-driven risk analysis, doctor-curated health packages, diagnostics and personalised health and treatment plans to support people in making lifestyle shifts to prevent physical or mental ill-health.

The ProHealth app includes home sample collection and medicine delivery, virtual consultations, medical reports, self-reporting of data and symptoms, alerts for non-compliance and abnormal values and annual health screening.

Apollo is one of the pioneers of telemedicine – using electronic communications to provide healthcare remotely.[12] It provides teleconsultations, teleradiology, telecardiology, telecondition management and tele-emergency services to provide care to isolated, poorly served and remote communities. So far it has delivered more than 16 million teleconsultations.

Its AskApollo portal enables people to book appointments with generalists and specialists chosen by the patient at a location and time of their choice, book lab tests and diagnostics such as blood tests, MRI scans and personalised health checks, and book homecare such as physiotherapy, vaccinations and nursing.

Development areas include assessing the clinical value of edge devices (which process data close to where it is generated rather than sending it to a central system for analysis, such as a smart, self-adjusting bed),[13] machine learning in monitoring people at the hospital bedside or at home, and the use of generative AI in clinical and operational processes.

"We need to support people in making lifestyle shifts to prevent physical or mental ill-health. AI-driven risk analysis, doctor-curated health packages, diagnostics and personalised health and treatment plans are the way to achieve this."

Dr Sangita Reddy, India

Clalit, Israel – primary-care led and personalised

Empowerment, behaviour change, collaboration, prevention

Israel spends just 7.4% of GDP on healthcare,[14] yet has a life expectancy of around 84 years.[15] Healthcare for four million people – just over half the population – is provided by Clalit Health Services, one of four not-for-profit health maintenance organisations (HMOs) in Israel. It is one of the most progressive public health organisations in the world, using technology to empower patients and deliver internationally impressive outcomes at low cost.

It runs 1,500 primary care clinics and 14 hospitals providing roughly a third of the country's beds, alongside a network of 1,600 pharmacies, dental clinics, laboratories, diagnostic imaging, specialist centres, mental health clinics and women's health centres. Like the other healthcare providers in Israel, Clalit spends more on primary and community care than hospitals. Its app is the digital front door to its services.

Clalit's philosophy is to use personalised data analysis to help people understand their health status and risks and collaborate with healthcare staff in improving their wellbeing. The smartphone app gives each person their risks of conditions such as cardiovascular disease, shows how lifestyle improvements can change them, and connects the user with services to help them achieve the goals they have chosen.

Chapter 2:

Digitally empowered care in action

Clalit provides digital services to over 1.25 million patients monthly. Innovations include online personal health records allowing people to book clinic visits, renew prescriptions and hold telehealth consultations, notably providing paediatric medical consultations via video conferencing for out of hours emergencies. A study at Clalit evaluating the first seven years of this service including 595,000 consultation calls found the average time from referral to obtaining medical advice was 6.6 minutes.[16]

One example of how Clalit has used AI to identify and mitigate serious health risks is using algorithms to analyse CT scans already in its system to identify patients at high risk of osteoporotic fractures by calculating bone density and identifying vertebral compression fractures.[17]

Working with Israeli start-up TytoCare,[18] Clalit is developing technology to conduct medical examinations and telehealth services remotely through a compact handheld device, which will allow patients to perform their own basic examinations under remote guidance such as checking temperature, ears, throat, lungs and heart. It offers huge potential for freeing up clinic space and time and speeding up access.[19]

Science-driven behaviour change

Key to Clalit's approach is exploiting the power of behavioural science and data modelling.[20] The aim is to identify the unique needs of each patient and offer personalised interventions that result in significant, sustainable improvements in patient engagement, adherence to medical advice and clinical outcomes.

By analysing large datasets on patients' behaviour, such as what food they buy, doctor visits and search queries, Clalit identifies patterns and trends in patients' behaviour and creates insights into the appropriate health-seeking response.

But it recognises that AI-driven advice, no matter how sophisticated and tailored, is not enough. It has identified a big gap between what the technology recommends and what patients do. To try to narrow this gap, each intervention is informed by behavioural analysis to decide what is most likely to promote the desired actions by each individual, such as adhering to medical guidance, exercising, taking medication and attending appointments.

Seha Virtual Hospital, Saudi Arabia – remote care

Access, equity

Countries across the globe struggle to provide adequate care to remote communities. The Seha Virtual Hospital in Saudi Arabia is a radical solution.

Seha opened in the Riyadh in 2022 and serves a network of 130 hospitals. It is the largest virtual medical facility in the world,[21] and has no physical patients. The aim is to provide patients in remote areas with specialist care previously only available in the capital. Using video, telemedicine and other digital technologies, local doctors can share data such as scans and test results with specialists at Seha, discuss complex cases and have patients monitored remotely. Services include emergency and critical care. The virtual hospital also reaches into people's homes to monitor heart disease.

Seha employs more than 150 doctors and can support more than 480,000 patients annually. Specialist clinics include psychiatry, kidney disease, endocrinology and diabetes, genetic and metabolic diseases, geriatric diseases, medical rehabilitation and heart disease. AI is used to analyse medical images in cases such as strokes, while augmented reality supports local surgeons.[22]

"Let's not be shy to point out the impact on quality and outcomes that digitalisation and AI have had and can have."

Tony O'Brien, Ireland

Chapter 2:

Digitally empowered care in action

HMG, Saudi Arabia – world-leading, real time digital care

Access, equity

Dr Sulaiman Al Habib Medical Group (HMG) is one of the largest private healthcare providers in the Middle East, managing 22 medical facilities in Saudi Arabia, the United Arab Emirates and Bahrain, with more being built.

HMG operates the largest medical command centre in the world, for 800 ITU beds across its hospitals in Saudi Arabia and abroad, supported by digital monitoring of vital signs, AI powered clinical decision support and command centre technology which optimises care, medical capabilities, patient flow and capacity in real time.

This brings the medical and technological expertise of one of the most advanced hospitals in the world to communities and clinical staff across three countries. It improves the speed and quality of critical care, widens patient access and develops the skills of staff in other hospitals.

"As well as patients, we are rapidly becoming customers and coproducers. Always thinking of us as patients is anachronistic in a world where digital technology is enabling citizens to take more responsibility for their health and care."

Jim Birch, Australia

University Hospitals Coventry and Warwickshire NHS Trust, England – virtual wards

Empowerment, remote care

The UK is the biggest user of 'virtual wards', also known as hospital at home. University Hospitals Coventry and Warwickshire NHS Trust tested the approach with people who had been discharged from hospital with COPD, before expanding to other chronic conditions.[23]

Virtual patients are managed by a dedicated team, and additional care prompted by information from the remote monitoring equipment is provided in the patient's home unless a readmission to hospital is unavoidable. Younger patients use mobile phones to enter their data, most patients get iPads, and those with sight or dexterity limitations have a larger piece of kit known as a care portal. Other equipment includes blood pressure monitors, scales, thermometers and pulse oximeters. Point of care blood testing is being added. Patients are trained to use the kit and can call on support. Each day patients are asked disease-specific questions such as whether their legs are swollen.

The response among the first patients was overwhelmingly positive. They liked the idea that they could take more ownership of managing their condition while knowing they had support if they needed it.

The virtual ward team worked with specialties such as the acute respiratory service to redesign care pathways to encompass the virtual ward model, while training the hospital's existing community services team. The scheme now has 40 'beds' running at 90% occupancy, and this will be expanded to 65 beds.

The rate of readmission to hospital is 5% and to date the mortality rate is zero. In a four-week period in late 2023 the scheme saved the hospital 876 bed days. Some patients, such as those with complex infections which need monitoring, have been spared weeks in hospital, with obvious benefits for their physical and mental health and their ability to continue living independently.

Chapter 2:

Digitally empowered care in action

Singapore – value-based healthcare

Engagement, empowerment, transparency

Combining empowered citizens with digital technology fits squarely into the concept of value-based healthcare, where providers are paid on health outcomes rather than activity or a capitation fee. This rewards them for helping patients improve their health, reducing the incidence and impact of chronic illness and cutting readmission rates.[24]

One of the biggest exponents of value-based healthcare is Singapore, which initiated a programme in 2017 to improve outcomes and reduce the rate of cost growth in SingHealth, projected to average 6.3% a year.[25] This approach seeks to promote patient engagement and empowerment, encouraging people to take an active role in managing their own health, participate in decision-making and access resources to achieve better outcomes.[26]

The Singapore system is underpinned by performance benchmarking, allowing long-term comparisons between institutions, teams and clinicians to identify improvement opportunities and close performance gaps. This only works if there is close collaboration between clinicians and managers to help clinicians navigate the data and plan and implement improvements.[27] It also depends on value being measured right across the system, which encourages investment in primary care and community services. A push to improve the level of GP registrations is one result.

