NIIN National Industry Innovation Network

Health x Digital Transformation Report 2024-2025

A practical guide for action, on the trends that matter

September 2024

RMIT UNIVERSITY

CISCO

Health <Transformation> Lab

NIIN
National Industry Innovation Network

The role of the NIIN

The NIIN is a dynamic network that brings together industry, university and government partners to drive digital technology advancements in economy and society. With its ready-to-access capability and existing infrastructure, the NIIN's Health Alliance provides a low-risk avenue for health agencies and hospital operators to engage in innovation activities. The NIIN's six innovation centres, eight Research Chairs, two health-focused labs, and specialised technology centres serve as a collaborative hub for industry, health agencies, hospital operators, researchers, and students tackling critical healthcare challenges, collectively using digital innovation.

Establishment of the NIIN Health Alliance

The importance of scaling healthcare innovation is evident in today's dynamic and intricate healthcare landscape. To fully leverage the potential of the NIIN healthcare ecosystem, it is essential to establish a network of carefully selected partners with relevant capabilities, projects, contributions, and platforms. The NIIN Health Alliance aims to achieve three major outcomes:

- Leverage collective health innovation capacity
- Build critical mass activity around health priorities
- Create a forum for idea exchange in the health ecosystem.

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Health x Technology: from provocation to action, by way of impact

> “…let us stride into a brighter health future the only way possible – together.”

Purpose

In an era marked by rapid technological advancements, the intersection of health and digital innovation presents an unprecedented opportunity to revolutionise healthcare. Leaps in computational power and network connectivity are driving digital innovation, and a wide collection of technologies are rapidly moving from ’might have future potential’ into ’can be usefully deployed today’. Artificial Intelligence, extended reality, digital twins, 3D-printing, autonomous robots, and more are all finally moving to the point where their long-promised potential can be realised.

The *Health x Digital Transformation Report 2024-2025*, spearheaded by the National Industry Innovation Network (NIIN) Health Alliance, boldly addresses this transformative potential. Focusing on the most significant technological trends, the report considers the potential for each to redefine health systems, describes proven applications in health, and offers a clear roadmap for actionable change in the next 12 months.

The digital opportunity in health

Digital transformation in healthcare is not just a future aspiration—it is an urgent and immediate necessity. For example, the sensible, clear-eyed adoption of AI *will* change the way health systems operate. But all of its potential hinges on underlying digital infrastructure, secure data collection, and having the right skills available.

Healthcare systems worldwide are grappling with escalating demands and unprecedented challenges, and the potential for digital technologies to enhance patient care, streamline operations, and foster innovation are entirely dependent on creating the right conditions for their success. Failure to do so may yet result in a health transformation, but it will not be in the direction of more efficient, personalised, and accessible health systems. The path to success is genuinely open, realising it requires that all those involved with the health system make the right decisions today.

Articulating the potential, and the decisions required to achieve it, is the central aim of this report.

Our approach

In preparing this report, we scoured thousands of journal articles, using natural language processing to identify the most popular topics of research. Supplementing our survey of research literature, we read through every trends report we could find. From international organisations considering global health systems to national think tanks focusing on country-specific challenges, we have distilled 2024's hottest properties – the trends that everyone is talking about.

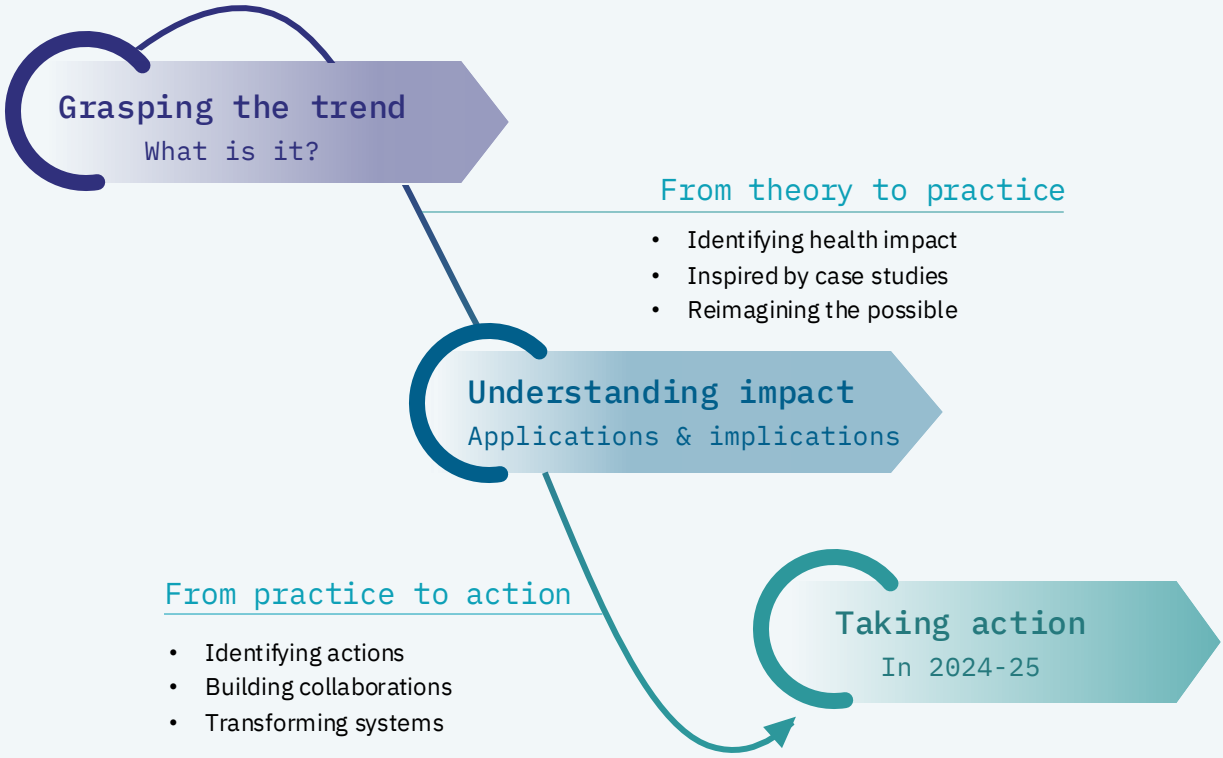
Five Transformation Dimensions of future digital-driven health emerged, representing a variety of technologies across different levels of activity. These are:

1. **Augmented intelligences:** the deployment artificial intelligence and machine learning to make healthcare genuinely smart
2. **Simulation and simulacra:** using digital replicas and simulation technologies to hack the real world
3. **Remote patient care:** leveraging digital means to provide care meets the patient where they need it
4. **Health system adaptability and dynamism**: technologies that foster system resilience in times of rapid change
5. **Harnessing biotechnology breakthroughs:** building the digital foundations of future healthcare.

The first – artificial intelligence – is an individual technological field and undoubtedly the most talked about current technology trend. The second and third dimensions are, in contrast, fields of application in which multiple different individual technologies can be harnessed towards a purpose. Thus, we consider the use of simulations in our second dimension, where different technologies like extended reality and digital twins bring digital tools to bear on the physical world. Similarly, in dimension three, with the overarching aim of creating genuine remote patient care, we see communication technologies, the Internet-of-Things and AI deployed together for a single purpose.

As we worked through these three dimensions, two other fields emerged as being particularly important. First is the need for constant adaptation in our health infrastructure and systems. The world is changing rapidly, creating ever new challenges for health systems. Building dynamism and adaptation into the health system – in its policies, along with physical and digital infrastructure – is the only way for health systems to efficiently cater to changing populations and conditions.

Finally, so much of the literature reveals genuine excitement about the possibilities of breakthroughs in biotechnology: from gene editing to nanotech to fulfilling long-held dreams of personalised medicine. The question for this report in respect of this last category has been: what role must digital play in harnessing these breakthroughs?



How to use this report to pursue transformative impact

The intention behind this report is to provide a clear line from the nature of each Transformation Dimension, through how it will impact health, and ultimately to the actions you can take today to realise and maximise that impact, depending on where you sit in or around the health system. Thus, the discussion of each Dimension is split into three parts.

Grasping the trend

For each Transformation Dimension, the first section considers the relevant technology trends in detail, providing depth beyond the buzzwords. We break down the field, highlighting facets that are most promising or well-developed, and identify aspects that are over-hyped.

Each of these sections aims to be a self-contained primer on the nature of the technology trend or dimension under examination.

Understanding impact

At the risk of tautology, health technologies must – whether realised or potential – have an impact on health. Therefore, second section in respect of each Transformation Dimension applies an impact framework to the Dimension in question, explaining the ways in which the technologies can impact patient care and wellbeing, and system infrastructure.

Wherever necessary, we highlight proclaimed technologies for which evidence of impact is scant or likely to be implausible. Such examples are, however, rare. The creation of good health and wellbeing is influenced by a wide variety of factors. Technologies that directly act on individual health – such as artificial titanium[1] hearts have the most obvious impact, but the maintenance of population health are equally based on robust administration, high-quality data, and clinical skills development.

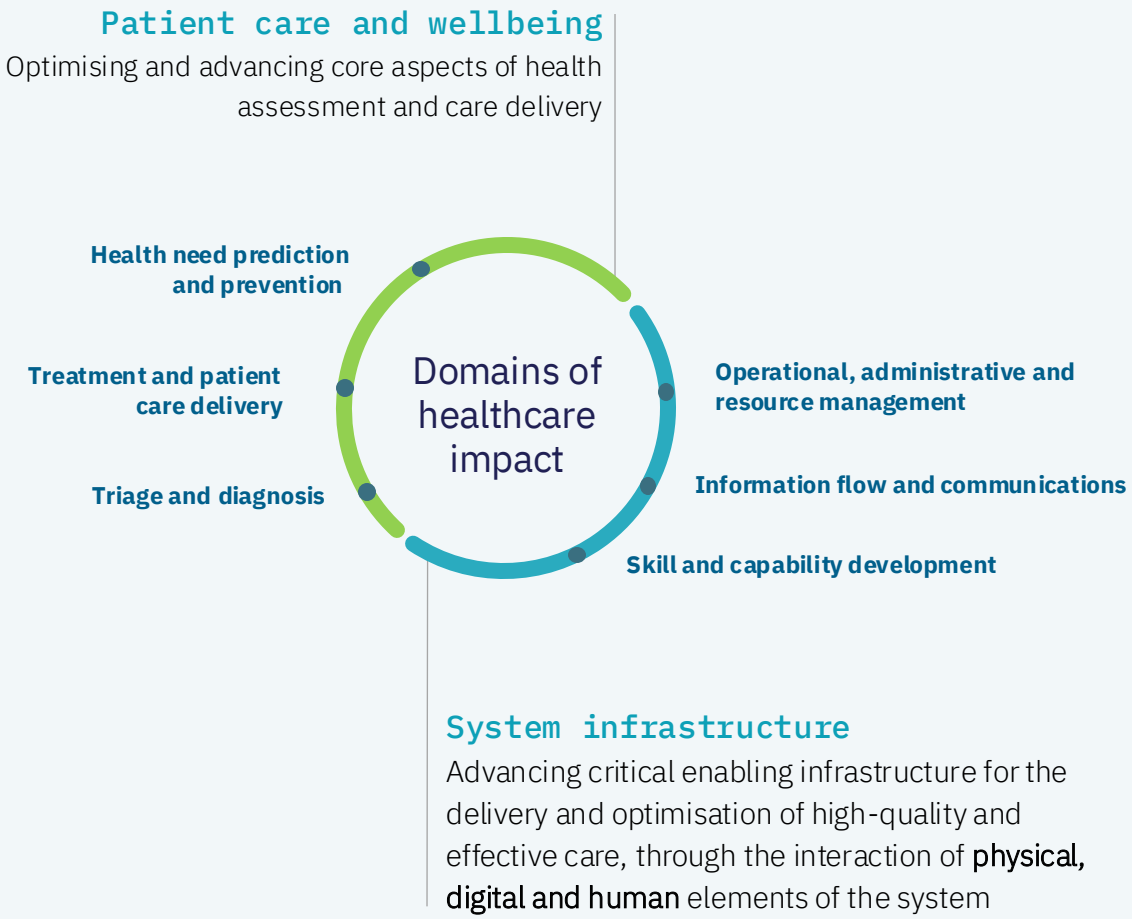
[1] Groch, S. (2024). His dad was dying. So Daniel built a world-first artificial heart – with pipes and magnets. from https://www.smh.com.au/healthcare/his-dad-was-dying-so-daniel-built-a-world-first-artificial-heart-with-pipes-and-magnets-20240215-p5f54u.html.

Our Impact Framework (please see below) categorises applications of health technologies according to their impact on patient care and wellbeing, and health system infrastructure. As depicted in the figure below, these domains of impact are broken down into further sub-categories to help specify the precise nature of impact.

Overall, the Impact Framework provides a heuristic for organising the different types of impact that a technology might deliver, simplifying decision-making and making clearer how maximised impact requires input from the many types of health professionals.

We then further illustrate and make granular that impact through the use of case studies – examples of where the technologies in question *are* having an impact already. Some of these case studies are drawn from NIIN universities and from our ecosystem – while we also include those from around the world.

These case studies aim to illustrate, to inspire and to act as a provocation for readers to identify interventions that they might like to pursue in their own services, contexts and domains.