The initial focus was on 17 high volume, high cost conditions such as total hip replacement, spinal fusion, breast cancer and congestive heart failure. Areas for improvement identified included optimising patients' length of stay and standardising clinical protocols.[28]

Digital transformation has been at the heart of the Singapore approach, such as updating regulations to support telemedicine in people's homes and government support for research and innovation.[29] It uses digital technology such as wearables and connected devices such as biosensors to provide real-time monitoring of functions such as heart rate and body temperature to improve operational efficiency and the patient experience.[30]

British Columbia, Canada – empowerment through digital services

Empowerment, access, equity

The Canadian province of British Columbia (BC) has been expanding its digital health services to empower patients to be active participants in their health journey. This is coordinated by the Provincial Health Services Authority (PHSA), a publicly funded health services provider that works collaboratively with partners across the BC healthcare system.

This development has been strongly influenced by lessons learned during the Covid-19 pandemic. One important lesson has been that virtual care can improve healthcare equity, in terms of both socio-economic position and geography across this vast province. This aligns with the overall goal of delivering a digitally enabled health system trusted by all who use it.

BC's Health Gateway enables people to securely access their personal health information, including by smartphone app. The Remote Patient Monitoring programme provides virtual monitoring for patients with chronic conditions, enabling them to receive care at home. This has the potential to improve the care of people living in rural and remote communities including many Indigenous Peoples and marginalised communities.

A legacy of colonialism is that Indigenous Peoples in Canada experience socio-economic, political, geographic and health disadvantages. They are also underrepresented in the healthcare workforce. The First Nations Virtual Doctor of the Day service enables First Nations people living in BC to make virtual appointments that are culturally safe. This brings services closer to home for First Nations people with limited or no access to primary care services. The service employs doctors of Indigenous ancestry and all healthcare professionals are trained to follow the principles and practices of cultural safety and humility.

Chapter 2:

Digitally empowered care in action

BC's youth can now access virtual mental health services through the Foundry BC app, managed by BC's Providence Health Care. Those aged 12-24 and their caregivers have access to same-day virtual services or can schedule a virtual counselling appointment, find peer support, access primary care and get help with employment, groups and workshops. The service helps young people struggling with issues such as body image, eating disorders, substance misuse, self-harm, violence and abuse, bullying and depression. Young people were heavily involved in designing the service.

Digital services are also playing a major role in strengthening the province's vaccination programme. The development and implementation of ImmsBC, a provincial solution for managing Covid-19 vaccine distribution and administration. ImmsBC functionality includes registration, appointment booking, notifications, clinic operations, vaccine inventory and reporting.

Australia – My Health Record

Transparency, empowerment

My Health Record is a national, integrated electronic record accessible by patients and healthcare staff containing information such as health conditions, medication, treatment summaries, test results and discharge notes, entries by patients and advance care planning – sometimes called a 'living will'.[31] [32]

Although people can opt out of the system, more than 90% of Australians – over 23 million people – have a My Health Record.[33] According to the Australian Digital Health Agency more than a quarter of a million people who had opted out reregistered as the Covid-19 pandemic drove renewed interest.[34] It integrates with the healthdirect app, which provides self-help tools, a symptom checker and access to healthcare services.[35]

The challenge is to extend use. While almost all GPs, pharmacies and public hospitals are connected to the system, use among specialists is patchy, many documents are not uploaded and emergency department staff are not routinely checking the record when patients arrive. [36] [37]

"Digital literacy enablement means the individual, healthy or sick, can cocreate with health systems to secure modern, value-based care."

Dr Reem Al Bunyan, Kingdom of Saudi Arabia

The federal government has now put My Health Record at the centre of a modernisation plan for primary care. The functionality will be improved, allied health professionals will be included, more information will be uploaded and there will be better integration with clinical software systems.[38]

What makes these organisations trailblazers?

These success stories show how the power of digital can be exploited to empower citizens and patients through disintermediation. Obstacles are removed to bring consumers and producers – or patients and professionals – closer together to improve the speed, access, quality and cost of services. It is notable that many come from the East. Key themes among the reasons for success include:

1. Systems are built at scale, using behavioural insights to meet patient and professional needs. The systems have a clear vision and are driven by stable leadership teams that are in it for the long term. In the case of Apollo in India, for example, they set five clear and unswerving goals – empower patients, support clinicians, optimise productivity, build digital platforms and meet community and public health needs.
2. They adopt the latest technologies to get closer to the patient and professional. They develop large language models and natural language processing and combine this with behavioural insights from patients and professionals to make it easier for new technology to be adopted and spread – and they spread quickly once early adoption has been tested. In the case of Clalit in Israel, their technology and algorithms are routinely used across its 1,500 primary care clinics.

Chapter 2:

Digitally empowered care in action

3. They use the necessity of meeting future demand to drive innovation. In Saudi Arabia the Seha Virtual Hospital was an inspired response to a chronic national shortage of radiologists which has had an impact right across the kingdom by thinking beyond traditional models of care. Similarly, HMG has established the largest virtual intensive care network in the world, all supported by a central command centre, to improve access to highly specialist care.
4. All the systems illustrated are tenacious, curious and forward-thinking. They do not allow themselves to be circumscribed by how things were done in the past or who did them. They start with the patients and design systems that intuitively meet their needs. In some cases, they have fewer regulatory or historical burdens, but it would be wrong to think they are unfettered.
5. They are driven by competition while working in partnership. Exploiting digital technologies such as AI is impossible without partnerships. From cloud computing to developing large language models, no healthcare organisation can do this alone. Much of the inspiration for these new approaches to healthcare comes from the interaction between imaginative healthcare professionals and gifted technologists. Competition is also a key driving force, whether it's the desire to be a leading performer in a state-led system such as the NHS, or ambitious providers growing at pace in countries such as India.

Defining the future

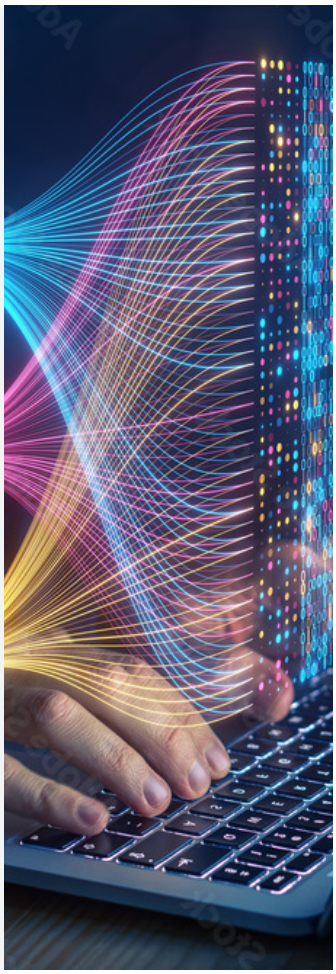
Artificial intelligence (AI) is a computer program with logic and rules that performs cognitive tasks usually associated with human minds, such as perceiving, reasoning, learning, interacting with an environment, problem solving and being creative.[39]

Machine learning (ML) is a branch of AI which imitates the way that humans learn and adapt, gradually improving accuracy without being explicitly programmed by using algorithms and statistical models to analyse patterns in data and draw inferences.[40] [41] [42]

Foundation models are large-scale machine learning models that are trained on a broad range of data at immense scale and can be adapted for a wide variety of tasks, such as medical imaging analysis, predicting the likelihood of diseases based on factors such as a patient's history and genetics, recommending treatments and predicting adverse drug interactions.[43]

Neural networks are a type of AI inspired by the structure and function of the human brain. They are computational models designed to recognise patterns and solve complex problems by simulating the way biological neurons interact.[44]

Large language models (LLMs) are a type of foundation model designed to understand, generate and work with human language. These models are large both in terms of the size of the neural network (often consisting of billions or even trillions of parameters) and the amount of data they are trained on. They are part of the broader family of machine learning models known as deep learning, designed to work with data that has complex, hierarchical structures like human language. [45]



Chapter 3:

Why healthcare systems need to act now

The consumer technology revolution is changing the world

Years after industries such as retail and travel exploited digital technology to slash costs while improving and personalising the consumer experience – such as with self-scanning checkouts and online flight check-in – healthcare is finally beginning to change. The risk for established and state-run healthcare systems is that they fail to keep pace with rising consumer expectations that digital technology will give them a better experience and greater control over their health and healthcare.