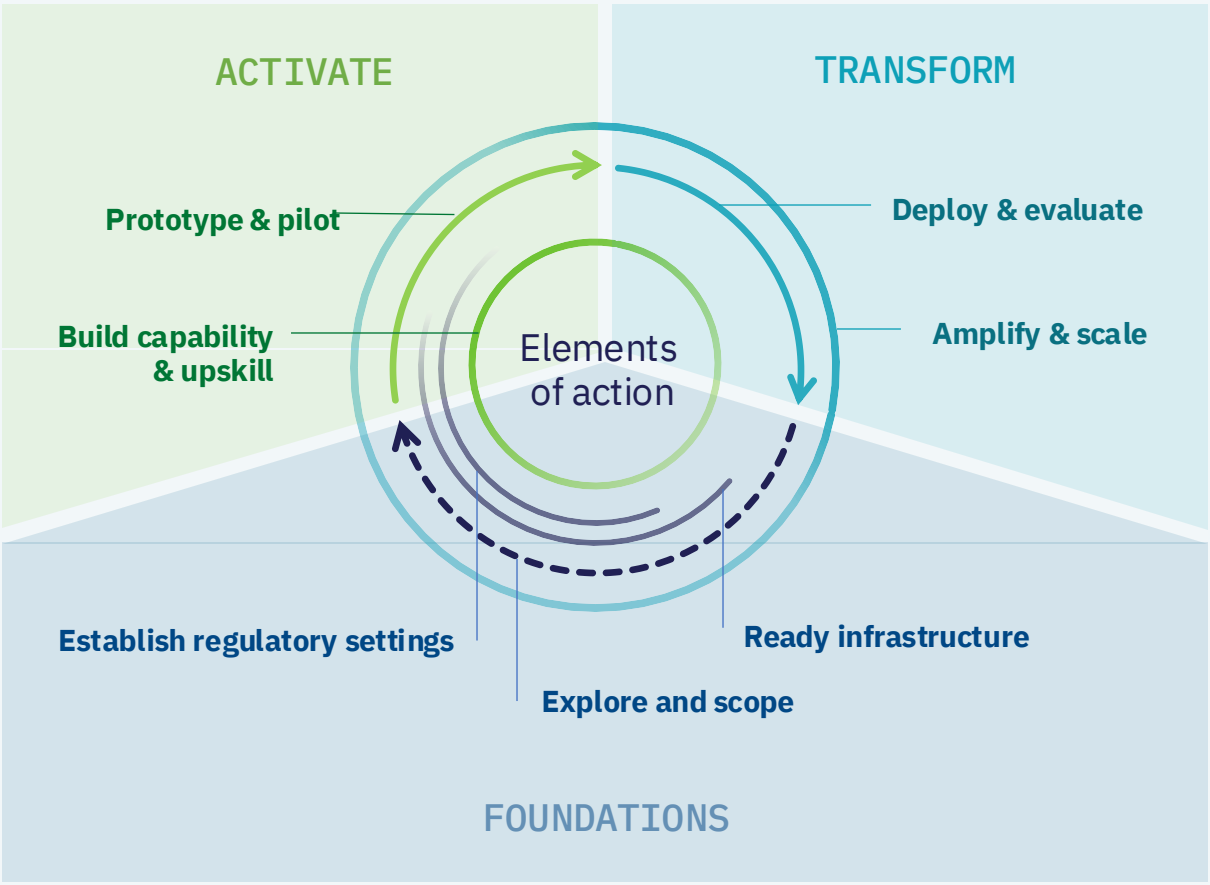
Taking action

Where there is the promise of health impact, the next question is, “What actions must be taken?”

In the final section we move from practice to action, focusing on the steps that can – and we recommend, should – be taken across 2024-2025. These range from ways to implement new technologies immediately, through to outlining the preparatory steps required to implement them in the future. This section considers action across a broad scale, including tasks for regulators, health services, researchers, and clinicians.

Our Action Framework (below) identifies and maps the actions that health ecosystem actors can take across 2024-2025, across three key phases of technology readiness:

- **Foundations:** Where technologies are nascent and/or still developing, actions across the health system can only be foundational, establishing the right regulatory settings, preparing the requisite infrastructure, and exploring the technology’s potential.
- **Activate:** For more established technologies, the imperative is activation, building capabilities and developing pilot studies. At this stage promising technologies are applied directly to health problems.
- **Transform:** For the most well-established technologies – with clear impact already being demonstrated - the task is to deploy and then scale. It is at this point that we start to see our health system transform, providing ever better health outcomes for patients and populations.



An integrated approach to strategic action

Put another way, across each of the five Transformation Dimensions, the three organising sections move from theory to impact and on to action, offering a detailed picture of what the dimension is, what it will do, and how you can make it happen.

The table below contains a distillation of this approach, highlighting core insights and recommendations for each of the five Transformation Dimensions.

Grasping the Trend What is it?	**Understanding impact** Applications and implications	**Taking action** Actions for 2024-25
Augmented intelligences		
Artificial intelligence is 2024's most hyped trend. Powered by neural networks and the ingestion of enormous quantities of data, AI identifies statistical trends in the data that can be applied to new contexts.	Potentially revolutionary across almost every major element of the health system, from diagnostics and care, to operational decision making and resource management. However, impact is dependent on the sophistication of digital infrastructure, data collection and management, and cybersecurity.	• Build robust data pipelines for high-quality data for AI training and operation. • Invest in skills around AI and potential uses. • Establish partnerships to explore prerequisites to implementation.
Simulation and simulacra		
Simulation technologies allow testing, prototyping and experimenting without the costs or consequences associated with the physical world. Includes Extended Reality, digital twins and 3D Printing.	Extensive potential impact, touching elements of the system across both patient care and system infrastructure. However, most technologies are still broadly in early stages of deployment, in even the most advanced health systems and providers.	• Build the technology foundations that simulation technologies need to work. • Collaboratively scope, prototype, and pilot these technologies to learn and plan for more fulsome deployment.
Remote patient care		
Involves utilisation of an array of communication technologies and network-connected sensors to provide care to an individual in circumstances where the carer and patient are not in the same physical space.	Potential for significant transformation, especially at the patient level, and with implications for the infrastructural and operational elements of the system. While the pandemic has driven exponential growth in RPC deployment, realising impact at scale will require more sophisticated data processing and cybersecurity.	• Scope and collaborate on the most strategic technologies for prototyping, deployment and iteration. • Building the technology infrastructure for scale. • Incentivise and enable hybrid healthcare at scale via policy and regulatory settings.
Health system adaptability and dynamism		
Involves creating systems that are flexible by default, designed with the anticipation of the need for future adjustment, and with a range of features that can achieve the required shifts – across physical and digital infrastructure, and organisational structures and processes.	Adaptation is not a choice. As the world changes, health systems can decide to build dynamism into their structures or be forced to change in periodic ruptures. Crafting flexible policy and building dynamic structures allows health systems to keep pace with the rest of society and respond to challenges confidently as they arise.	• Build the technology infrastructure of dynamism, calibrating to strategic goals and key areas across organisations and the health system more broadly. • Embed a focus on collaboratively prototyping and learning.
Harnessing biotechnology breakthroughs		
The great breakthroughs in health have come from breakthroughs in biotechnology deep scientific research. Today, the implementation of such breakthroughs is enhanced by appropriate digital infrastructure - or hampered by its absence.	Biotech research into gene editing, personalised genomics and regenerative medicine appear set to transform medical practice. Each is powered by AI and data analytics and will require robust digital systems for implementation.	• Build partnerships across health, biotech and research institutions to prepare for new technologies as they become available. • Build redundant capacity into data management systems to handle influxes of biological and patient data.

Call to action: join the transformation

Throughout this report we highlight case studies of real action across each of the five Transformation Dimensions. We have collected more than 100 such examples (see the Appendix for the full complement), each demonstrating what is possible today along with the pitfalls and challenges to navigate.

From this we have crafted a list of actions that anyone in the health system can look to implement today. These actions are summarised in the right-most column of the table above and presented in full throughout the report. These 'action tables' appear at the end of each section and together provide a comprehensive overview of measures that are not simply possible today, but that have been tested, tried and implemented somewhere in the world already. Each action is real, validated, and demonstrably achievable.

The NIIN Health Alliance stands at the forefront of this digital revolution. By uniting government, industry, and academic partners, the NIIN has created a dynamic ecosystem designed to drive advancements in digital health technology. With six innovation centres, eight Research Chairs, two health-focused labs, and specialised technology hubs, NIIN is uniquely positioned to address critical healthcare challenges through collaborative digital innovation.

The NIIN Health Alliance is not, however, merely a collective of researchers or technology vendors; it is a catalyst for transformative impact in healthcare. This report aims to be a clarion call to action, urging stakeholders to move beyond the theoretical and into practical implementation. By joining forces with the NIIN Health Alliance, healthcare providers, policymakers, and technologists can collectively drive innovation and create a collaborative, future-ready healthcare ecosystem.

The NIIN Health Alliance stands ready to catalyse innovation efforts across our health systems. Join us – and let us stride into this new era of healthcare together, leveraging the power of digital transformation to achieve unprecedented advancements in patient care and operational excellence.

The future of healthcare is now—engage with the NIIN Health Alliance and be part of the revolution.

Health x digital: Insights to create a collaborative future

Against stagnation | Towards action | Chasing impact

> "The most dangerous phrase in the English language is: **'we've always done it this way'**."
>
> — Rear Admiral Grace Hopper

The NIIN health alliance & its goal

The National Industry Innovation Network (NIIN), anchored by Cisco Systems, is a bold and collaborative initiative aimed at generating economic and societal impact, by tackling national and global challenges through digital transformation and innovation.

Bringing together eight leading Australian universities, and housing significant health transformation assets, in late 2023, the NIIN launched a dedicated Health Alliance, designed to help industry and government solve their most pressing health-related challenges.

The NIIN Health Alliance – led by the Cisco-RMIT Health Transformation Lab – quickly agreed that the Australian and Asia-Pacific health innovation ecosystems would benefit from clarity about pressing possibilities and urgent opportunities being created by technology, in respect of health and care.

The Health Alliance mobilised around this task. Starting with the idea of a technology trend analysis, the Alliance quickly realised that, to have impact in our health ecosystems, we needed to provoke and support innovative activity in the system. We need to build on what we have and be inspired by what others are doing. Critically, we need to catalyse and guide, not just philosophise and theorise.

The results of the Health Alliance's work and analysis is captured in this report – a practical guide for action against the trends that will have the greatest impact in the health system today.

Searching for action and impact

Through and post COVID, there has been an explosion in attention to technology development and its implications for health. This is welcome and important attention – surely the space is full of opportunities, and our systems cry out for new ways of doing what we have done, as well as entirely new things to be done. The imperative to act is unambiguous and urgent.

An effect, however, of this explosion in attention is that there has been a proliferation of thousands of reports, articles and opinions on the most important technological trends in health. This literature covers academic, industry and expert-opinion literature and seems to be ever-expanding in volume.

The result, however, has not been optimal. Libraries of dusty and digitally-filed reports, but still relatively little *practical* guidance for action. A dizzying array of articles – but health sector leaders still grappling to determine the best way forward in digital transformation in key areas.

… we need to provoke and guide, not just philosophise and theorise…

A multi-year approach

The NIIN Health Alliance seeks to address this through a multi-year approach, tightly focused on practice and applied efforts.

In this report, you will find analysis generated and framed in deliberately provocative terms, encompassing and extending what is already in the literature.

You will see a focus on the areas – ideas, technologies and directions – that the NIIN Health Alliance considers most urgent for ecosystem players (e.g. health system, policy-makers, technology firms).

Each of these areas – which we term 'Transformation Dimensions' – is outlined in detail, describing what it is, why it matters, who is already successfully doing it, and, most importantly, what type of action is possible in 2024-25. There are also opportunities for you to connect directly with the NIIN Health Alliance, to advance collaborative activity in these areas.

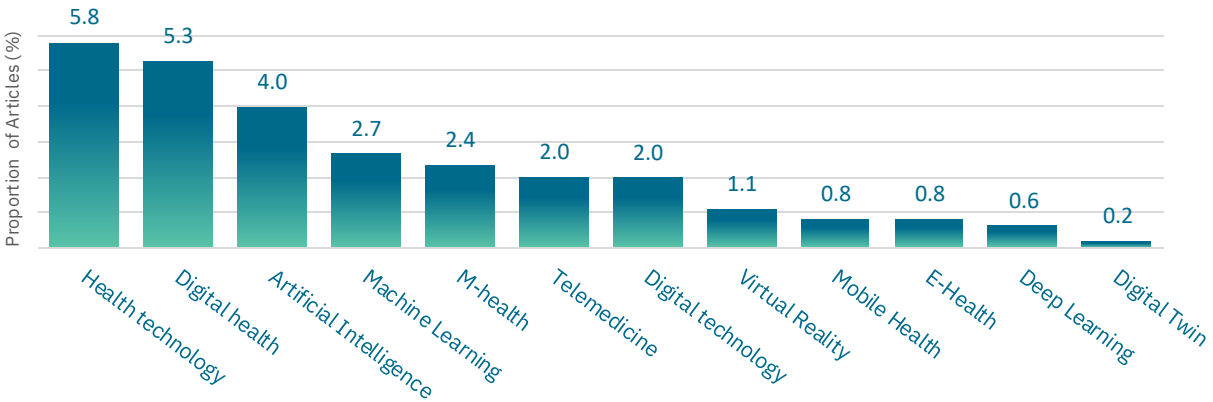
This report will be part of an annual review – with publications produced each year to foster and support an innovation pipeline and program of activity and learning over meaningful timeframes.

How we did it: leveraging and extending repeated themes about the future

The ever-growing expanse of literature on health technology is vast, complex and hard to synthesise in timeframes that can support rapid discernment of opportunities for action or implementation. We have arrived at this view by looking at as much of it as we can.

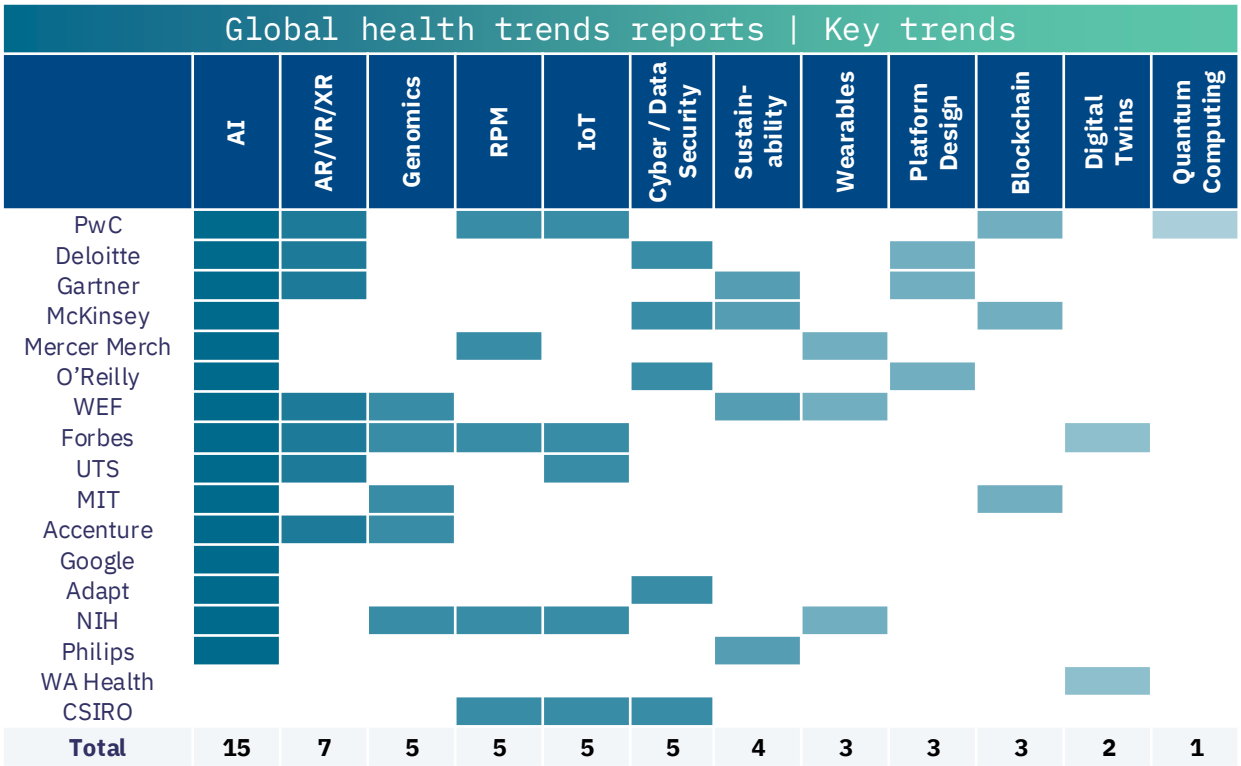
We reviewed 9,367 academic articles, indexed on the PubMed database and published between 2020-2024. Natural language processing was used to extract prominent keywords, giving a strong sense of trends across the research and academic landscape. These are presented in the figure below.

Proportion of articles featuring prominent key words (9,367 articles searched)



Prominent key words ranked by popularity
Total does not add to 100%: themes returning less than 0.1% are excluded.

We also reviewed in detail 17 significant health and technology trends reports from major firms, governments and international organisations, collating key trends appearing across multiple reports, as depicted in the figure below.[1-17]



We have found a remarkable convergence across the academic, industry and other literature, concerning the broad kinds of technologies that are considered likely to have an impact and an application in health.

In prioritising technologies and trends for inclusion in this report, however, our primary focus has been on trends that fulfil a dual criteria:

1. **Potential for impact on healthcare:** We prioritised trends that have the potential to significantly enhance patient outcomes, improve operational efficiency, and reduce costs. This includes technologies that facilitate better diagnosis and treatment, streamline healthcare processes, and enhance patient engagement and satisfaction.
2. **Actionability in 2024-2025:** Recognising the rapid pace of technological advancement, we focused on trends that can be realistically pursued and implemented within the next two years. This involves assessing the maturity of the technology, the readiness of the healthcare ecosystem to adopt it, and the availability of resources and infrastructure required for its deployment.

As such, there are a number of trends we have ruled out of inclusion in this analysis.

Quantum computing and blockchain applications in healthcare, for example, both hold great promise for addressing complex medical problems, advancing drug discovery, or creating disintermediated systems in healthcare. However, current applications are still experimental and not easily ready for action in healthcare settings over 2024-25.

At the same time, wearable fitness trackers and mobile health wellness apps might very much be deployable in the short term, but – at least on their own – are unlikely to result in significant health impact, in respect of large functions of our health systems.

This approach ensures that our recommendations are both forward-thinking and practical – visionary but also grounded in practical feasibility – enabling stakeholders to make informed decisions that can be executed effectively in the near term. This methodology sets the report apart by providing a balanced view of visionary and immediately actionable trends, making it a valuable resource for strategic planning.

The 5 Transformation Dimensions

This process has resulted in five key Transformation Dimensions that require action by health system and technology players:

1. **Augmented Intelligences:** Towards the promise of genuinely smart healthcare
2. **Simulation and simulacra:** Using digital replicas to hack the real world
3. **Remote patient care:** Care that meets the patient where they need it
4. **Health system adaptability and dynamism**: Resilience in times of rapid change
5. **Harnessing biotechnology breakthroughs:** The digital foundations of future healthcare

We have taken the most immediate of these technologies, and then worked across the Health Alliance to refine and re-render them, in light of actionability now. We have facilitated this by collating case studies in respect of specific trends, while also applying several filters to help us to identify the most high-potential ideas and case studies for ecosystem actors in 2024-25.

Don't just read it – join us: the NIIN Health Alliance

To be clear, this analysis is not just to be read. It is not to sit on a shelf (or a list of bookmarks in your browser). It is to be taken up and acted on. And the NIIN Health Alliance is a purpose-built machine to facilitate this.

Within the Health Alliance, we have data specialists and prototyping spaces, simulation labs and new skills development infrastructure, we have health economists, design thinkers, novel digital technologies, robots and innovation hubs. Across the network, we can bring together entire ecosystems of expertise that can be brought to bear on almost any health technology, policy, innovation, workforce or implementation challenge.

The NIIN Health Alliance doesn't have – and doesn't claim to have – all of the answers to all of the problems confronting our health systems, the technologies they use and the skills they demand. What it does have is a network of expertise, assets, insights and capabilities unrivalled in the Australian and indeed the broader Asia-Pacific space, that is ready and primed to be used to explore how we can address these problems – in partnership with technologists, governments, service providers and communities. This creates a remarkable set of possibilities – that we at the NIIN want to use to drive real impact, in real time.

You will see throughout the discussion that we highlight very specific ways that ecosystem players can envision and connect to specific action to pursue these various technology directions and impact possibilities, right now.

This is the great strength of the NIIN Health Alliance – it is not a mere collection of researchers, nor is it attempting to sell specific products or technologies. Its mission is to create impact in health through spurring technology-related innovation and skills, to support others who are doing so, and to solve the kind of national and regional challenges that confront us in health and in care, now and into the future.

So, we conclude with a plea: don't just read this report – join us. And let us stride into a brighter health future the only way possible...together.

Transformation Dimensions: Overview

Moving from understanding, to impact, to action

Understanding the Transformation Dimensions

As outlined previously, this report presents and explores five Transformation Dimensions which we believe have the potential to deliver significant health impact, and which are actionable for 2024-25.

The first Dimension, **augmented intelligences**, is comprised of a cluster of different subfields, technologies and methods, encompassing disparate domains, including algorithmic and deep learning, natural language processing, computer vision, autonomous navigation and robotics and more.

The second, **simulation and simulacra**, is centred on a group of technological advancements that digitally simulate, replicate, augment, or enhance our interactions with the physical world, including: Extended Reality (Virtual Reality, Augmented Reality, Mixed Reality), digital twins, and 3D printing.

Remote patient care – the Dimension most used in the current health system – covers a wide array of technologies that enable care delivery in circumstances where the carer and patient are not in the same physical space. Examples include video conferencing and other telehealth technologies, remote sensors like wearables or ingestible sensors, and electronic medical records.

Health system adaptability and dynamism deals with ways of creating or updating systems to be flexible by default, designed with the anticipation of a need to adjust at some point in the future, and to have a range of features that can achieve the required shifts. In particular, we outline the kinds of adaptability that should be built into our physical and digital infrastructure, as well as organisational structures and processes.

Our final Dimension, **harnessing biotechnology breakthroughs**, is concerned with strengthening the 'digital backbone' required to leverage and capture value from biotechnology and deep science innovations, poised to bring about the next wave of transformation in healthcare.

These Transformation Dimensions broadly group into two categories, each of slightly different order or type:

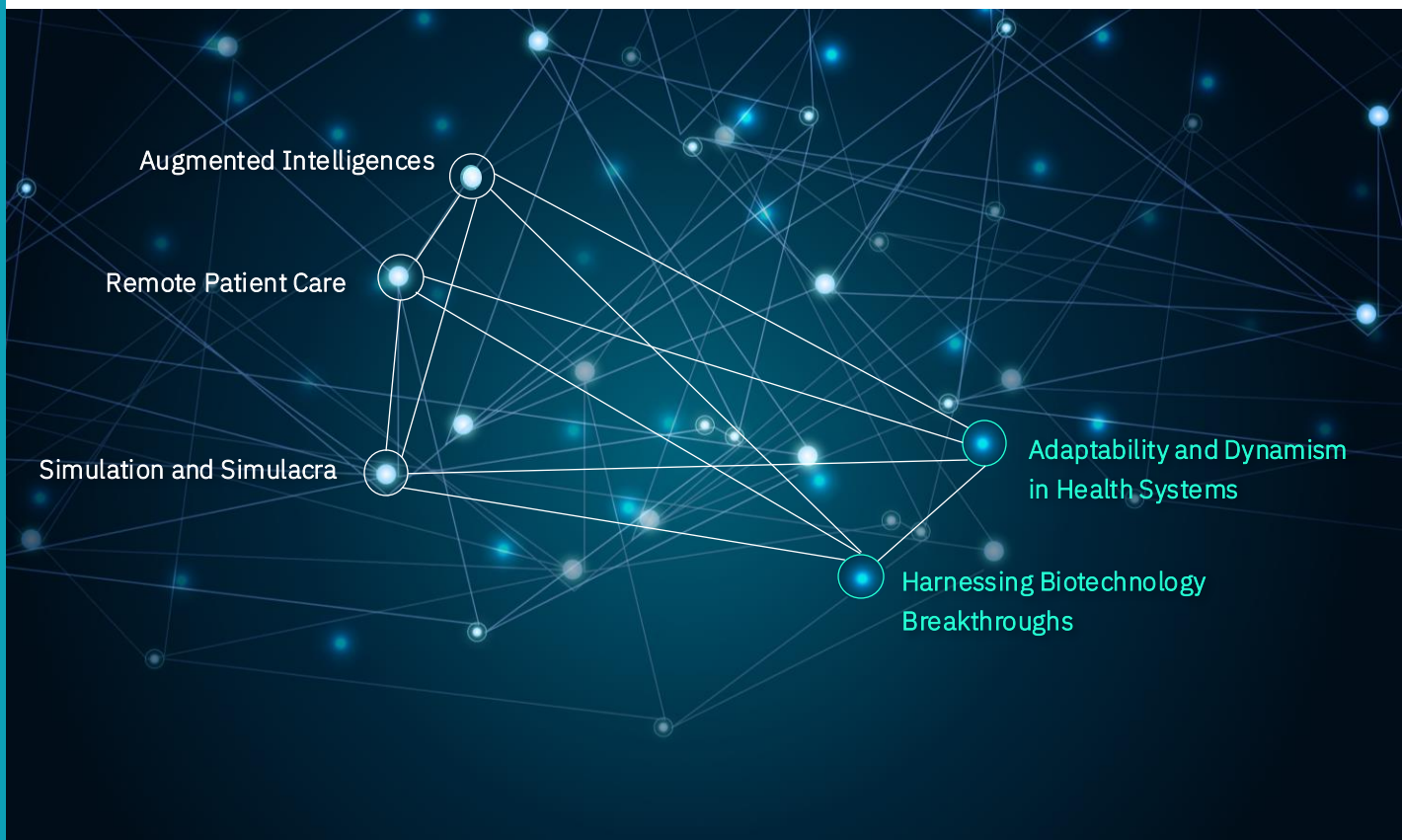
- The first three – Augmented Intelligences, simulations and simulacra, and remote patient care – are *technologies or clusters of discrete technologies* that can, are, and should be applied to health for impact.
- The final two – health system adaptability and dynamism, and harnessing biotechnology breakthroughs – relate to *characteristics or capabilities of the system.* Specifically, the former is concerned with capacity of the system to respond to new or emergent challenges, stressors or shocks; while the latter concerns the ability of the system to respond in ways that leverage value from adjacent fields or breakthroughs.

A note on complementarity

While – for the purposes of presentation and exploration – we have articulated these five transformation dimensions as discrete areas or vectors of technological change, in practice, they are highly interdependent and complementary.

Deploying these various technologies in an integrated way has the potential to greatly enhance health impact; in some cases, impact is dependent on this integration. For example, the potential impact of remote patient care can powerfully be enabled at scale by deploying AI to effectively process the vast body of data produced by remote monitoring technologies. Similarly, system adaptability and dynamism can be unlocked through deployment of scaled up simulation technologies. And so on.

Put another way, nothing in this report should be seen as distracting from this truth: the future will be integrated.

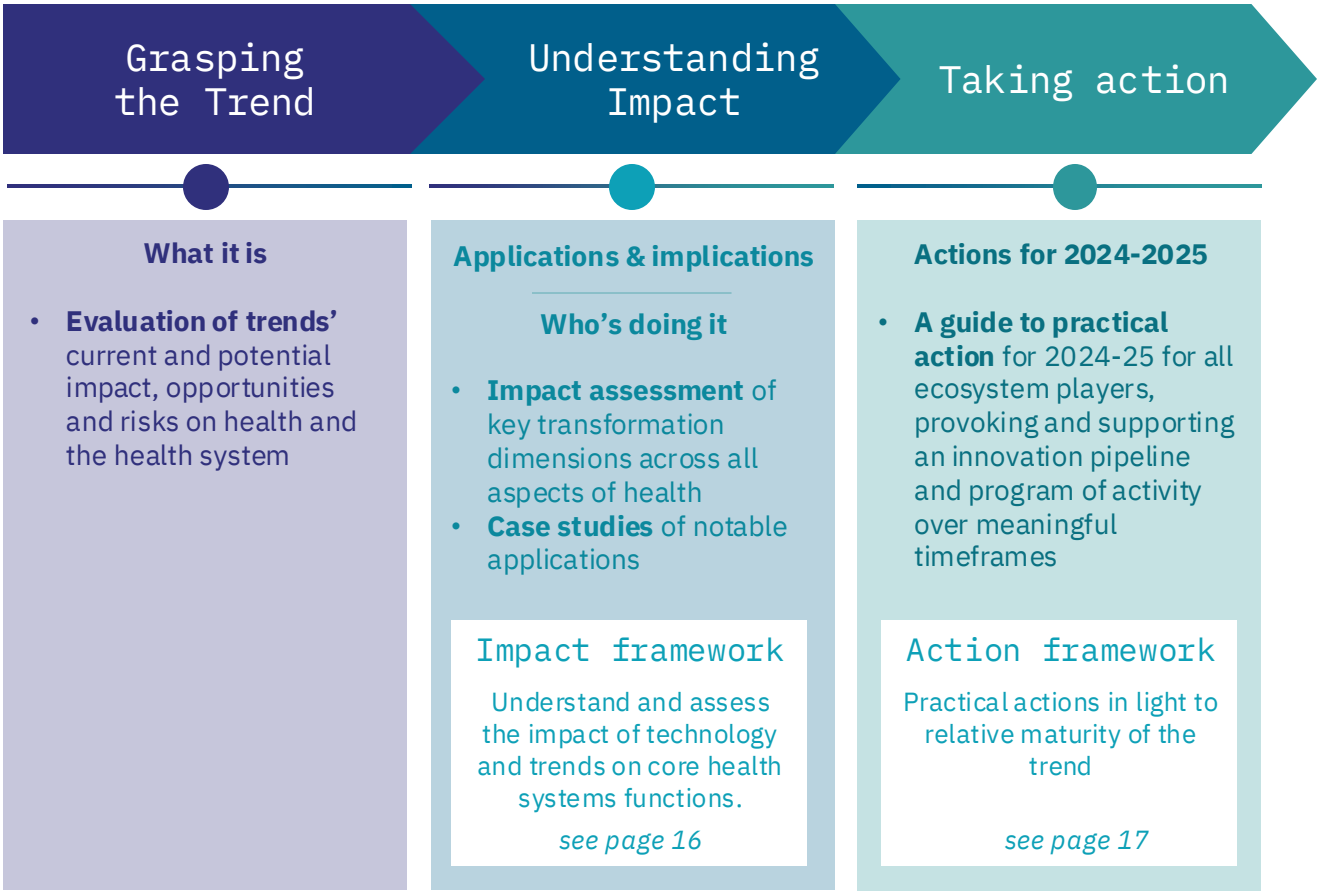


Navigating the Transformation Dimensions: from understanding, to impact, to action

In the next section, we outline each Transformation Dimension in detail. For each, we move:

- from understanding what it is and why it matters,
- to where in the health system it has potential to be most impactful, including illustrative examples of who is doing it around the world (and across the NIIN), and
- finally – and most importantly – to what type of action ecosystem actors should prioritise in 2024-25.