This challenge comes as a healthcare borders are starting to be eroded. The five Nordic countries are pursuing an ambitious, digitally-driven plan to integrate their health systems, with a strong focus on self-management, while the European Union (EU) is working towards cross-border continuity of care through its MyHealth@EU initiative.[46] [47] The medical tourism market is expected to grow to over $43 billion by 2030 at a compound annual growth rate (CAGR) of 33%, while cross-border online consultations and other forms of telemedicine are testing providers, payers and regulators.[48]

The development of apps, wearables and 'nearables' illustrates how consumer technology is transforming healthcare – they can already measure sleep quality, heart rate, skin discolouration, eye discolouration, blood pressure, blood oxygenation, breathing rate, glucose level, cadence, balance, body temperature, voice quality and behavioural changes.[49]

But the barriers to developing consumer-facing healthcare technology are considerable, with the need to ensure the quality and safety of care, protect patient privacy, comply with regulations, integrate different technology platforms and connect them to legacy systems.[50] Research by Deloitte found:[51]

- Health systems are increasingly using consumer tech to help people manage their health and wellbeing, shifting away from a treatment-based approach. But healthcare providers are still a long way from being digitally driven.
- Many health systems are failing to meet consumers' needs beyond the basics of booking appointments and checking symptoms. For example, the integration of technology such as fitness trackers and wearables to promote good health is low, and services such as helping people adhere to care plans are underpowered.
- Health systems know they need to realign business models, reskill their workforce and improve workflows to meet consumer needs, but they are struggling to do it. Problems include fragmented ownership of digital initiatives and the difficulties of attracting staff with the right skills.

"The paradigm is shifting. More and more, patients see themselves as the consumer of the healthcare organisation treating them. Systems and providers who understand this will pull further ahead."

Associate Professor Cheng Ooi Low, Singapore

Channel shift and omnichannel health

The ideal would be to provide an omnichannel service, whereby people can interact in person, on the phone, the web, email, app, chatbots, social media, remote devices (such as wearables and monitoring equipment) and instant messaging in a seamless experience. The key point of omnichannel – as opposed to multichannel – is that moving from one channel to another is seamless, removing all barriers between the virtual and in-person customer journey.[52]

But omnichannel choice requires omnichannel costs, such as staffing and infrastructure. Companies focus on channel shift rather than omnichannel to reduce costs, such as by moving people from face-to-face to chatbots. Since healthcare systems need to ensure people are not digitally excluded, the logical approach is to encourage shifts to more timely and cost-effective channels, such as video consultations and patient-initiated follow-ups, while ensuring everyone has access.

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The backbone of omnichannel is the decision support system. This analyses customer data from all channels to identify patterns and trends, enabling the healthcare provider to make faster and better decisions around, for example, how to engage with a particular customer, how to customise and target information and interactions and where to allocate resources.[53]

Delivering omnichannel requires the integration of everything from cloud computing and big data analytics to mobile technology. It means substantial investment in infrastructure, the redesign of clinical pathways, retraining of clinical and nonclinical staff, expansion of the technology and data workforce and a regulatory environment which permits the flow of data. But it is the future of healthcare.

Patients, consumers and coproducers

Health systems need to challenge paternalistic attitudes to service users by thinking of them as customers, consumers and partners, not simply patients. Consumers have choice, agency and rights. The term 'patient' is anachronistic in a world where digital technology is enabling citizens to have lifelong engagement with services which help them sustain their mental and physical wellbeing rather than just use healthcare when they are sick, and to share decisions and increasingly manage their own conditions.

Thinking of us as consumers encourages learning from consumer technology and markets which increasingly expect a seamless, personalised and responsive service across multiple channels built on a deep understanding of each person's wants and needs. Coproduction takes this a stage further by people actively participating in their healthcare, collaborating with healthcare professionals in making decisions and managing their health and care.

Getting hung up on the terminology is missing the point. Sometimes we will simply be patients, when we need clinicians to take decisions quickly or use information which we cannot adequately understand. At other times we will be consumers and coproducers. What matters is that the healthcare system itself understands our different needs at different times and gives us the space to have those needs met in the most appropriate way.

A renowned example of culturally sensitive healthcare demonstrates the power of the consumer and coproduction approach. The Nuka System of Care has been provided for around 30 years by the Southcentral Foundation in Anchorage, Alaska, and driven by the Alaska Native people.[54] It is infused with the culture of this region, which recognises that disease and its treatment has social, psychological and cultural components as well medical.[55]

The patient is treated as a customer and owner of their care system. Treatment is founded on long-term relationships with teams that understand each person's values, goals, priorities and strengths and provides an integrated approach to the mind, body and spirit alongside a commitment to measurement and quality. Since its inception, Nuka has secured a 50% reduction in emergency room and urgent care visits, striking results for illness prevention and screening and a cultural respect rating of 99.2%.[56]

Sharing information

Several countries are developing systems to share patients' entire health record with them. Similar to Australia's My Health Record, Sweden's Patient Accessible Electronic Health Record (PAEHR) allows citizens to access their complete medical record, built around a unique patient identifier.[57] A national survey found 84% of citizens agreed or strongly agreed that communication with medical staff had improved. However, only 31% said the content was discussed with care professionals,[58] showing how sharing information alone is insufficient to secure patient empowerment.

"The two components to make this a reality are data and trust. The examples in this report highlight successful systems who have created the conditions to make this happen."

Roger Taylor, UK

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Why healthcare systems need to act now

The whole experience

Digital transformation and patient empowerment need to be understood in the context of the totality of the healthcare experience. For example, the HIMSS (Healthcare Information and Management Systems Society) AsiaPac conference in 2023 heard about a hospital in China which clerks a patient electronically before they come to the hospital, identifies them as they enter the premises, has personalised information ready for them when they arrive at reception, helps them navigate the building to their destination and has automated ward admission and discharge.

Some hospitals are attempting to replicate the technology of the most advanced cruise ships, where everything from an unresolved customer complaint to a technical problem in the kitchens is managed in real time on a single integrated system, giving operation managers near complete oversight and the ability to quickly and effectively direct resources to resolve disruption.

"The long-term sustainability of our healthcare systems is facing its biggest threat. These new approaches to patient centric care will ensure their survival."

Thomas Jackiewicz, US

It is the way to improve population health

AI will become the bedrock of population health management. Its ability to integrate and analyse vast datasets and mimic human communication makes it perfectly suited to investigating the social, behavioural and environmental determinants of health, identifying and predicting trends and making targeted public health interventions.

It could transform disease surveillance, population and individual health interventions, health promotion and the allocation of health resources. Since population health measures can impact the health and care of millions, this field could prove to be where digital health and AI have the greatest impact.

Precision public health

As well as the vast array of formal health data, AI can exploit the rich insights from social media, search engines, apps, wearable tech, censuses and environmental data such as air and water quality to enable population health interventions to be targeted towards the right people and places at the right time, with important implications for resource allocation and the returns on investment in public health.[59] [60] The term "precision public health" has been coined to articulate the seismic impact AI will have.[61]

One example of how powerful AI will become as a public health tool is work by the Ministry of Health in Malaysia to predict and control infectious diseases. Having digitised its health records, it mapped health burdens and disease outbreaks by applying machine learning to identify correlations among numerous variables and complex datasets including weather patterns, wind speeds and roof angles, and natural language processing of news reports and social media posts. The department can predict the location and timing of the next dengue fever outbreak three months in advance, while further machine learning algorithms enable it to decide which control interventions will be most effective and to plan when and where to roll them out.[62]

AI-driven population health interventions could play a key role in helping countries manage healthcare costs by identifying the risks of groups and individuals to specific diseases, such as chronic, lifestyle-related illnesses. A study by the National Institutes of Health in the US found that AI chatbot technology – GPT-3 – could be used to predict the risk of developing type 2 diabetes with an accuracy of up to 90%.[63] It collected and analysed data from patient records such as age, sex, and lifestyle as well as data from social media such as dietary habits and physical activity.

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Why healthcare systems need to act now

"We need to stimulate clinician adoption to make this a reality. Often the hurdles relate to a lack of training and creating the right conditions for change."

Dr Anuschka Coovadia, South Africa

A Canadian study applied machine learning to the health records of 1.85 million Ontario residents aged between 65 and 74 years old to see if it could predict the risk of hospitalisation in the coming year that could be avoided through outpatient intervention. The model demonstrated a high accuracy, and showed up factors such as the increased risks from living in a rural area.[64] This study highlights how risk predictions can be used to allocate health resources.

In mental health, AI is being used to understand the influence of social networks on people's wellbeing. One project has applied this to understanding suicides among US military personnel on active duty. The hope is that prevention programmes could be designed to act upon the social networks around the personnel.[65]

Social media offers the opportunity for personalised health interventions on a massive scale. Facebook uses AI to identify posts that express suicidal thoughts and provide tailored support.[66]

While it is impossible to estimate the potential impact of digital health promotion on population health with any precision, a 2017 study by IQVIA estimated that the adoption of digital health promotion in just five patient populations, such as people with diabetes or asthma, would save the US healthcare system $7 billion a year, around 1.4% of the total for these populations.[67]

In the long run, the biggest impact of AI on population health may prove to be its ability to identify health problems long before symptoms become apparent. For example, it may be able to identify a cholesterol plaque forming in a coronary artery years before it will cause a heart attack. Difficult to identify conditions such as metabolic syndrome, a group of health problems that increase the risk of heart disease and type 2 diabetes, could become much easier to identify early and treat.

It can help deliver health equity

The use of digital technology during the Covid-19 pandemic, particularly for education and healthcare, showed that digital technology has the power both to narrow inequality gaps and widen them.

Using digital technology to improve access to health, particularly for deprived, isolated or remote communities, can improve outcomes and benefit individuals and communities economically. In 2017 community health provider Silver Chain showed how far this can be taken by launching the world's first holographic doctor to serve rural and remote communities in Western Australia. Using technology known as EMMR – enhanced medical mixed reality – patients could see healthcare professionals sitting in Perth projected into their home via a HoloLens headset.[68]

Equitable information

Personalisation doesn't just refer to sending personal information, but doing so in a format which works for that individual, such as reading age or cultural context. There is a big difference between having information and understanding it, let alone acting on it. An observational study in England concluded that 61% of the adult working age population lacked the literacy and numeracy needed to understand commonly used health information materials – so-called poor health literacy. This result mirrored findings in other industrialised countries.[69] Those at greater risk of poor health because of sociodemographic factors have a higher risk of struggling to understand what they are being told.

This shows that ensuring people have the skills or tools to interpret health information is a vital part of empowerment. It is a big issue – being unable to understand or contextualise information from clinicians can add to the stress of ill health and feel disempowering, belittling and humiliating.

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Why healthcare systems need to act now

"Public expectations of their healthcare providers are changing rapidly. Established healthcare systems will get left behind if they don't recognise and embrace this."

Janet Davidson, Canada

Large language models such as ChatGPT can help make health information more personalised, understandable and actionable,[70] by explaining health terms and data and what it means in ways which matches the literacy, numeracy and circumstances of the user. Large language models are a part of generative AI, programs which can produce text, images, audio and video. This raises the prospect of delivering health information in different formats, such as an animation or audio.[71]

Digital access is still a barrier

Even in wealthy societies internet access is far from universal. In England, about 3% of the population do not have any internet access and 8-10% do not own a smartphone.[72] Across the UK around 15% of the population lack even the most basic digital skills, and about 22% are classified as having low digital engagement.[73] In 2022, 2.4% of the EU's 450 million citizens could not afford an internet connection.[74] Smartphone penetration is around 82% in Germany and 81% in France.[75]

Groups at high risk of being digitally excluded include people over 75 years old, people in more deprived groups and communities and people with disabilities – many of the people who have most need and most to gain from empowerment.[76]

But the pandemic had a profound impact on digital engagement with healthcare, with the public routinely using virtual consultations and apps monitoring Covid-19 infections and providing proof of vaccination status. In 2018 users of NHS websites and apps in the UK peaked at 13 million in a month. In March 2021 monthly users had doubled to 26 million, getting towards half the population.[77]

Millions of people engage with fitness apps. In 2020 Fitbit was being used by 3.2 million people a month in the UK, alongside 2.2 million for the Apple Health app and 1.2 million for the Strava app popular with runners.[78]

Trust and motivation

An Australian study in 2021 indicates the willingness of people to interact with health digitally. Numbers are high, although even during the pandemic there was a lot of resistance.[79] Over 80% were willing to share their health data and 70% were ready to use virtual health, which can be defined as sharing data and content and performing personalised interactions remotely.[80] Around 56% were willing to use mobile applications, wearable tech and other personal medical devices to manage their health. [81]

But 29% were not aware of digital technology for monitoring and supporting health and 19% were unwilling to use technology for health.[82] People with a university education or higher were five times more willing to use digital health technology compared with people with a high school education or lower.

The survey also highlighted a theme seen in other countries – 51% were unwilling to share even anonymised health information with private sector health businesses.

Even if people have the access and skills, they may still lack the motivation to use digital healthcare options. Reasons can include not seeing clear benefits, concerns over security of their data and concern about the clinical effectiveness and reliability of digital options.[83]

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Lack of belief in the effectiveness of apps is exacerbated by the vast number of poorly evidenced ones being promoted, notably in fields such as mental wellbeing and weight management. It can be hard for people to distinguish the small number of rigorously tested and evidenced apps from official bodies and reputable providers.

A UK survey highlighted different levels of acceptance for different technologies. Those that empowered people to manage their health and connect them to NHS services and information were more popular than technology such as chatbots or care robots which were seen to come between clinicians and patients.[84] Women and those most likely to be on low incomes were significantly less positive about the use of health technology than men and those more likely to be on higher incomes.

Another UK survey showed it is unwise to make assumptions about attitudes to technology based on age. While 79% overall said they would be happy to use technology to manage their health if it was recommended by the NHS, this increased to 89% of over 75s.[85]

Defining the future

Generative AI focuses on generating new content or data that is similar to the data it was trained on. This can include text, images, music, videos and interactive experiences. 'Generative' refers to the ability to create, rather than just analyse. Many of the most powerful and versatile generative AI systems are built on, or closely related to, the concept of foundation models.[86]

Natural language processing (NLP) enables computers to understand, interpret and generate human language. This involves understanding syntax (the arrangement of words), semantics (their meaning), and pragmatics (how context influences meaning).[87]

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Winning clinicians' trust

How AI will change the workforce

With growing demand for healthcare staff globally, automation will change the nature of the work rather than reduce the need for staff. The McKinsey Global Institute estimates that activities that consume 35% of healthcare staff time could be automated. Working on a more modest scenario that 15% of current work hours will be automated by 2030, McKinsey thinks this would effect, for example, 29% of pharmacy technicians' time, alongside 23% for pharmacists, medical records technicians and health information technicians, 21% for radiation therapists, 13% for MRI technologists, 12% for GPs, 11% for obstetricians and gynaecologists, 8% for nurse practitioners, 7% for surgeons and 4% for psychiatrists.[88]

"The quality of the data is critical to meet these ambitions. While we have data bias and incomplete data this won't work – until we get this spot on, we're not going to leverage it fully."

Professor Keith McNeil, Australia

Clinician attitudes towards digital technology

Clinician buy-in to using AI tools to augment their skills and reshape their relationship with service users is clearly vital. Clinicians are broadly positive about technological advances but are wary of changes that undermine the personal relationship with patients or are used to cut staff costs.

A worldwide survey of doctors and nurses in 2023 on the "clinician of the future" found 73% believed it would be desirable for physicians to be expert in the use of digital health technology, alongside 71% for nurses.[89] Around 55% believed it would be desirable for telehealth to be the main route for routine check-ups and 51% thought it would be desirable for medical students to use AI powered tools such as ChatGPT during their education. Just under half – 48% – wanted physicians to be using AI tools such as ChatGPT to make clinical decisions, while 28% described this as undesirable.

The survey revealed that 7% of doctors and 16% of nurses were already using AI tools to support clinical decisions, with the Asia Pacific region notably higher than Europe and North America.

It also exposed fears that AI could be used without medical oversight and to cut costs, and reinforced the message that clinicians do not want technological advances to undermine the relationship with the patient – digital health should enhance human care, not replace it. Maintaining the humanity of care is one of the key concerns clinicians express as they consider their digital future, arguing that personal interaction allows health professionals to ensure care is compassionate and reflects what matters to each patient.[90]

This matches the views of patients, who want to make better use of health technology, but not at the expense of face-to-face contact with clinicians.[91]

Building clinicians' trust and confidence in AI

Clinician trust in AI-driven technologies will be increased through robust and transparent governance, high ethical standards, effective evaluation before implementation and rigorous and open monitoring once in use.[92]

While trust is generally regarded as a binary choice, confidence is more nuanced. Clinicians will need to determine appropriate confidence in AI-derived information depending on the technology, clinical context and other information sources.[93] They will need to understand how to use AI tools appropriately, how to apply their own judgement and how to navigate the risk of excessive dependence.

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"There are information asymmetry issues between patients, providers and producers. We need patient powered digital interventions to narrow this imbalance."

Martin Bowles, Australia

Involving clinicians at every stage, including design, development, testing, validation, implementation, training and monitoring, will go a long way to securing acceptability, and help ensure the technology works and is usable by busy staff under pressure.

Inevitably, regulators of clinical professions will have to grapple with who will be held to account if AI leads to patient harm. It could be the clinician, the organisation, the regulator or the developer. High-profile test cases could have a big impact on clinicians' willingness to embrace this technology.