To aid in navigating this progression from understanding, to impact, to action, we use two frameworks: one to **understand the potential for impact** (see Impact Framework); and one to articulate ways in which ecosystem players can **take action** across the next 12-month horizon (see Action Framework). These frameworks are outlined in the following pages and referred to throughout.

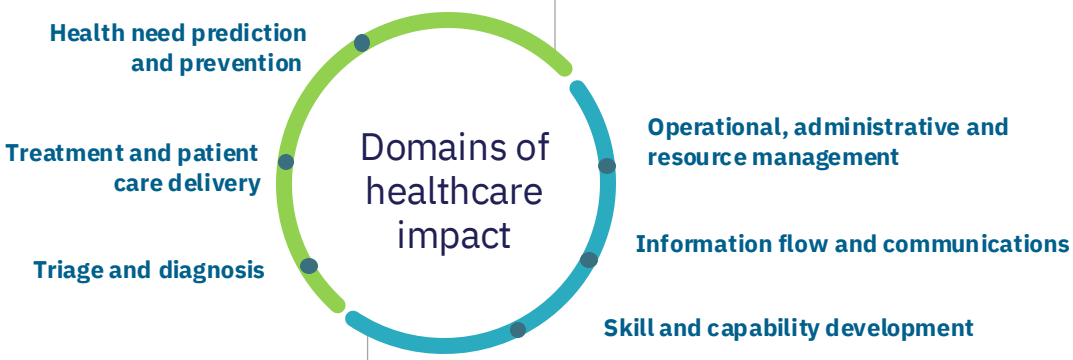


Impact Framework

When assessing the potential application of the Transformation Dimensions, we have categorised the nature of their impact across different aspects of healthcare delivery and management.

Patient care and wellbeing

Optimising and advancing core aspects of health assessment and care delivery



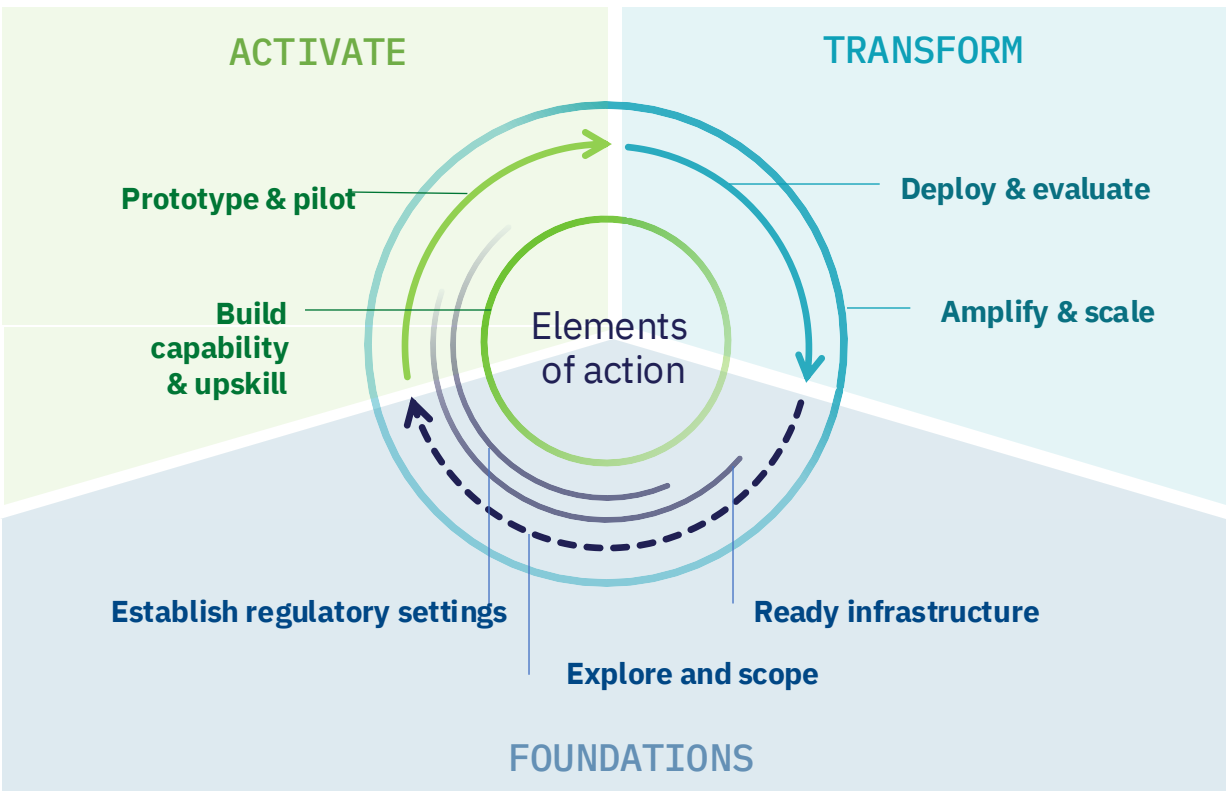
System infrastructure

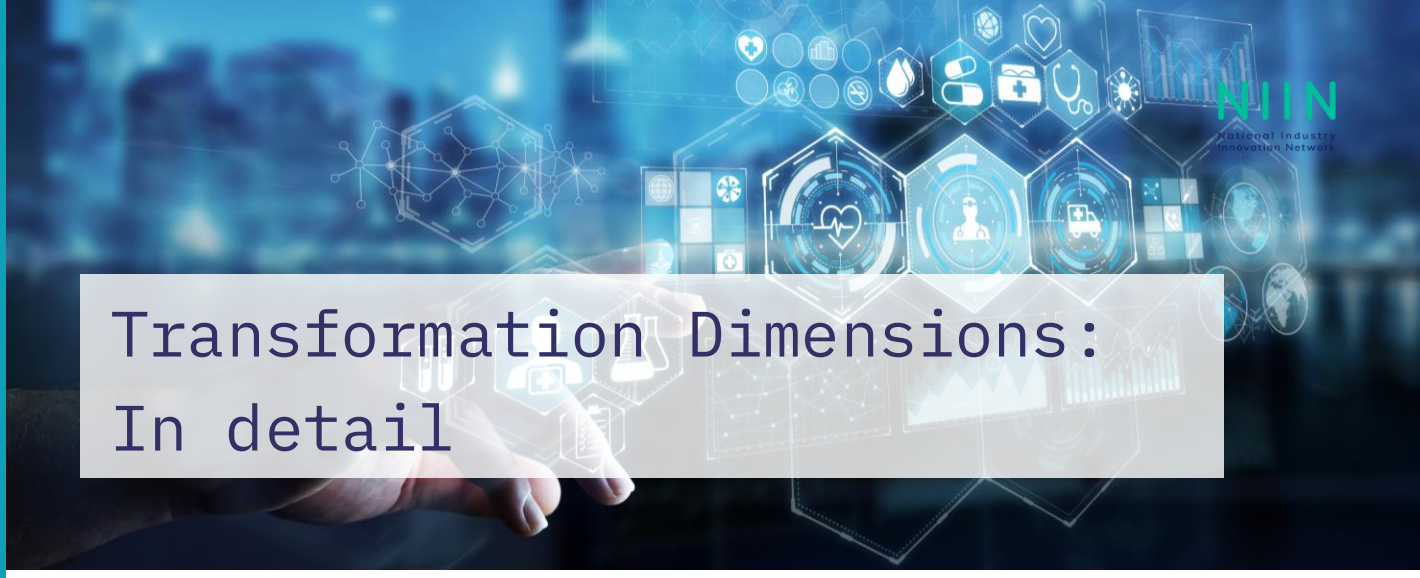
Advancing critical enabling infrastructure for the delivery and optimisation of high-quality and effective care, through the interaction of **physical, digital and human** elements of the system

Action Framework

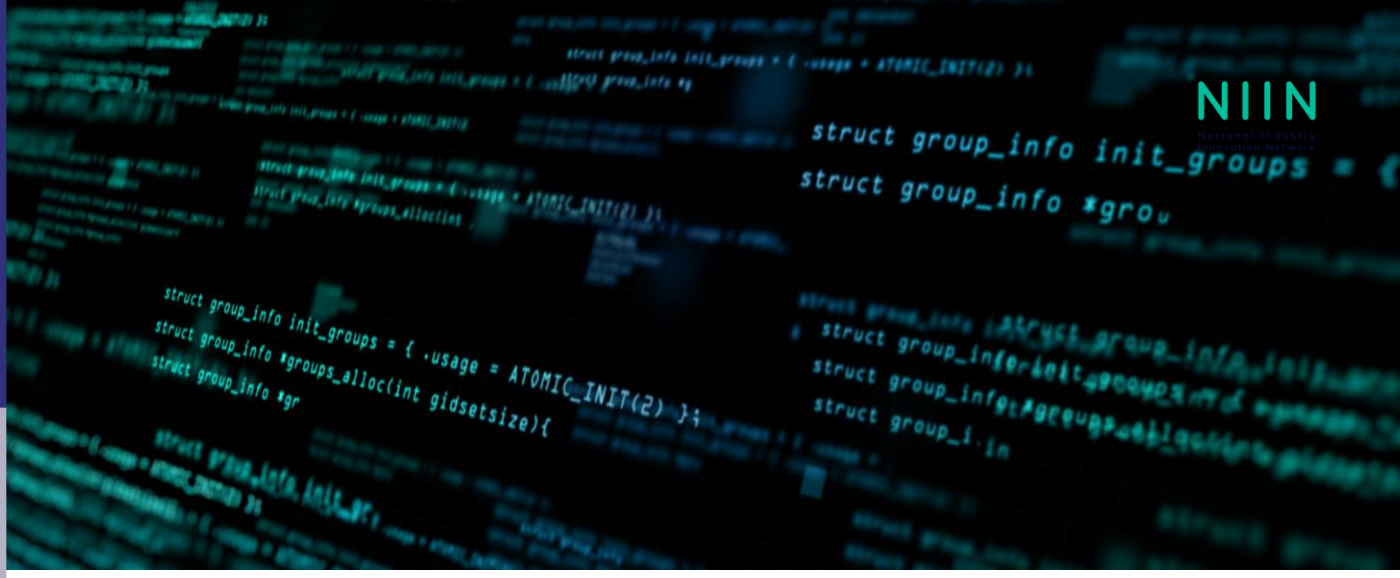
This Action Framework identifies and maps the actions that health ecosystem actors can take across 2024-2025, across three key phases:

- **Foundations**: Identifying and establishing the enabling conditions necessary for successful and ethical implementation. Includes digital and physical infrastructure, human resources and partnerships, and enabling governance, systems and process.
- **Activate**: Designing and activating small-scale in-situ trials to test, iterate and refine solutions; and mobilising workforces through pilot learnings and formal skills development.
- **Transform:** Planning and scaling implementation and adoption across organisations – and the broader system – through ecosystem partnerships and knowledge sharing.





Transformation Dimensions: In detail



Augmented intelligences

Towards the promise of genuinely smart healthcare

2024's most **hyped technology trend**

What is it?

Artificial Intelligence (AI) is undoubtedly the most hyped trend in health technology – and digital technology, more broadly – in 2024. Driven by the public unveiling of consumer generative AI in 2023, AI appeared as a top trend in every health-related report we surveyed and was the most common discrete technology mentioned in the health technology research literature.

That said, hyped terms are the most likely to be ill-defined, and the AI space is no exception to this. Rather than being a singular monolith or unified trend, the AI space is in fact a cluster of different subfields, technologies and methods, encompassing disparate domains, such as:

- algorithmic and deep learning (often called machine learning or ML)
- natural language processing
- computer vision
- autonomous navigation and robotics and more.

Traditional AI is an established technology, trained on specific types of data, to identify patterns and apply them to new cases. For example, Prenosis, a sepsis detection algorithm, is trained on patient vital signs, electronic medical records, and blood results, all annotated by humans to indicate whether sepsis was present.[18] When deployed, it scans these data points in real-time, alerting clinicians to potential sepsis cases, often before they would have otherwise noticed. This type of AI doesn't replace clinical decision-making but supports it by acting as an additional set of eyes.

Generative AI is less tested in clinical settings but has the ability to create text, images, and audio, that aren't direct copies of its training data. Trained on vast amounts of unannotated data, it identifies relationships between words, contexts, and concepts. At its best, generative AI can seem almost magical, responding thoughtfully to human queries or creating art in the style of long-dead masters. However, it can also make nonsensical recommendations, like suggesting glue to keep pizza toppings in place. Despite its powerful potential, generative AI isn't yet ready for deployment in healthcare due to its unpredictability.