Training will be vital, not just in the specifics of a particular piece of technology but in the principles underpinning AI, so clinicians have at least a basic understanding of how it works and an appreciation of concepts such as large language models and how they could transform many tasks.

Encouraging clinicians' entrepreneurial talents

Healthcare organisations need to be more ambitious in promoting the entrepreneurial talents of clinicians commercialising their own digital health innovations, such as by supporting start-ups and monetising their intellectual property. The Sheba Medical Center, Israel's biggest hospital and ranked one of the best in the world,[94] has a portfolio of tech start-ups worth $2 billion, several set up by doctors who get to keep 35% of the profits.[95]

Tackling the danger of biased data

AI medical devices are only as good as the data on which they are trained. Quality can be undermined by incomplete or biased datasets which lead to missed or erroneous diagnoses. Simply being a large dataset is not enough – it needs to reflect the population for which the technology will be used.

Building an unbiased dataset is hard. Far from being a theoretical or marginal problem, there are countless cases of biased datasets leading to AI tools delivering poor outcomes. Dermatological tools largely trained on images of light skin tones are a well-known example.[96] There is a serious bias towards people of European descent in genome data.[97] Training AI on health records could build bias into an algorithm if there is unequal access to healthcare, such as in the US, where Black, Hispanic and some Asian populations have lower levels of insurance coverage.[98]

Steps that should be taken to ensure good quality data include:

- Standardised data – definitions and clinical codes need to be rigorously implemented across all the data. This is an essential first step in building a viable dataset. The accuracy of clinical coding has a direct relationship with care quality, hospital funding, benchmarking and clinical decision-making (see the appendix on Beamtree's RISQ tool for ensuring the accurate reporting of harmful incidents).
- Active engagement with the risk of bias – developers need to demonstrate they grasp the issue of bias, have considered it in the selection and use of training data and have taken reasonable steps to address it.
- Transparency – datasets need to be clearly labelled so there is transparency around their source and contents. This should include where the data has come from and essential details such as the sex, age and ethnicity breakdown.
- Define fairness – fair outcomes from the use of the data should be defined and tested.

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- Mitigation – steps should be taken to mitigate biases or risks of biases inherent in the data. This is not straightforward. For example, trying to 'balance' a dataset by excluding some records can introduce new problems.
- Retraining – like humans, AI tools need to be retrained as more data becomes available and disease patterns and knowledge change.
- Analyse feedback from clinicians and patients – the people using the tool and receiving the treatment are ideally placed to identify risks and shortcomings in the AI model.

"This report clearly shows the possibilities that digital empowerment will bring to health and care systems globally. As healthcare leaders we need a united call to action to make this a reality."

Professor Christine Bennett, Australia

Building trust by developing AI ethically

AI use in healthcare is already widespread, far beyond formal, tested systems such as imaging analysis. As the global survey of doctors and nurses showed, a significant proportion are already using tools such as ChatGPT in their work, and many will be doing so informally and without guidelines or oversight. Researchers will be using it for writing papers for medical journals. Doctors will be writing discharge summaries with it. So the question is how to use it appropriately and with what standards, boundaries and protocols, not whether it should be used.

The stakes are high. With few clinicians, let alone members of the public, having at least a basic grasp of how AI tools such as large language models work and how they are applied, both could lose confidence in their use, safety and ethics. This in turn could lead to even greater public concern about the potential misuse of their medical data.

One ethical framework for building trust in the use of generative AI in healthcare consists of:[99]

- Accountability – establishing frameworks for the ethical release and use of generative AI applications. This needs to include educating users on the capabilities and risks of the technology and responsibilities and sensitivities in using it.
- Fairness – put in place measures to mitigate biases in the model.
- Data privacy and selection – establishing legal and ethical rules for selecting and managing training data, including data ownership and consent.
- Transparency – AI generated content needs to be clearly identified.
- Explainability – users should be able to validate the correctness and soundness of the AI's work. This is a complex and emerging field.
- Aligning value and purpose – the AI system needs to follow the values and purpose of its human creators and users.

"This agenda will only succeed if we listen to the perspective of professionals and understand how doctors and clinicians can participate in this endeavour. Otherwise, we will still remain in the ideal world and not tackle resistance to change."

Professor Walter Ricciardi, Italy

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Every healthcare institution and system should be debating these issues and establishing governance and ethics frameworks to manage them transparently and publicly. Service users and the public need to be an integral part of that endeavour.

It would be easy to assume that, as AI progresses, systems will become ever more massive, complex and opaque. But this will not necessarily be the case. A new approach to developing generative AI aims to improve usability and performance for evidence-based knowledge such as healthcare. The idea is to design smaller models and train them on smaller datasets rather than simply assuming that ever more data will inevitably improve outcomes.[100] Examples are Google's Med-PaLM and Microsoft's BioGPT. This could offer significant advantages in data quality and transparency, and being able to explain how the model works and is tested.

Making cyber security a priority

Healthcare organisations have become major targets for cyber criminals. In the US alone there were around 500 attacks on healthcare organisations in 2023, with the average breach potentially exposing the records of 200,000 people – a total of around 100 million.[101]

Healthcare is a lucrative and soft target. Medical records are seen as valuable, the records need to be widely accessible, obsolete systems and the huge array of connected devices provide easy entry points, the need for remote access is a vulnerability and many staff do not have the skills to identify and mitigate online threats.[102]

All this makes cyber security one of the biggest threats to patient safety and public trust in digital health technology. Managing these risks requires focus, investment and innovation.

Having a balanced approach to AI regulation

Regulation needs to navigate the conflict between ensuring safe and ethical development of AI without stifling innovation. It needs to be a collaboration between governments, industry, researchers and healthcare practitioners. The rules need to be adaptable to new developments and should take a risk-based approach, focusing on the biggest risks such as privacy breaches, bias and unethical development.

Clinicians, patients and regulators will want maximum transparency in AI development, which will be resisted by researchers and companies wanting to protect their intellectual property. Lines of accountability will be contested – if there is a medical error, who is at fault?

Regulators need to be wary of moving too early, stifling innovation by clamping down on a theoretical risk which has yet to be understood. One way they can encourage innovation is using techniques such as sandboxing, where new technologies can be tested in controlled environments.

Regulation needs to be proportionate and realistic, balancing the dangers of using AI in a given situation against the dangers of not using it, rather than aiming for perfection. Risk aversion among Western politicians and regulators could become a barrier to innovation.

Constant engagement with the public, clinicians and healthcare leaders will be key to building trust and being able to have open discussions about the inevitable problems.

"The key to making this work is stimulating partnerships between the public and private sectors but also between innovators and larger companies. Get the partnership model to work and we will get the right technology to patients."

Anne McElvoy, UK

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What needs to happen

Making it happen

Empowering patients through the power of digital technology and AI will require a concerted effort by governments, researchers, health systems, providers, clinicians, managers and the private sector.

Governments and system leaders need to champion controlled disruption. Governments need to establish innovation clusters bringing together academia, health systems and the private sector, while health system leaders need to support the faster adoption and spread of proven, high impact innovations which put power in the hands of patients and citizens.

The knowledge and insight of patients and the public need to be harnessed to drive innovations that make a difference and address issues such as inequalities and bias.

Regulators need to be far more agile, championing high impact innovations and establishing processes which facilitate good ideas coming to market in good time. Simultaneously they need to ensure that industry and healthcare systems work within a clear and transparent ethical framework which has public confidence.

Investment in robust, secure, high capacity digital infrastructure is essential, while on the human side, faster cycles of training and retraining will be vital as innovation cycles get shorter.

Clinicians need to be closely involved in every stage of AI development, from concept to rollout.

Above all, development must build and maintain the trust of the public and keep the interests of citizens at the centre.

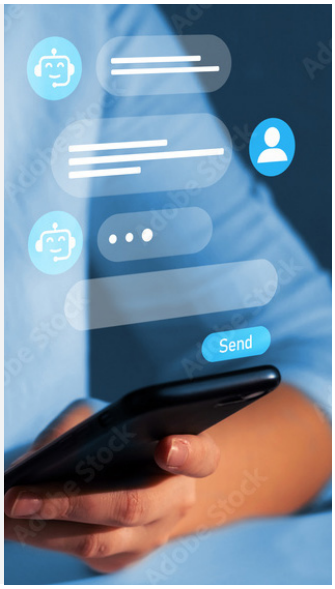
Defining the future

Chatbots are software applications designed to simulate conversation with human users. Simple ones may just be rules-based decision trees, while the most sophisticated generate coherent conversation using LLM technology.[103]

Telemedicine is the use of electronic communications to provide healthcare remotely, such as consultations and remote monitoring.[104]

Telehealth is a broader term than telemedicine, also encompassing nonclinical services such as medical training and public health information.