What binds AI together as a technology area is the ability to analyse data and then make predictions (or generate applications) about new, previously unseen cases. The promises of AI and ML are the mimicry or augmentation of certain aspects of human cognition and intelligence, such as learning, reasoning, problem-solving, perception, language understanding, and content generation for gains in speed, efficiency, productivity, resource deployment and the like.

Beyond a narrow view of AI

The implication of this technology is profound. However, some (though of course not all) of the prevalent narrative about AI often seems to undersell this potential. Today, much of the marketing around AI highlights its potential to eliminate undesirable or low-value tasks. Google, for example, promotes an AI assistant to handle scheduling, while Microsoft's GitHub Copilot aims to automate routine coding. Similarly, in the health domain, numerous products, like the Australian-based *mAIscribe*, promise to handle clinical note-taking, allowing clinicians to focus more on patient care.[19]

This approach, while perhaps practical given AI's current capabilities, perpetuates an unhelpful distinction between tasks deemed suitable for humans and those relegated to machines. Instead of emphasising how AI can work alongside human intelligence in creative and analytical roles, current applications often target routine tasks. And from this the fear of displacing potentially millions of jobs becomes a dominant talking point.

There are, however, two compelling reasons to rethink AI's role more broadly:

- Firstly, limiting AI to routine tasks underestimates its potential to augment human creativity and analytical abilities. Imagine AI helping an artist become more innovative or a clinician more insightful—not by replacing them but by enhancing their skills and speeding up their journey from novice to expert.
- Secondly, history shows that automating routine tasks does not necessarily reduce workload. The computerisation of workplaces from the 1980s onwards promised to eliminate paperwork yet email and digital documentation have arguably increased administrative burdens. Just as steam-powered factories did not replace workers, computers have not eliminated the strain of administrative work. We should be sceptical that AI will be any different in this regard.

By focusing on how AI can enhance human cognitive tasks, rather than simply replace or displace them, we can better understand its current applications and future potential. Importantly, this approach can reorient our perspective and allow us to harness AI's capabilities more effectively and ethically across the healthcare landscape.

Healthcare intelligence(s)

Healthcare is a complex field that involves a wide range of tasks and cognitive functions.

By understanding and harnessing the capabilities of AI, we can fundamentally transform these functions, making AI ubiquitous throughout the healthcare system and radically remaking our healthcare delivery models.

In addition to all of the administrative, scheduling and similar benefits of AI, consider, for example, the following ways that it can strike to the heart of the health system's purpose and mission:

- AI being used to **predict and prevent** health needs before they arise, analysing vast swathes of data to evaluate and predict risks.
- The use of AI to radically improve **diagnosis and analysis**, analysing and interpreting images and test results at a pace and with a breadth unimaginable for individual clinicians.
- The ability of AI to **analyse and prioritise** healthcare, emergency response, resource usage or specific patient needs at a whole-of-provider or whole-of-system level (e.g., within a hospital, or across an ambulance network).
- Positive effects in **care and treatment planning and management** in light of continuous tracking and analysis of patient conditions and/or treatment effectiveness.

These cognitive elements – these healthcare intelligences – can be profoundly augmented through AI.

The transformative potential of healthcare AI

The effects of such an augmentation is potentially wide-ranging. AI's potential to enhance patient care and diagnostics is vast. AI applications that never tire, that never miss an element of a report, that cannot be distracted, that are constantly monitoring and responding to a global stream of data and evidence, hold unbelievable potential.

This augmentation also holds the possibility of radically and rapidly improving human skills in the health system.

Studies have shown that AI imaging diagnostics can quickly reach the diagnostic accuracy of expert radiologists.[1] At present, most diagnostic images are reviewed by junior radiologists but pairing them with AI support can improve diagnostic accuracy and accelerate their training. Humans and AI both learn by recognising patterns; however, humans need far fewer examples to generalise these patterns. Training with AI can thus enhance the learning curve, helping junior staff achieve expert-level proficiency more quickly.

Add to that AI's ability to 'cash-out' what is sometimes called the 'social contract of data'. Our ability to collect and analyse data has exponentially increased, presenting challenges in making sense of that vast amount of information. Wearables, like smartwatches, collect continuous data on physical activity, heart rate, and sleep quality, while hospitals gather data on patient flow, satisfaction, and other metrics. At a broader level, health departments map disease spread, identify health inequalities, and track mortality rates.

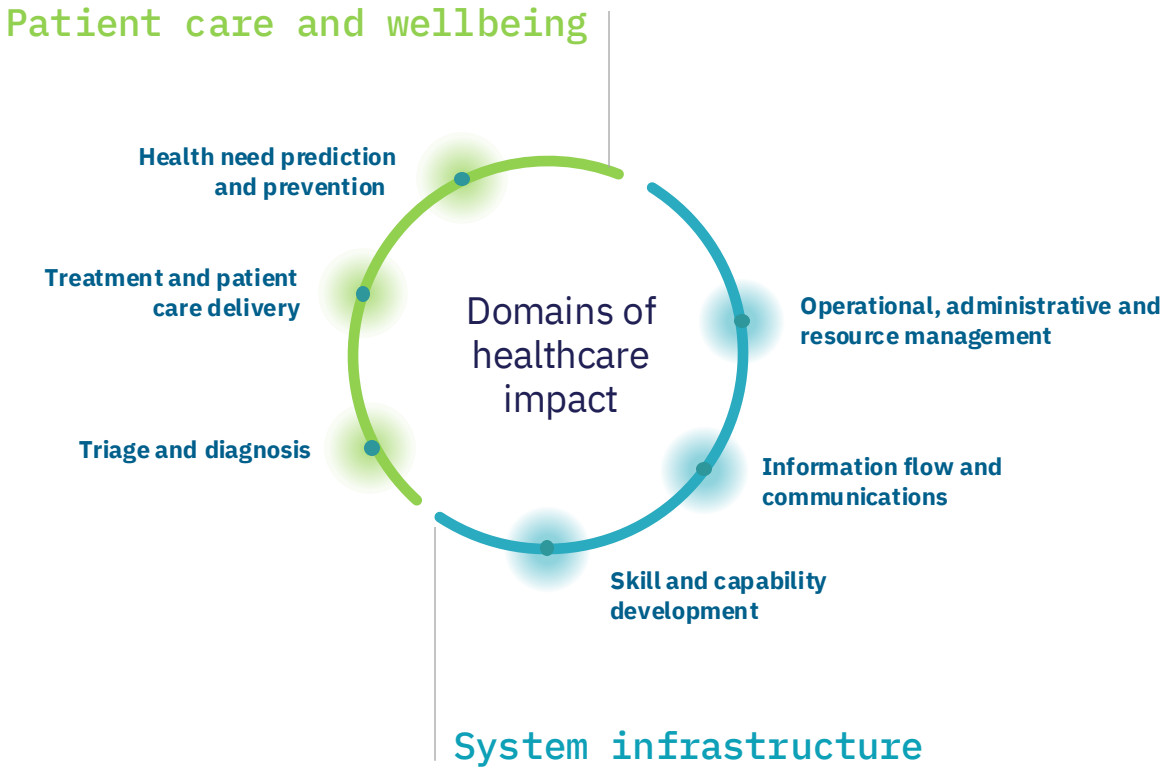
But for most individuals and most patients, the gains or benefits from this greater collection of data remain largely unrealised. In order to satisfy the implied consent – the social contract – of data collection, value must somehow be generated and provided in respect of that collection. Without demonstrating the value of data collection, its justification falters. AI holds the promise of extracting maximum value from data, providing real-time analyses that empower decision-makers. It can summarise data to enable effective decisions, highlighting the integration of human and machine thinking. As such, AI, in a way, can fulfil the promise of data collection.

Put another way: AI can – and should – be at the core, rather than the periphery, of tomorrow's healthcare systems.

Applications and Implications

As we have discussed, while early, the potential impact of AI across the core functions of the health system and its operations are extensive, touching almost every major element of the system.

In this section, we set out some illustrative applications and possibilities for AI across some of the key functions of the health system, using the system impact framework discussed above on page 16.



The table and pages that follow set out and describe these applications and implications, referring to and providing detail on illustrative case studies that help to demonstrate and bring this impact to life. Further case studies that have inspired us are contained in the Appendix on page 87.

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PATIENT CARE & WELLBEING

Health need prediction and prevention

Disease prediction
AI models can predict disease outbreaks and progression, enabling proactive care and preventive measures. This helps in early intervention, reduces the incidence of severe disease, and improves overall population health.

Risk assessment
AI can assess patient risks, suggesting preventive actions to reduce the likelihood of developing serious conditions. This enhances patient safety, prevents complications, and lowers healthcare costs by avoiding emergency situations.

Epidemiological analysis
AI can analyse epidemiological data to identify trends and potential health threats, aiding public health planning and interventions. This supports timely public health responses, improves resource allocation, and enhances community health outcomes.

Patient education
AI can analyse patient data and provide personalised educational content to patients on self-care and device usage through interactive apps and virtual assistants, improving their understanding and engagement in their own care. This empowers patients, enhances health literacy, improves chronic disease management and supports better health outcomes through informed decision-making.

Who's doing it:

Predictive Intelligence for Mosquito-Borne Diseases (BlueDot)

Triage and diagnosis

Medical imaging analysis
AI algorithms can analyse medical images quickly and accurately, assisting radiologists and other clinical professionals in diagnosing conditions more efficiently and accurately. This reduces the workload on clinicians, decreases human error, and speeds up diagnosis time for patients.

Pathological examination
AI can analyse laboratory results to detect patterns and anomalies, helping lab technicians and clinicians diagnose diseases faster. This improves diagnostic accuracy, reduces turnaround time for lab results, and enhances patient care.

Diagnostic decision making
AI can support clinicians by providing diagnostic suggestions and identifying potential issues based on patient data. This improves diagnostic accuracy, reduces diagnostic errors, and enhances clinical decision-making.

Who's doing it:

AI-Powered Breast Cancer Screening (ScreenPoint Medical)

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PATIENT CARE & WELLBEING

Treatment and patient care delivery

Treatment planning
AI can offer personalised, evidence-based treatment plans by analysing patient data and suggesting tailored therapies, improving treatment outcomes. This ensures more accurate and effective treatments, enhances patient satisfaction, and optimises care management.

Medication management
AI can recommend optimal medication dosages and schedules, reducing adverse drug reactions and improving therapeutic outcomes. This minimises medication errors, enhances patient safety, and improves treatment efficacy.

Patient monitoring
AI processes data from wearables and other monitoring devices, providing real-time insights and alerts to healthcare providers for timely interventions. This improves patient monitoring, enables early detection of issues, and enhances chronic disease management.

Patient support
AI-powered virtual assistants and chatbots offer 24/7 support, answering patient queries and providing guidance. This improves patient satisfaction, ensures adherence to treatment plans, and reduces the burden on healthcare providers.

Who's doing it:

AI-Powered Medication Safety (MedAware)

SYSTEM INFRASTRUCTURE

Operational, administrative and resource management

Resource allocation
AI can optimise resource allocation by predicting patient admission rates and suggesting efficient staffing and bed management strategies. This improves hospital efficiency, reduces waiting times, and ensures better patient care through optimal resource utilisation.

Appointment scheduling
AI automates scheduling, optimising patient flow and reducing administrative burdens. This enhances patient satisfaction, reduces no-shows, and improves the overall efficiency of healthcare delivery.

Supply chain management
AI can forecast demand for medical supplies, maintaining optimal inventory levels and reducing waste. This ensures the timely availability of necessary supplies, reduces costs, and improves the overall efficiency of the healthcare supply chain.

Who's doing it:

AI-Powered Healthcare Operations Automation (Qventus)

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SYSTEM INFRASTRUCTURE

Information flow and communications

Privacy and security
AI enhances data security by monitoring for breaches and ensuring compliance with data protection regulations. This protects patient privacy, builds trust in the healthcare system, and ensures compliance with legal requirements.

Health records management
AI can automate EHR management, ensuring records are up-to-date and reducing manual entry errors. This improves data accuracy, enhances clinical workflows, and ensures clinicians have access to comprehensive patient information for better care.

Data analysis
AI can identify trends and patterns in healthcare data, providing insights for improving patient care and operational efficiency. This enables data-driven decision-making, enhances health outcomes, and supports effective healthcare policies.

Emergency response
AI can enhance emergency response by analysing real-time data and offering decision support during critical situations. This improves response times, enhances patient outcomes in emergencies, and supports emergency medical personnel.

Who's doing it:

AI-Powered Security with Cisco Hypershield (Cisco)

Skill and capability development

Professional development
AI can deliver personalised training modules and continuous education, helping healthcare professionals stay current with medical advancements. This enhances professional development, improves clinical skills, and ensures high standards of patient care.

Medical education
AI-driven simulators and virtual reality environments provide immersive learning experiences for medical students. This improves hands-on learning, accelerates skill acquisition, and prepares students for real-world clinical scenarios.

Skill acquisition
AI-based training programs offer interactive and adaptive learning experiences, helping healthcare workers acquire new skills efficiently. This improves staff competencies, enhances patient care, and supports continuous professional development.

Who's doing it:

Touch Surgery™ Ecosystem for Surgical Training (Medtronic)

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Who is doing it

Predictive intelligence for mosquito-borne diseases

Who: Blue Dot

What: BlueDot employs predictive intelligence to forecast global climatic suitability for Aedes albopictus and Aedes aegypti mosquitoes under various climate change scenarios projected for the next decade. This allows health services to plan for any forecast increases in the incidence of mosquito-borne illnesses. BlueDot's methodology utilises a gradient-boosted regression tree model, integrating data on precipitation, surface temperature, and elevation. Historical mosquito occurrence data informs the model, which predicts suitability at a detailed resolution of 5km by 5km. The model accounts for three climate change pathways: SSP 1-2.6 (best-case scenario), SSP 2-4.5 (most-likely scenario), and SSP 5-8.5 (worst-case scenario) from the 6th Coupled Model Intercomparison Project.

Links: BlueDot

AI-powered breast cancer screening

Who: ScreenPoint Medical

What: ScreenPoint Medical has created Transpara®, an advanced AI solution for breast cancer screening. Developed over a decade, Transpara® analyses mammograms to assist radiologists by highlighting potential areas of concern, enhancing the accuracy and efficiency of breast cancer detection. It identifies abnormalities and prioritises cases by cancer likelihood, allowing radiologists to focus on the most critical cases. This AI system integrates seamlessly into existing workflows, improving diagnostic confidence and reducing healthcare professionals' workloads. Transpara® significantly advances breast cancer screening by providing earlier and more reliable detection, thereby optimizing healthcare resources.

Links: ScreenPoint Medical

AI-powered medication safety

Who: MedAware

What: MedAware has developed an AI-driven platform to enhance medication safety by identifying and preventing prescription errors. Leveraging extensive data from electronic health records (EHRs), MedAware's system utilises machine learning algorithms to detect anomalies and potential adverse drug events (ADEs). The technology analyses prescription patterns, comparing them to historical data to flag deviations that could indicate errors. By integrating seamlessly into existing healthcare workflows, MedAware's solution supports healthcare providers in making safer, more informed prescribing decisions, thereby reducing the risk of medication errors and improving patient outcomes. The platform also addresses challenges like alert fatigue by refining the accuracy of its notifications, ensuring that healthcare professionals receive only the most pertinent alerts. This approach not only enhances patient safety but also optimises the efficiency of healthcare operations.

Links: MedAware

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Qventus: AI-powered healthcare operations automation

Who: Qventus

What: Qventus offers an AI-driven platform designed to optimise hospital operations by predicting bottlenecks, recommending solutions, and automating processes through seamless EHR integration. The platform improves surgical scheduling, discharge planning, and resource utilisation, enhancing efficiency and reducing length of stay. By combining real-time data and machine learning, Qventus helps healthcare providers create capacity, reduce manual work, and increase revenue. Trusted by top healthcare institutions, Qventus delivers significant ROI and improves patient care through intelligent automation.

Links: Qventus

AI-powered security with Cisco Hypershield

Who: Cisco, in collaboration with NVIDIA and Isovalent

What: Introduced in 2024, Cisco Hypershield is a groundbreaking security architecture designed for the AI era. Built from the ground up with AI-native technology, it redefines how data centres and cloud environments are secured.

Hypershield provides autonomous segmentation, distributed exploit protection, and self-qualifying upgrades. It leverages the power of AI to automatically segment networks, identify and shield vulnerabilities before they can be exploited, and deploy upgrades without downtime. This AI-driven approach significantly enhances security while reducing the complexity and cost traditionally associated with manual processes.

Links: Cisco hypershield blog

Medtronic Touch Surgery™

Who: Medtronic

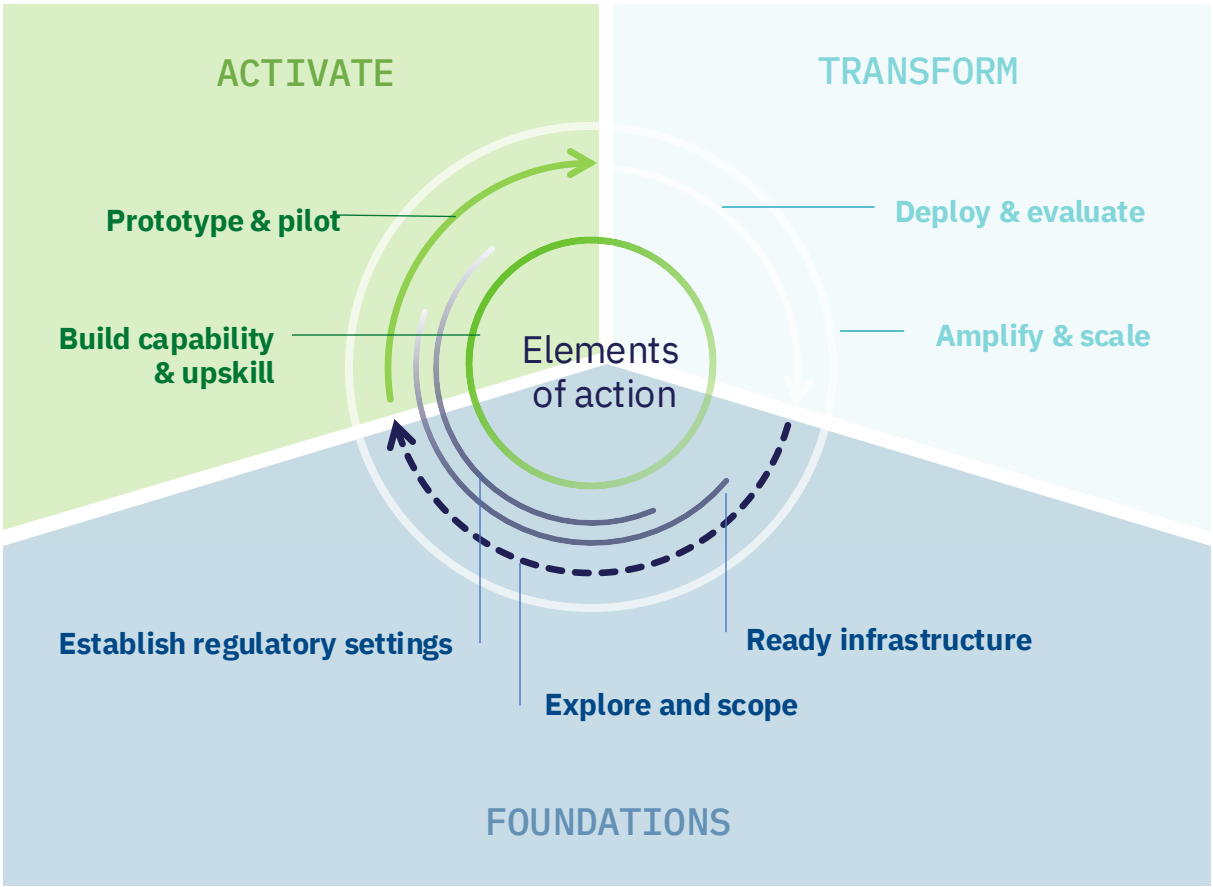
What: Touch Surgery™ is an AI-powered ecosystem that enhances surgical procedures through digital solutions. It offers tools for video capture, performance insights, live streaming, simulations, and connectivity. These features enable surgeons to turn complex data into actionable insights, track progress, and improve surgical efficiency. The platform integrates next-generation computing and visualisation technology, supporting surgeons before, during, and after surgery.

Links: Medtronic

Actions for 2024-2025

The potential for AI technologies to revolutionise nearly every major function of the health system is staggering. And the focus in technology and healthcare circles in developing applications has been laudable. That said, these technologies – though prominent and visible – require a good amount of further development before they are ready for at-scale deployment, as does the technology infrastructure in the health system on which they will rely.

As such, we recommend that actors from across the health and technology ecosystems disproportionately focus in 2024-25 on setting the foundations, activating and putting in place building blocks across several domains of the system to scope, position for, and experiment in AI deployments in key strategic areas.



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Actions

	Healthcare Providers	Technologists	Government & Policy Makers	Researchers & Universities
FOUNDATIONS				
Establish regulatory settings: • Strengthen regulations around data privacy and security to protect patient information. • Develop and enforce AI use standards in healthcare to ensure safety, efficacy, and ethical use. • Provide funding and incentives for AI research and development in healthcare.			●	
Explore & scope • Establish partnerships to drive AI innovation and implementation. • Define specific goals, desired impacts, and assess AI's appropriateness for specified challenges. • Consider and resource human oversight and supplementary decisions to mitigate risks of AI application. • Prioritise AI initiatives that enhance patient safety and health outcomes.	●	●	●	●
Ready infrastructure: • Build and maintain robust data pipelines, warehouses and data management systems to ensure high-quality, structured health and other data for AI training and operation. • Implement advanced cybersecurity protocols and conduct regular audits to protect sensitive health data. • Standardise data formats and collaborate to enhance data interoperability and streamline AI integration.	●	●		
ACTIVATE				
Build skills & capability: • Invest in technology professionals with the skills to distinguish between AI tools that are fit for purpose and those that are mere hype. • Develop health specific training in AI management for technology professionals.	●	●		●
Prototype & pilot: • Start with narrow AI applications to health settings (e.g., imaging analysis, sepsis detection, operational domains). • Foster collaboration between technology companies and healthcare providers to develop AI tools tailored to specific clinical and operational needs. • Implement strategies to identify and mitigate biases in AI models and ensure transparency. • Create platforms for sharing best practices and lessons learned from AI implementations • Work with tech developers to provide clinical insights and advocate for necessary resources and support. • Actively explore use of existing AI tools in diagnostics, treatment planning, and patient monitoring.	●	●	●	●

Simulation and simulacra

Using digital replicas to hack the real world

The frontier of the **Digital** and the **Real**.

What is it?

The physical world is hard, finite, and often dangerous. Making changes to it – building a hospital, operating on a patient – is doubly so. It involves real risk and significant cost.

However, the boundary between that hard, real world is becoming increasingly blurred with the world of the digital. Technological advancements have ushered us into an era where digital simulations can replicate, augment, and even enhance our interactions with the physical world.

Imagine a world where we can experiment without consequences, where we can mould and manipulate reality without fear of failure or harm. This convergence of digital and physical realms is not merely a futuristic fantasy; it is today's reality, with profound implications for healthcare.

By leveraging the power of simulations and simulated reality, we can explore new frontiers, test solutions, push the boundaries of innovation, and ultimately improve the quality of care. This section delves into the cutting-edge technologies that are making this vision a reality, exploring their applications, benefits, and implications – and how digital tech is allowing us to 'hack' the real world.

There are three key types of simulation technology that contribute to this domain of change: Extended Reality (XR), digital twins and 3D printing.

Extended Reality (XR): hybridising the digital and the real

XR comprises Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). These technologies create immersive and interactive environments that blend the physical and digital worlds. As these technologies develop and the barriers between them break down, expect to see the term 'Extended Reality' become more commonplace. We will use Extended Reality and XR as catch-all terms, specifying particular technologies where relevant.

Virtual Reality (VR) is experienced through a VR headset and involves the creation of immersive 3D-environments. Completely replacing a user's view of the world, VR is ideal for depicting things that do not exist: a proposed hospital build; practicing with a virtual prosthetic while waiting for a real one. The immersive nature of VR can also be used to distract from the real world and has been used successfully to distract patients undergoing treatment or with chronic pain.

Augmented Reality (AR) refers to any technology that overlays digital images onto a real-time visual stream. That stream can be a person's direct vision – for example, with transparent glasses projecting information onto their view – or it can be through a digital camera with the real and digital worlds married together on a screen. The latter are widespread, with applications including:

- AI computer vision recognition. Industrial uses include traffic monitoring, room occupation and security. Consumer applications abound ranging from all-purpose services (e.g. Google Lens) to more specific applications (e.g. SkyView, which overlays constellation names and other information onto vision of the night sky).
- Visualising digital objects in real spaces, popular for interior design and planning.
- Games that place fanciful objects into real world vision (e.g. Pokémon Go).

However, AR glasses for real-time direct vision have proven to be a significant engineering challenge. Google Glass was discontinued soon after launch and Microsoft's HoloLens remains large, heavy and with few compelling uses.

Mixed Reality (MR) is the least well-developed of these technologies, blending physical and digital interaction together. MR encompasses two distinct applications:

- Physical manipulation of digital objects. The archetypal example of which is a holographic projection of objects that can be picked up and moved around.
- Digital manipulation of physical objects. In this case an end-user's movements are conveyed back into the real-world. Remote surgery, where a surgeon uses VR to remotely control a surgical robot, is an oft-suggested, though currently unproven, example of this type of MR.

A key dimension of extended reality technologies in healthcare is their ability to provide immersive training environments where medical professionals can practice complex procedures without risk. Virtual Reality (VR) and Augmented Reality (AR) offer realistic simulations of surgical procedures, allowing clinicians to refine their skills in a safe, controlled setting. Mixed Reality (MR) blends physical and digital interactions, enabling hands-on practice with virtual tools. This hands-on experience is invaluable, accelerating the learning curve and ensuring that medical professionals are well-prepared for real-world scenarios.

Digital twins: metaphors and mirrors of reality

A digital twin is a high-fidelity virtual model of a physical object or system, where the state of the model at any time is a mirror of the twin. In popular conception digital twins are synonymous with the visualisation of a space or system, though the visualisation aspect is the least essential part of a true digital twin. In their purest form, digital twins are streams of data taken from sensors on physical objects, which can then be manipulated to model how these changes would affect the rest of the system.

Digital twins are a natural extension of computational models long used in fields like aeronautical and automotive engineering. Digital wind tunnels, for example, have largely replaced their physical counterparts, offering equivalent accuracy at a much lower cost. At a system-level, digital twins have been used to recreate assembly lines so that (a) the efficiency of the line can be examined and assessed and (b) the impact of any proposed changes can be modelled before implementation.

In this role digital twins can present to a decision maker the complex, interlocking process of a large system in a way that is understandable. The incorporation of digital twins into health systems is less well developed than in other industries and still a work in progress. Publications on digital twins and health have exploded in the last 4 years (among the papers indexed on PubMed, two-thirds of those on digital twins have been published since 2020) but working implementations are rare – and the opportunity to pioneer this space is immense.

For example, building new healthcare facilities is a significant investment, and design flaws can be costly. The Royal Adelaide Hospital in South Australia serves as a cautionary tale. At the time of its opening, it was the most expensive hospital build in Australia at $2.4 billion.[20] However, it quickly became apparent that the facility had several design flaws: the Emergency Department did not have enough space to accommodate a predictable number of patients; resuscitation rooms, when filled with the necessary equipment, had no room for a patient and treating team; no discharge lounge was included, leaving patients on wards for longer, slowing movement from Emergency onto the ward, and ending with ambulances 'ramping' because occupants could not be moved through the facility.[21]

Digital twins can transform this process by creating high-fidelity virtual replicas of the proposed – or indeed existing – facilities, allowing for thorough testing and optimisation before construction begins. A digital twin can simulate patient flow through the hospital, revealing inefficiencies and bottlenecks in the design. For instance, it would highlight the inadequate space in the Emergency Department and the need for a discharge lounge to ensure smooth patient transitions. Such insights enable designers to make informed adjustments before construction, saving significant time and money.