Augmented reality superimposes a computer-generated image on a user's view of the real world to produce a composite view. One application is to overlay the body of a patient in surgery with images from medical scans, greatly enhancing the surgeon's ability to navigate delicate procedures such as tumour resections.[105]



Conclusion – Tim Kelsey

CEO, Beamtree

The endless potential of digital technology and AI to transform the relationship between healthcare and service users is both an extraordinary opportunity and a threat to healthcare systems.

It offers a unique chance to put power in the hands of individuals and create the conditions for a lifelong digital connection with health and wellness, rather than simply engaging with healthcare services when we fall sick. It gives us the power to understand and manage our own risks and, when we need care, to be active partners in managing our treatment and long-term needs.

But the mature health systems of the West risk being left behind by growing consumer expectations of seamless integration of physical and digital services and health providers in countries such as Singapore, Saudi Arabia, India and Israel who are already putting AI-driven patient empowerment at the heart of their services.

All health systems have a lot to do in building the trust of the public and clinicians in the safety, privacy and efficacy of digital health. Developments need to be transparent and accountable, built on accurate, standardised, coded, unbiased data overseen with robust and publicly accountable oversight. It must be built on the principle of participation, with service users able to access, interrogate and use data. Finally it must be collaborative, giving us all agency in working with healthcare professionals to shape how we engage with health and care services and the decisions which affect our lives.

What comes through in the case studies we have examined is the paramount role of leadership. Healthcare CEOs and other senior leaders need to put technology at the heart of everything they do. They need to build a culture of designing systems and care pathways around patients rather than the needs of staff and institutions. They need to build partnerships with government, digital disruptors and the private sector and encourage the entrepreneurial spirit in their clinical staff.

Particularly in Western healthcare, system leaders and politicians need to embrace the disruption of digital technology and the opportunity it offers for transforming our relationship with health and healthcare. This is the best chance we will have to reverse the growing burden of chronic disease which is leaving huge swathes of our populations enduring decades of ill-health, while threatening the sustainability of the services on which we all depend.

Tim Kelsey
CEO, Beamtree

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Dr Don Rucker, US
Physician leader with national clinical informatics success

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Appendix

Reducing preventable harm using Beamtree's RISQ tool for clinicians and coders

The best hospitals deliver high quality care and improve outcomes by reducing preventable harm. A priority for many organisations is the clinical governance for Hospital Acquired Complications (HACs). The Australian Commission on Safety and Quality in Health Care defines a HAC as a patient complication for which clinical risk mitigation strategies may reduce (but not necessarily eliminate) the risk of that complication occurring.

If the coded data underpinning HACs is unreliable, clinicians will not trust what it is telling them, so organisations need to foster collaboration between clinical coders and clinicians to ensure the HAC data accurately reflects the true incidence of HACs.

To enable this to happen, Beamtree has developed a cloud-based HAC management platform called RISQ (Relative Indicators for Safety and Quality). Used across public and private hospitals, RISQ is a reporting, benchmarking and management tool to improve the accuracy of HAC data. It analyses hospital data to provide reliable HAC rates, confirmed by clinicians and coders and benchmarked against industry best practice.

RISQ supports hospitals in achieving sustainable reductions in HACs (>16%) by embedding improved practices for clinicians and coders and facilitating a collaborative, multidisciplinary approach underpinned by high quality, trusted HAC data.

RISQ reviews coded episodes to assess the incidence of HACs and the underlying data quality, providing a method of measuring and comparing the safety and quality of performance for reporting, benchmarking and clinical service improvement. RISQ drills down into hospitals, specialties and clinicians. Users can identify areas for action and set targets, allowing improvements to be monitored over time.

A key feature is the coder and clinician workflow, which has enhanced collaboration between coders and clinicians by facilitating a seamless way to share and validate the reportable HAC.

RISQ at work – St Vincent's Health, Australia

St Vincent's Health Australia (SVHA) set a target in 2019-20 to reduce HACs by 10%. In the private hospitals' division there were two components to achieving the reduction target. The coded HAC data and the processes for HAC data management were reviewed, then clinical working groups were convened to identify the three top HACs (identified by a mix of high rates, outliers, harm caused and clinical documentation and coding issues) and implement improvements to clinical care and processes. The working groups focussed on a review of clinical practices, improved compliance with standards and clinical documentation.

Key to reducing the HACs was implementing the RISQ portal, to support coding accuracy and provide a seamless way to communicate with the clinical teams. All coded HACs are validated by the coders within 24 hours using the coding workflow tool. RISQ provides real time identification of HACs, reviews coding quality and provides comprehensive reporting and benchmarking.

The results were:

- 16% reduction in the HAC rate in 2019/20, well ahead of target.
- Significant reductions were seen in the 3 priority HAC areas: 70% reduction in pressure injuries, 21% reduction in surgical site infections and 22% reduction in VTE.

Appendix

RISQ at work – improving the quality and reliability of coded HAC data at Uniting Care

Uniting Care operates one of the largest not for profit private hospital groups in Queensland. A priority for the health information services teams was to improve the accuracy of coded HACs and to work more collaboratively with the quality and safety teams by having trusted HAC data, which is now reported publicly by Queensland Health via the Inform My Care portal.

Preventing HACs is the most effective strategy, but it depends on HAC data being of the highest quality to maintain confidence in the data as a single source of truth. If the coding of HACs does not accurately reflect incidence rates, mistrust in the data can build and clinical governance programs focus on querying the data rather than preventing HACs.

Uniting Care partnered with Beamtree in implementing RISQ. This has led to greater trust in coded data by clinicians, a reduction in HACs and greater collaboration between coders and clinicians.

Uniting has reported a 28% reduction in HACs since the introduction of RISQ, with HAC rates reducing in all four hospitals. This is due to improvements in clinical documentation, enhanced clinical coders knowledge of HACs through ongoing coder education, a dedicated HAC auditor and enhanced collaboration with the quality and safety teams on definitions and clinical service tools and improvements. HAC data is now a trusted source of information.

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References

1 World Health Organization (1998). Health promotion glossary.
iris.who.int/bitstream/handle/10665/64546/WHO_HPR_HEP_98.1.pdf

2 Berwick, D, et al (May 2008). The Triple Aim: care, health and cost. Health Affairs.
www.healthaffairs.org/doi/abs/10.1377/hlthaff.27.3.759

3 Bodenheimer, T, and C Sinsky (November 2014). From Triple to Quadruple Aim: care of the patient requires care of the provider. Annals of Family Medicine.
www.ncbi.nlm.nih.gov/pmc/articles/PMC4226781/

4 Klitzman, R (2007). When doctors become patients. Oxford University Press.
www.ncbi.nlm.nih.gov/pmc/articles/PMC2336889/

5 NICE (March 2019). Evidence standards framework for digital health technologies: user guide.
www.nice.org.uk/Media/Default/About/what-we-do/our-programmes/evidence-standards-framework/user-guide.pdf

6 Sanchez, T (26 November 2021). Defining digital public health and the role of digitization, digitalization, and digital transformation: scoping review. JMIR Public Health and Surveillance.
www.ncbi.nlm.nih.gov/pmc/articles/PMC8665390/

7 Sanchez, T (26 November 2021). Defining digital public health and the role of digitization, digitalization, and digital transformation: scoping review. JMIR Public Health and Surveillance.
www.ncbi.nlm.nih.gov/pmc/articles/PMC8665390/

8 Sanchez, T (26 November 2021). Defining digital public health and the role of digitization, digitalization, and digital transformation: scoping review. JMIR Public Health and Surveillance.
www.ncbi.nlm.nih.gov/pmc/articles/PMC8665390/

9 PRnewswire.com (7 February 2023). Apollo Hospitals rolls out Clinical Intelligence Engine (CIE) for doctors across India.
www.prnewswire.com/in/news-releases/apollo-hospitals-rolls-out-clinical-intelligence-engine-cie-for-doctors-across-india-301740454.html

10 Apollo247.com (accessed 15 October 2023).
www.apollo247.com

11 Rudra, T (19 December 2022). Google helping Apollo Hospitals build a clinical intelligence platform with its AI tech. INC42.
inc42.com/buzz/google-building-a-clinical-intelligence-platform-in-collaboration-with-apollo-hospitals/

12 Field, M (ed) (1996). Telemedicine: a guide to assessing telecommunications in health care. National Academies Press.
www.ncbi.nlm.nih.gov/books/NBK45440/

13 HP (accessed 15 October 2023). What is an edge device?
www.hpe.com/us/en/what-is/edge-device.html

14 OECD (accessed 8 March 2024). Health at a glance 2023 country note – Israel.
www.oecd.org/israel/health-at-a-glance-Israel-EN.pdf