At the system level, digital twins enable predictive analytics that inform public health strategies and interventions. By continuously analysing data from various sources, digital twins can predict disease outbreaks, monitor public health trends, and evaluate the impact of health policies. This proactive approach allows health systems to respond quickly to emerging threats, allocate resources effectively, and implement preventive measures that improve population health.

Perhaps further afield, digital twins hold promise for creating detailed models of individual patients. These models integrate data from genetic profiles, medical histories, and real-time physiological readings, allowing for the simulation of personalised treatment plans. This precision in treatment planning can lead to improved outcomes and reduced side effects. Though it is not yet possible to model the full complexity of human physiology, improvements in computing power coupled with the development of AI are making it possible to create computational models of a sufficient complexity, to accurately predict treatment effects in real patients.

At present the areas of greatest promise are those where treatments occur with the most limited information. A project to create a digital twin of human brains, for example, is being trialled to assist in neurosurgery for people suffering severe epilepsy.[22] Existing practice is to excise parts of the patient's brain thought to be triggering seizures, but precise information about the damaged locations is extremely limited. By collating data across thousands of such surgeries, it is hoped to improve surgical success rates.

Crucially, the utility of digital twins is fundamentally dependent on the nature, quality, and comprehensiveness of its data. A digital twin can only model or predict the effects of variables included in the data, meaning that failing to include one or another piece of information can result in models that appear to operate flawlessly while – in actuality – they have no true relationship to their physical counterpart. In an individual, missing one seemingly small aspect of their physiology might make treatment predictions invalid or unreliable. Collecting all possible relevant data and dynamically following all the different interactions in a system are, therefore, essential if a digital twin is to be a useful tool.

3D printing: when the digital becomes the real

In an era where digital simulations increasingly overlap with tangible reality, 3D printing stands out as a revolutionary technology that brings digital designs into the physical world. Known as additive manufacturing, 3D printing constructs three-dimensional objects by successively layering materials based on precise digital models. This technology has expanded the boundaries of innovation, enabling the creation of complex structures that were once impossible to fabricate, using traditional manufacturing methods.

3D printing begins with a digital design, often created using computer-aided design (CAD) software. This digital blueprint is sliced into thin horizontal layers, each representing a cross-section of the final object. The printer then follows these instructions, depositing material layer by layer to build up the object. Materials used in 3D printing range from plastics and resins to metals and even biological substances, depending on the application. The process is incredibly versatile, allowing for the creation of intricate geometries and custom designs with high precision.

One of the most transformative aspects of 3D printing is its ability to personalise production. In healthcare, this means creating custom-made prosthetics and implants tailored to the unique anatomy of each patient, improving comfort and functionality. Surgical models that match a patient's specific anatomy can be printed to assist surgeons in planning and rehearsing complex procedures, thereby increasing the success rates of surgeries. Moreover, the technology is pushing the frontiers of tissue engineering, with researchers exploring the possibility of printing biological tissues for use in regenerative medicine and transplants.

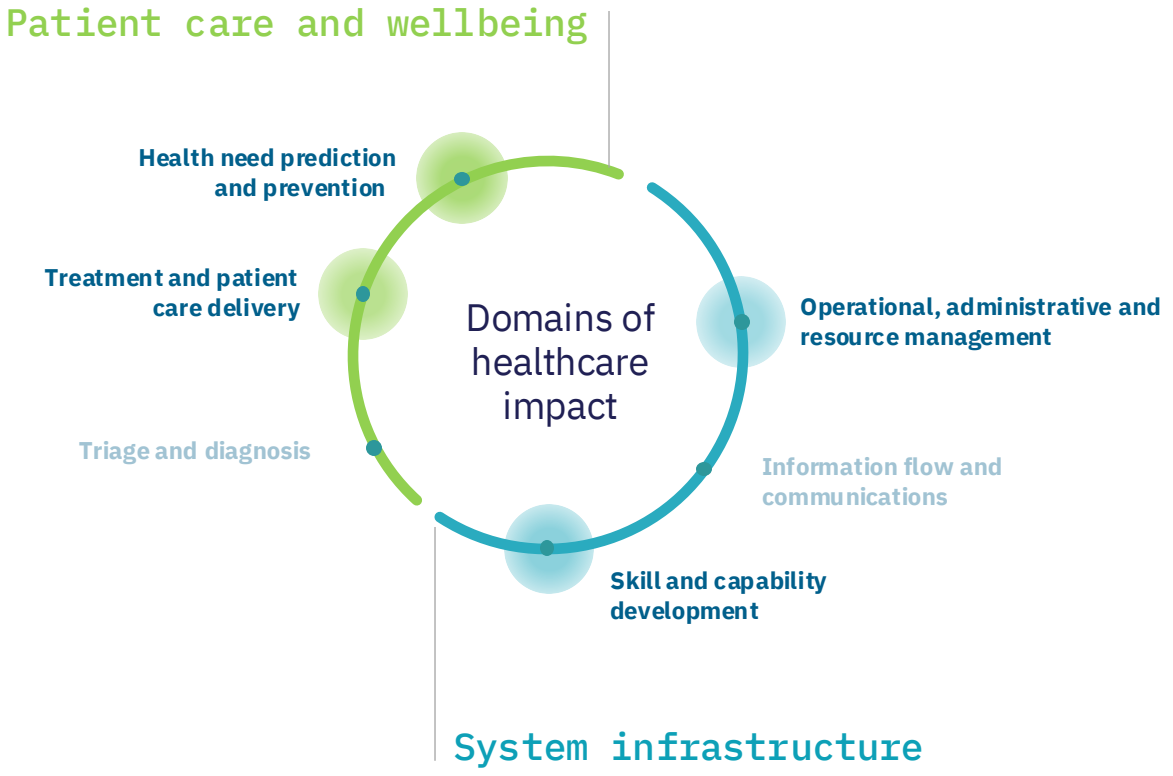
The implications of 3D printing extend far beyond its immediate applications. It embodies the convergence of digital and physical realms, where digital designs are not merely confined to computer screens but are brought to life as tangible objects. This shift transforms the way we think about things like pharmaceutical manufacture and prescribing: 3D-printing bespoke personalised medicines at home would be a dramatic shift from the status quo.

In essence, 3D printing is a manifestation of the digital actually *becoming* real in a sense – bridging the divide between the real and digital worlds – and offering unprecedented opportunities to customise and optimise products in various fields, particularly in healthcare.

Applications and Implications

As we have discussed, the potential impact of simulation technologies across the core functions of the health system and its operations are extensive, touching elements of the system across both patient care and system infrastructure.

In this section, we set out some illustrative applications and possibilities for simulation technologies across some of the key functions of the health system, using the system impact framework discussed above on page 16.



The table and pages that follow set out and describe these applications and implications, referring to and providing detail on illustrative case studies that help to demonstrate and bring this impact to life. Further case studies that have inspired us are contained in the Appendix on page 87.

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PATIENT CARE & WELLBEING

Health need prediction and prevention

Digital Twins for clinical trials
These digital twins allow clinical researchers to enrol participants in a treatment group and estimate their twin's response as if they were in the control group. This can make clinical trials less expensive by reducing the required number of participants and participant recruitment easier by offering higher odds of treatment.

Digital Twins for clinical workflow prediction
Digital twins of system processes can highlight ways in which systems can become more efficient. Though ultimately implemented as computational models, construction first requires detailed organisational research to understand a clinical system's moving parts (clinicians, patients, allied health) and how they interact.

Who's doing it:

Digital twin control groups in clinical trials (Unlearn AI)

Treatment and patient care delivery

VR for patient care
VR can be used for pain management and rehabilitation. This provides therapeutic environments, reducing pain and enhancing rehabilitation outcomes.

Digital Twins for personalised care
Personalised digital models of individual patients are beginning to close the gap between the enormous complexity of human physiology and the still limited capabilities of computational models. Models to predict simple drug responses are becoming increasingly accurate and may in future aid in optimising patient care and reducing adverse drug responses.

Treatment guide Digital Twins
In fields with persistent uncertainty (such as neurosurgery for epilepsy), composite digital models of many patients can provide guidance, striking a balance between the individual anatomy of patients and the overall physiological similarity between humans to estimate treatment sites.

3D-printed implants and prosthetics
3D printing allows medical devices to be customised to individual patient specifications. Open-source prosthetic repositories also empower patients to print a prosthetic to fit any activity.

3D printing in research
Printing biological tissues for research and potential future transplants advances research in tissue engineering and regenerative medicine, opening new treatment possibilities.

3D-printed surgical models
Printing patient-specific anatomical models for surgical planning enhances surgical precision and planning, reducing risks and improving outcomes.

Who's doing it:

Printing Cures: 3D-printed liver tissue (Organovo)

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SYSTEM INFRASTRUCTURE

Operational, administrative and resource management

Digital twins for hospital ops
Simulating hospital operations to optimise resource allocation and patient flow enhances efficiency, reduces operational costs, and improves patient care.

Who's doing it:

Digital twin of Intensive Care (Mayo Clinic)

Skill and capability development

VR simulations
Creating immersive 3D environments for training medical professionals provides risk-free practice environments, enhancing skill acquisition and retention.

AR training
Overlaying digital information on real-world views for medical training enhances understanding of anatomical structures and surgical procedures.

Who's doing it:

Osso VR

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Who is doing it

Digital twin control groups in clinical trials

Who: Unlearn

What: Unlearn is an AI and digital twin company seeking to reduce the cost and increase the effectiveness of clinical trials. By creating simplified digital twins of human trial participants, Unlearn can model the effect of that participant being enrolled in the placebo arm of a trial. Being able to model a digital placebo arm means that trials can enrol a greater proportion of participants into treatment (which can also boost overall enrolment numbers since most potential participants would prefer the treatment) and it can also boost the statistical power of the trial, resulting in a need for fewer participants overall. As a statistical methodology, the use of digital twin controls has received approval from the European Medicines Agency and Unlearn is in the process of proving that its digital twins accurately represent the disease progression of physical participants in a control arm.

Links: Unlearn

Printing Cures: Organovo advances with 3D-printed liver tissue

Who: Organovo

What: Organovo, founded in 2007 and based in San Diego, pioneer's 3D printing in tissue engineering. Their technology, licensed from the University of Missouri, utilises droplet-based, inkjet, and continuous deposition methods to create human cell-based tissues without exogenous scaffolds or plastic culture dishes. These tissues closely mimic human physiology, making them valuable for in-depth in vitro studies and potentially reducing reliance on animal models in drug testing. Organovo aims to develop biocompatible tissues for transplantation, starting with smaller tissue grafts such as liver patches. These grafts have shown promise in animal studies, demonstrating stable engraftment and protein circulation akin to human liver function. The company targets paediatric inborn errors of metabolism and acute-on-chronic liver failure for initial applications, seeking FDA approval to advance into clinical trials.

Links: Organovo

Digital twin of intensive care

Who: Mayo Clinic

What: Recognising that clinical workflow is a key predictor of patient outcomes, researchers with the Mayo Clinic developed a digital twin of the Intensive Care Unit (ICU). A key challenge in creating a digital twin is properly conceptualising the different parts of a system and how they interact. To solve this, qualitative interviews and focus groups were conducted with clinicians, nurses and allied health. From this the team developed a hybrid simulation model capturing both system state and individual movement through the system. That model then underwent a series of validation iterations with prospectively recruited patients. The final product accurately modelled the state of the ICU at any time point and was used to model the effect of different management policies on patient outcomes. Overall, this was a significant, multi-stage process taking in model conceptualisation, systems engineering, qualitative and quantitative data collection, a real-time utilisation study and the computational modelling of interventions.

Links: Mayo Clinic

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Osso VR

Who: Osso VR

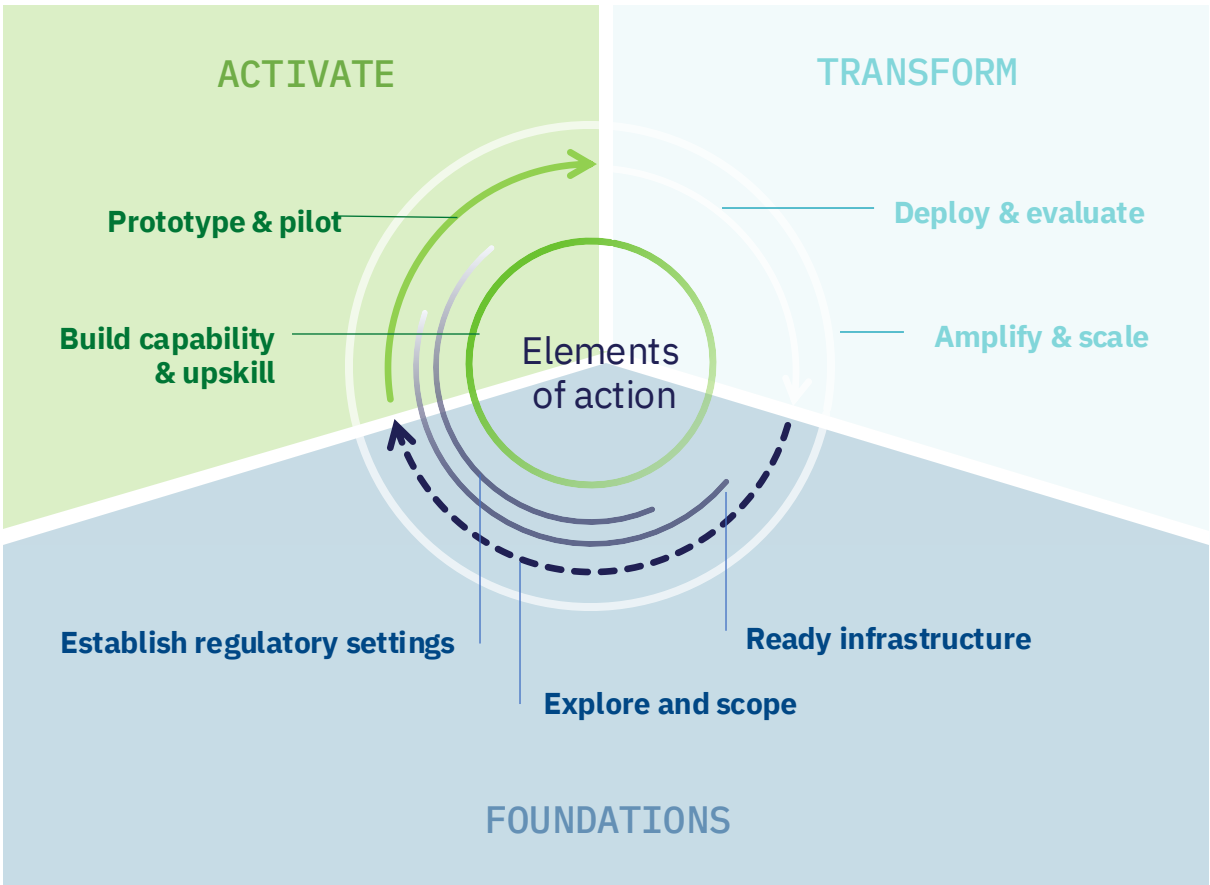
What: Osso VR is a leading virtual reality surgical training and assessment platform. It offers custom-developed VR modules, early career healthcare professional (HCP) training, and extensive research resources. The platform enhances learning, improves procedural competency, and provides detailed performance analytics. Osso VR's technology supports medical device companies and healthcare professionals by enabling realistic, immersive training experiences that accelerate skill acquisition and improve patient outcomes.