15 Macrotrends (accessed 8 March 2024). Israel life expectancy 1950-2024.
www.macrotrends.net/global-metrics/countries/ISR/israel/life-expectancy

16 Waisman Y (2016). Telemedicine in pediatric emergency care: an overview and description of a novel service in Israel. Journal of Intensive and Critical Care.
www.primescholars.com/articles/telemedicine-in-pediatric-emergency-care-an-overview-and-description-of-a-novel-service-in-israel-96697.html

17 PR Newswire (21 January 2020). New study published on Nature Medicine unveils the power of AI in predicting osteoporotic fractures
www.prnewswire.com/il/news-releases/new-study-published-on-nature-medicine-unveils-the-power-of-ai-in-predicting-osteoporotic-fractures-300990287.html

18 No Camels (25 February 2018). TytoCare Partners With Israel's Clalit Health Service Organization.
nocamels.com/2018/02/tytocare-israel-clalit-health/

19 Britnell, M (2019). Human: solving the global workforce crisis in healthcare. Blackwell's.
blackwells.co.uk/bookshop/product/Human-by-Mark-Britnell/9780198836520

20 Clalit Innovation (accessed 15 October 2023). AI & behavioural insights.
www.clalit-innovation.org/aibehavioral

21 Khashogji, Z (28 February 2022). Saudi Arabia launches first virtual hospital. Arabic News.
www.arabnews.com/node/2033356/saudi-arabia

22 Health Tech Newspaper (7 July 2023). A look at the Kingdom of Saudi Arabia's Seha virtual hospital – a vision for the future?
htn.co.uk/2023/07/07/a-look-at-the-kingdom-of-saudi-arabias-seha-virtual-hospital-a-vision-for-the-future/

23 Interview with Jodie Storrow, clinical operations manager, integrated care, University Hospitals Coventry and Warwickshire NHS Trust, 7 December 2023.

24 NEJM Catalyst (1 January 2017). What is value-based healthcare?
catalyst.nejm.org/doi/full/10.1056/CAT.17.0558

25 Singapore Biodesign (2022). Value-based healthcare and health economics research in healthcare financing.
www.a-star.edu.sg/docs/librariesprovider38/default-document-library/case-studies/case-study---value-based-healthcare-and-health-economics-research-in-healthcare-financing.pdf

26 AIA (accessed 4 January 2024). Driving quality of care through value-based healthcare (VBC).
www.aia.com.sg/en/health-wellness/healthcare-services/vbc

27 Lim, EK (2022). Value-based healthcare: implementation in Singhealth. Journal of Patient Safety and Healthcare Quality.
hqss.org/journal/jpshq-issue/jpshq2022v01n02c02/

28 SingHealth (7 July 2020). Partnering up to drive value.
www.singhealth.com.sg/news/tomorrows-medicine/partnering-up-to-drive-value

29 Global Compliance News (accessed 4 January 2024). Singapore: the Ministry of Health launches healthcare industry transformation map 2025.
www.globalcompliancenews.com/2023/09/03/https-insightplus-bakermckenzie-com-bm-healthcare-life-sciences-singapore-ministry-of-health-launches-healthcare-industry-transformation-map-2025_08302023/

30 Perdana, A and I Mokhtar (18 May 2022). Leverage in digital technologies for information technology-enabled healthcare transformation at SingHealth. Journal of Information Technology Teaching Cases.
journals.sagepub.com/doi/10.1177/20438869221091582

31 Health Direct (accessed 2 January 2024). About My Health Record.
www.healthdirect.gov.au/my-health-record

32 Prictor, M (2 March 2023). My Health Record is meant to empower patients – but with little useful information stored, is it worth saving? The Conversation.
theconversation.com/my-health-record-is-meant-to-empower-patients-but-with-little-useful-information-stored-is-it-worth-saving-199508

33 Prictor, M (2 March 2023). My Health Record is meant to empower patients – but with little useful information stored, is it worth saving? The Conversation.
theconversation.com/my-health-record-is-meant-to-empower-patients-but-with-little-useful-information-stored-is-it-worth-saving-199508

34 Karp, P (2 February 2023). An improved My Health Record will be at centre or push to modernise the primary healthcare. Guardian.
www.theguardian.com/australia-news/2023/feb/03/an-improved-my-health-record-will-be-at-centre-of-push-to-modernise-primary-healthcare

35 Australian Digital Health Agency (accessed 4 March 2024). My Healthcare Record.
www.digitalhealth.gov.au/initiatives-and-programs/my-health-record/manage-your-record/view-my-health-record-using-an-app

36 Prictor, M (2 March 2023). My Health Record is meant to empower patients – but with little useful information stored, is it worth saving? The Conversation.
theconversation.com/my-health-record-is-meant-to-empower-patients-but-with-little-useful-information-stored-is-it-worth-saving-199508

37 Mullins, A, et al (5 July 2022). The effect of My Health Record use in the emergency department on clinician-assessed patient care: results of a survey. BMC Medical Informatics and Decision Making.
bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-022-01920-8

38 Karp, P (2 February 2023). An improved My Health Record will be at centre or push to modernise the primary healthcare. Guardian.
www.theguardian.com/australia-news/2023/feb/03/an-improved-my-health-record-will-be-at-centre-of-push-to-modernise-primary-healthcare

39 McKinsey & Co (24 April 2023). What is AI?
www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-ai

40 Brown S (21 April 2021). Machine learning, explained. MIT Management.
mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained

41 Oxford English Dictionary

42 IBM (accessed 4 March 2024). What is machine learning?
www.ibm.com/topics/machine-learning

43 Information provided by ChatGPT4, accessed 4 January 2024.

44 Information provided by ChatGPT4, accessed 4 January 2024.

45 Information provided by ChatGPT4, accessed 4 January 2024.

46 Lears, S (15 June 2022). The world's first cross-border digital health accreditation system to be launched at HIMMS [sic] Europe. NorDec.
norddec.org/2022/06/15/the-worlds-first-cross-border-digital-health-accreditation-system-to-be-launched-at-himms-europe/

47 European Commission (accessed 7 March 2024). Electronic cross-border health services.
health.ec.europa.eu/ehealth-digital-health-and-care/electronic-cross-border-health-services_en

48 Collingwood, J (1 August 2022). Using telehealth for cross-border care. ITIJ.
www.itij.com/latest/long-read/using-telehealth-cross-border-care

49 Flutter, C, et al (8 June 2023). Digital health in Australia and New Zealand: what's next? Boston Consulting Group.
www.bcg.com/publications/2023/australia-and-new-zealand-digital-health-strategy

50 Tomlin, T, et al (20 June 2023). Why it's time for a digital, direct-to-consumer health care revolution. EY.
www.ey.com/en_gl/alliances/why-its-time-for-a-digital-direct-to-consumer-health-care-revolution

51 Appleby, C, et al (11 April 2023). Integrating digital tools to help improve the whole consumer experience. Deloitte.
www2.deloitte.com/uk/en/insights/industry/health-care/digital-health-always-on-care.html

52 Moreira, A, et al (3 April 2023). An overview of omnichannel interaction in health care services. Mayo Clinic Proceedings: Digital Health.
www.mcpdigitalhealth.org/article/S2949-7612(23)00016-0/fulltext

53 Moreira, A, et al (3 April 2023). An overview of omnichannel interaction in health care services. Mayo Clinic Proceedings: Digital Health.
www.mcpdigitalhealth.org/article/S2949-7612(23)00016-0/fulltext

54 King's Fund (accessed 4 October 2023). Nuka system of care, Alaska.
www.kingsfund.org.uk/publications/population-health-systems/nuka-system-care-alaska

55 Britnell, M (2019). Human: solving the global workforce crisis in healthcare. Blackwell's.
blackwells.co.uk/bookshop/product/Human-by-Mark-Britnell/9780198836520

56 Gottlieb, K (5 August 2013). The Nuka System of Care: improving health through ownership and relationships. International Journal of Circumpolar Health.
www.ncbi.nlm.nih.gov/pmc/articles/PMC3752290/

57 Open Notes (accessed 2 January 2024). Beyond deployment of ehealth: examples of population-wide open Notes.
www.opennotes.org/ehealth-in-sweden

58 Moll, J, and H Rexhepi (16 June 2020). The effect of patient accessible electronic health records on communication and involvement in care – a national patient survey in Sweden. Studies in Health Technology and Informatics.
pubmed.ncbi.nlm.nih.gov/32570543/

59 Fisher, S, and L Rosella (22 November 2022). Priorities for successful use of artificial intelligence by public health organisations: a literature review. BMC Public Health.
bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-14422-z

60 Fisher, S, and L Rosella (22 November 2022). Priorities for successful use of artificial intelligence by public health organisations: a literature review. BMC Public Health.
bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-14422-z

61 Khoury, M, et al. (4 November 2015). Precision public health for the era of precision medicine. American Journal of Preventive Medicine.
www.ncbi.nlm.nih.gov/pmc/articles/PMC4915347/

62 US AID (May 2022). Artificial intelligence in global health: defining a collective path forward.
www.usaid.gov/sites/default/files/2022-05/AI-in-Global-Health_webFinal_508.pdf

63 Jungwirth, D, and D Haluza (3 March 2023). Artificial Intelligence and public health: an exploratory study. International Journal of Environmental Research and Public Health.
doi.org/10.3390%2Fijerph20054541

64 Yi, SE, et al (2021). Predicting hospitalisations related to ambulatory care sensitive conditions with machine learning for population health planning: derivation and validation cohort study. BMJ Open.
bmjopen.bmj.com/content/12/4/e051403.citation-tools

65 Harvard University (accessed 2 January 2024). Predictive modelling for early identification of suicidal thinking.
teamcore.seas.harvard.edu/predictive-modeling-early-identification-suicidal-thinking

66 Gomes de Andrade, N, et al (26 December 2018). Ethics and artificial intelligence: suicide prevention on Facebook. Philosophy & Technology.
link.springer.com/article/10.1007/s13347-018-0336-0

67 Aitken, M, et al (November 2017). The growing value of digital health. Iqvia Institute.
regresearchnetwork.org/wp-content/uploads/the-growing-value-of-digital-health.pdf

68 O'Leary, C (2 October 2017). World-first holographic doctor launched in Perth. West Australian.
thewest.com.au/news/wa/world-first-holographic-doctor-launched-in-perth-ng-b88615356z

69 Rowlands, G, et al (26 May 2015). A mismatch between population health literacy and the complexity of health information: an observational study. British Journal of General Practice.
www.ncbi.nlm.nih.gov/pmc/articles/PMC4439828/

70 Mistry, P (17 August 2023). Can AI help put people firmly at the centre of their care? King's Fund.
www.kingsfund.org.uk/blog/2023/08/can-AI-help-put-people-firmly-at-the-centre-of-their-care

71 Mistry, P (17 August 2023). Can AI help put people firmly at the centre of their care? King's Fund.
www.kingsfund.org.uk/blog/2023/08/can-AI-help-put-people-firmly-at-the-centre-of-their-care

72 Health and Social Care Committee (21 June 2023). Digital transformation in the NHS. House of Commons.
committees.parliament.uk/publications/40637/documents/198145/default

73 Health and Social Care Committee (21 June 2023). Digital transformation in the NHS. House of Commons.
committees.parliament.uk/publications/40637/documents/198145/default

74 World Economic Forum (14 August 2023). Bridging the digital divide in the European Union.
www.weforum.org/agenda/2023/08/how-to-bridge-the-digital-divide-in-the-eu/

75 Statista.com (accessed 15 October 2023). Smart phones in Europe – statistics & facts.
www.statista.com/topics/3341/smartphone-market-in-europe/#dossier-chapter3

76 NHS England (28 September 2023). Inclusive digital healthcare: a framework for NHS action on digital exclusion.
www.england.nhs.uk/long-read/inclusive-digital-healthcare-a-framework-for-nhs-action-on-digital-inclusion

77 Ofcom (9 June 2021). Online nation.
www.ofcom.org.uk/__data/assets/pdf_file/0013/220414/online-nation-2021-report.pdf

78 Ofcom (9 June 2021). Online nation.
www.ofcom.org.uk/__data/assets/pdf_file/0013/220414/online-nation-2021-report.pdf

79 Deloitte et al (March 2022). Australia's health reimagined.
www.deloitte.com/au/en/Industries/life-sciences-health-care/perspectives/australias-health-reimagined.html

80 Deloitte (2020). The future of virtual health.
www2.deloitte.com/cn/en/pages/life-sciences-and-healthcare/articles/the-future-of-virtual-health.html

81 Deloitte et al (March 2022). Australia's health reimagined.
www.deloitte.com/au/en/Industries/life-sciences-health-care/perspectives/australias-health-reimagined.html

82 Man Ying Lee, C, et al (24 May 2022). Educational attainment and willingness to use technology for health and to share health information – the reimagining healthcare survey. International Journal of Medical Informatics.
www.ncbi.nlm.nih.gov/pmc/articles/PMC9760096/

83 Health and Social Care Committee (21 June 2023). Digital transformation in the NHS. House of Commons.
committees.parliament.uk/publications/40637/documents/198145/default

84 Thornton, N, et al (24 November 2023). Exploring public attitudes towards the use of digital health technologies and data. Health Foundation.
www.health.org.uk/publications/long-reads/exploring-public-attitudes-towards-the-use-of-digital-health-technologies

85 NHS Confederation (13 June 2023). Patient empowerment: what is the role of technology in transforming care?
www.nhsconfed.org/publications/patient-empowerment-what-role-technology-transforming-care

86 Information provided by ChatGPT4, accessed 4 January 2024.

87 Information provided by ChatGPT4, accessed 5 January 2024.

88 Spatharou, A, et al (10 March 2020). Transforming healthcare with AI: the impact on the workforce and organisations. McKinsey.
www.mckinsey.com/industries/healthcare/our-insights/transforming-healthcare-with-ai

89 Elsevier Health (2023) Clinician of the future 2023.
www.elsevier.com/en-gb/promotions/clinician-of-the-future-2023

90 Lenfant, T, et al (19 December 2023). Five principles for the development of minimally disruptive digital medicine. BMJ.
doi.org/10.1136/bmj.p2960

91 NHS Confederation (13 June 2023). Patient empowerment: what is the role of technology in transforming care?
www.nhsconfed.org/publications/patient-empowerment-what-role-technology-transforming-care

92 NHS AI Lab and Health Education England (May 2022). Understanding healthcare workers' confidence in AI.
digital-transformation.hee.nhs.uk/binaries/content/assets/digital-transformation/dart-ed/understandingconfidenceinai-may22.pdf

93 NHS AI Lab and Health Education England (May 2022). Understanding healthcare workers' confidence in AI.
digital-transformation.hee.nhs.uk/binaries/content/assets/digital-transformation/dart-ed/understandingconfidenceinai-may22.pdf

94 Sheba Medical Center (accessed 7 March 2024). World-class medicine with a personal touch.
www.shebaonline.org

95 Sylvester, R (25 May 2023). The AI revolution can put patients at the centre of the NHS. Times.
www.thetimes.co.uk/article/ai-revolution-can-put-patients-at-centre-of-nhs-times-health-commission-vhs6tv8sf

96 Kleinberg et al (2022). Racial underrepresentation in dermatological datasets leading to bias the machine learning models and inequitable healthcare. Journal of Biomedical Research & Environmental Sciences.
www.ncbi.nlm.nih.gov/pmc/articles/PMC9815490/

97 Liverpool, L (20 January 2021). Genomic medicine is deeply biased towards white people. New Scientist.
www.newscientist.com/article/mg24933180-800-genomic-medicine-is-deeply-biased-towards-white-people/

98 Bulatao, R, and N Anderson (2004). Understanding racial and ethnic differences in health in late life: a research agenda. National Research Council Panel on Race, Ethnicity, and Health in Later Life. National Academies Press.
www.ncbi.nlm.nih.gov/books/NBK24693/

99 Harrer, S (14 March 2023). Attention is not all you need: the complicated case of ethically using large language models in healthcare and medicine. eBioMedicine.
www.thelancet.com/journals/ebiom/article/PIIS2352-3964(23)00077-4/fulltext

100 Harrer, S (14 March 2023). Attention is not all you need: the complicated case of ethically using large language models in healthcare and medicine. eBioMedicine.
www.thelancet.com/journals/ebiom/article/PIIS2352-3964(23)00077-4/fulltext

101 Southwick, R (18 December 2023). Healthcare cyberattacks have affected more than 100 million people in 2023. Chief Healthcare Executive.
www.chiefhealthcareexecutive.com/view/health-data-cyberattacks-have-affected-more-than-100-million-people-in-2023

102 Swivelsecure (accessed 6 March 2024). 9 reasons why healthcare is the biggest target for cyberattacks.
swivelsecure.com/solutions/healthcare/healthcare-is-the-biggest-target-for-cyberattacks/

103 Information provided by ChatGPT4, accessed 4 January 2024.

104 Field, M (ed) (1996). Telemedicine: a guide to assessing telecommunications in health care. National Academies Press. www.ncbi.nlm.nih.gov/books/NBK45440/

105 Cvetko, S (12 October 2023). Advancements in AR surgery: transforming healthcare and saving lives. Forbes. www.forbes.com/sites/forbestechcouncil/2023/10/12/advancements-in-ar-surgery-transforming-healthcare-and-saving-lives

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