Links: Osso VR

Actions for 2024-2025

Simulation technologies, as we have seen, are developing but are still broadly in early stages of deployment, in even the most advanced health systems and providers.

As such, we recommend that actors from across the health and technology ecosystems focus in 2024-25 on setting the technology foundations that simulation technologies need to build upon, and on collaborative scoping. prototyping, and piloting of these technologies to learn and plan for more fulsome deployment and leverage.



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Actions

		Healthcare Providers	Technologists	Government & Policy Makers	Researchers & Universities
FOUNDATIONS	**Establish regulatory settings:** • Develop a flexible regulatory framework that allows for safe experimentation with new technologies. • Provide funding and incentives to build the necessary data infrastructure for advanced simulation technologies.			●	
	Explore & scope • Investigate potential uses of 3D printing for custom medical devices and establish initial use cases to support digital twin implementation.	●	●		●
	Ready infrastructure: • Evaluate readiness for digital twins: assess current data infrastructure and identify gaps that need to be addressed • Implement advanced cybersecurity protocols and conduct regular audits to protect sensitive health data. • Implement strategies to identify and mitigate biases in models and ensure transparency and accountability. • Standardise data formats and protocols to ensure seamless integration of simulation technologies.	●	●		
ACTIVATE	**Build skills & capability:** • Develop ongoing training and resources to healthcare providers in VR, AR, and MR training programmes to build familiarity and skills with these technologies.	●	●		●
	Prototype & pilot: • Foster collaboration between healthcare providers, technology companies, and universities to design pilot projects. • Start incorporating simulation tools like digital twins and 3D-printed models into clinical practice on a trial basis to build internal capacity and evaluate their effectiveness. • Focus on creating scalable and adaptable simulation solutions that can grow with healthcare providers' needs.	●	●		●

Remote patient care

Care that meets the patient where they need it

A long-standing concept **suddenly catalysed**.

What is it?

Remote patient care (RPC) is not a new idea. It is, in fact, a high-tech reversion to the type of system that was prevalent for hundreds of years.

Before the dual medical advancements of anaesthesia and antisepsis in the mid-19th century hospitals were dangerous places, catering only to those patients who could not afford to receive treatment at home. Not until the 1950s did the hospital become the centre of healthcare provision and, perhaps unsurprisingly, as soon as technology had advanced to the point where hospital-level care was available at home, patients have started to request it.

Over time, these healthcare settings have moved from being a sensible and efficient innovation, to being perceived as a fetter on the ability of care systems to meet patient needs – and patients themselves – where they are. The brilliant idea of concentrating infrastructure, care contexts and specialised professionals in one place has become bemoaned as forcing patients to conform to the system, rather than the other way around.

Technology change, however, has brought us full circle. Enter RPC.

As a concept, RPC is easily summarised as the utilisation of communication technologies and network-connected sensors to provide care to an individual in circumstances where the carer and patient are not in the same physical space.

No single area of health technology was pushed harder by the pandemic. Faced with unprecedented challenges, healthcare systems worldwide rapidly integrated telehealth and other remote care solutions to ensure continuity of care, while minimising physical contact. What once took years to develop and deploy was accomplished in mere weeks, belying the usual tropes of lethargy and aversion to change, and showcasing the healthcare system's agility and capacity for rapid innovation.

While the concept is straightforward, in practice implementation involves a dizzying array of technologies and settings – each that demand tailoring, to meet specific patient needs – and hence some further clarification is required.

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A cluster of technologies...

RPC is made possible by the linking together of multiple technologies, including:

- **Video conferencing:** Widespread and the basis for telehealth.
- **Electronic Medical Records:** Cybersecure but shareable with community health practitioners.
- **Remote sensors:** Wearables, nearables, ingestible sensors, computer vision, implanted sensors like implantable cardioverter defibrillators.
- **Extended Reality:** VR consultations, AR and remote control between ED and paramedics.
- **Robotics:** Telepresence and remote deliveries (particularly for pharmaceuticals).
- **3D printing:** Home printing of pharmaceuticals.
- **Artificial Intelligence:** To monitor incoming data from remote sensors and alert when patient condition deteriorates.
- **Cloud computing and Storage:** For anywhere access to patient records and to receive sensor readings.

...utilised across multiple moments...

There are several healthcare contexts in which RPC can operate. Thinking about the structure of healthcare, we can be clearer about the ways that RPC has, and can, be integrated into healthcare systems.

Preventive Care and Wellbeing Support

- *Remote Screening and Early Detection:* Patients can use home diagnostic tools to conduct regular screenings for conditions like atrial fibrillation, sleep apnoea and respiratory issues.
- *Interactive Tools for Mental Health:* For patients experiencing complex mental health issues, interactive tools can help them, and their families, to respond appropriately to changes in their condition.

Initial Contact

- *Virtual Emergency Department:* Emergency physician rostered onto telehealth shift to accept emergency patients over telehealth.
- *Paramedics:* Utilised as an extension of the emergency department, powered by virtual communications between paramedics and dedicated emergency staff.

Ongoing Care

- *Chronic Disease Management:* Chronic diseases require ongoing monitoring to reduce their burden and avoid acute episodes. Background monitoring from wearables and other sensors can reduce the need for routine check-ups.
- *Infectious diseases:* During pandemics, or other outbreaks, treating patients outside hospitals can reduce risk of in-hospital spread and keep hospital beds free for the most seriously ill. Wearable sensors can be used to flag any deterioration in condition
- *Rehabilitation:* Following trauma or injury patients can spend months as in-patients so they can complete daily rehab sessions. Moving these to virtual sessions allows patients to return home much sooner.
- *GP Management:* The availability of virtual hospital care empowers GPs to manage patients in the community with the option of transitioning to hospital care if necessary.

Leaving Care Settings

- *Post-Operative Monitoring:* Patients discharged with biosensors as a safety net in the case of deterioration. Often combines wearables, mobile apps and virtual consultations.
- *Hospital in the Home:* Home visits managed through the admitting surgical or medical team reduce lengthy in-patient stays.
- *Telehealth Follow-up*: The simplest version of RPC involves moving post-surgery follow-ups online for patients who find it more convenient or otherwise preferable.

…to promote systemic hybridity

Unlike the other themes covered in this Report, the implementation of RPC is not a new intervention in the sense that it is not seeking to introduce new treatment modalities or to improve upon the best standard of care.

In fact, the purpose is to maintain the already high standard of care being provided within hospitals *while* making it available and possible elsewhere. For some, for whom hospitals are inaccessible whether by distance or some other factor, then the standard of care provided in the community will improve. But the core aim is not to better the gold standard, rather to make it available in more places.

From this we extract the notion of health system 'hybridity': the notion that the health system should strive to combine the advantages of traditional face-to-face healthcare with the innovative capabilities of digital technology to enhance patient care. This approach integrates remote patient monitoring, telemedicine, and digital health tools with in-person visits, creating a seamless and more efficient healthcare experience. By leveraging both in-situ and remote care, hybrid health systems can offer continuous monitoring and support, improve patient outcomes, and increase access to healthcare services, especially for those in remote or underserved areas.

Remote patient care, enabled by digital technologies, allows for real-time monitoring of patients' vital signs and health metrics, from the comfort of their homes. Wearable devices, mobile health apps, and telemedicine platforms facilitate continuous data collection and enable healthcare providers to track and respond to changes in patients' conditions swiftly. This continuous monitoring can lead to early detection of potential health issues, timely interventions, and more personalised care plans. Additionally, telemedicine consultations provide patients with the convenience of virtual visits, reducing the need for travel and minimizing exposure to infectious diseases.

Furthermore, the hybrid model supports system benefits such as devolution and specialisation. By decentralizing care through remote health services, healthcare systems can distribute workloads more evenly across various regions and facilities, reducing pressure on centralised hospitals. This devolution allows for a more equitable distribution of – or perhaps more properly, access to – healthcare resources.

Specialisation is also enhanced as routine check-ups and follow-ups can be managed remotely, freeing up specialists to focus on more complex cases and procedures that require their expertise. This stratification of care can contribute to patients receiving the most appropriate and specialised attention based on their specific health needs.

Moreover, hybrid health systems can improve healthcare efficiency and resource allocation. By managing routine care and follow-ups remotely, healthcare facilities can focus their in-person resources on more critical cases and procedures. This can help reduce patient wait times, optimise the use of healthcare professionals' time, and decrease the overall burden on healthcare infrastructure.

Ultimately, the hybrid health system represents a forward-thinking approach to healthcare, leveraging technology to bridge gaps in service delivery, enhance patient engagement, and create a more resilient and adaptive healthcare ecosystem.

A note of caution

In discussions of remote patient care, it is common to emphasise the 'remote' aspect, often at the expense of the 'patient care' component. This focus on technology overlooks the critical importance of maintaining the human touch in healthcare. As health systems increasingly incorporate remote options, three critical considerations emerge: prioritising patient needs over technology, ensuring user-centred design, and addressing patient satisfaction.

Prioritising patient needs over technology

Designing RPC should prioritise patient needs, using technology as an enabler to enhance, rather than replace, the *essential* human elements of care. Technology should support and enhance the delivery of high-quality, compassionate care. Remote connectivity opens new possibilities, such as making healthcare more accessible to patients in rural or underserved areas, enabling more frequent monitoring of chronic conditions, and reducing the need for travel. However, in many circumstances, in-person interaction remains essential. Complex diagnoses, sensitive discussions, and certain treatments still require the empathy and nuance that only face-to-face interactions can provide.

For example, telehealth consultations can efficiently handle routine check-ups and follow-ups, but they may not be suitable for initial consultations where a comprehensive physical examination is necessary. Similarly, remote monitoring can provide valuable data on a patient's condition but cannot replace the reassurance and support of a clinician's presence during a critical moment.

Ensuring user-centred design

Another crucial aspect of effective RPC implementation is user-centred design. Many innovative technologies have failed because they did not adequately consider the end-user's needs and context. Google Glass's privacy issues, early electronic health records prioritising administrative needs over clinical workflows, and the infamous Microsoft Clippy – all illustrate the pitfalls of ignoring the user's experience.

In the realm of RPC, user-centred design is equally essential. Despite the significant increase in research on RPC, many studies lack robust evaluation and user-centred approaches. Of the 15,675 articles related to RPC indexed by PubMed since 1990, less than a third include any type of evaluation, and fewer than 50 consider user – or patient – centred design. This gap highlights the need for a more focused approach that integrates feedback from both patients and healthcare providers into the development and implementation of RPC technologies.

Addressing patient satisfaction

There are many factors driving RPC in healthcare. The overburdening of health systems caused by demographic and population changes represents one cluster of reasons. However, a key driver – an urgent one that further underscores the need for user-centred design – is patient satisfaction.

Now that technology has developed to a point where high-quality medical care is available at home, patients have begun to demand it. Following the pandemic, there is a wealth of research on what patients do and do not like about RPC. It is particularly this second topic – the dislikes – that can provide guidance in the creation of RPC systems that focus on care first and the importance of patient-centred design.

There have been a number of research studies undertaken in respect of telehealth – perhaps a first-step implementation of RPC – which are instructive here. Almost universally, studies have found a majority of patients report high satisfaction with telehealth, with a clear preference for video rather than telephonic appointments.[23-32]

However, these studies equally find some dissatisfied patients, with the causes of their poor experience falling into three categories: technical problems, privacy concerns, and – perhaps unsurprisingly – issues concerning lack of personal interaction.

Technical problems and concerns about privacy are perhaps the simpler of these to address and manage.

The first of these appears in almost every study on telehealth and is quite obvious: if telehealth does not *technically* work, patients are not satisfied with it.[23-30] Although the quality of internet access across large distances is outside the control of a health system (and particularly challenging in remote areas), much can be done to minimise technical problems. Rigorous user testing before deployment can ensure the service is user-friendly and easy to navigate. Comprehensive staff training, clear patient instructions, and interoperability across different platforms can also help minimise technical difficulties. Importantly, having a human-staffed helpline that patients can call if they are having trouble connecting is crucial.[26]

Concerns about the *privacy* of medical information sent over the internet also reduce patient willingness to engage with telehealth and are an obstacle to patient satisfaction.[25,30-32] Promoting patient confidence in the system requires rigorous network security to prevent cyber-attacks. This is a concern for all health providers since privacy breaches by any service reduce trust in all of them. For example, the breach of Medibank details in Australia in 2021 reduced trust in the cybersecurity of the entire Australian health system. Thus, it is not enough for a single health service to have excellent security procedures; the entire system and all the services within it must uphold the same high standards, if confidence is to be maintained.

A more complex question relates to patient dissatisfaction with *the lack of personal interaction* over telehealth. To some extent, it may be unavoidable as an issue; there will always be a cohort of patients who prefer face-to-face interaction. However, we consider that this is not a reason to doubt the efficacy of hybrid care itself, but rather the need to ensure that hybrid systems and care models are thoughtfully designed with flexibility as a key element.

If these challenges can be managed, RPC and hybridity in our health systems can generate tremendous impact and bring to life the long-held strategic dream of many policymakers and health system theorists to enable new forms of specialisation, access, outreach, outcomes and compassion in healthcare.

Implementations of RPC are still in their early stages, and there is an opportunity to optimise their instantiations. We can look to science fiction for inspiration; futuristic communications and telepresence technologies—everything from neural links to virtual presence holograms—are often presented as adjuncts to human connection, not replacements. Remote connectivity opens up new possibilities, but in many circumstances, in-person interaction remains essential.

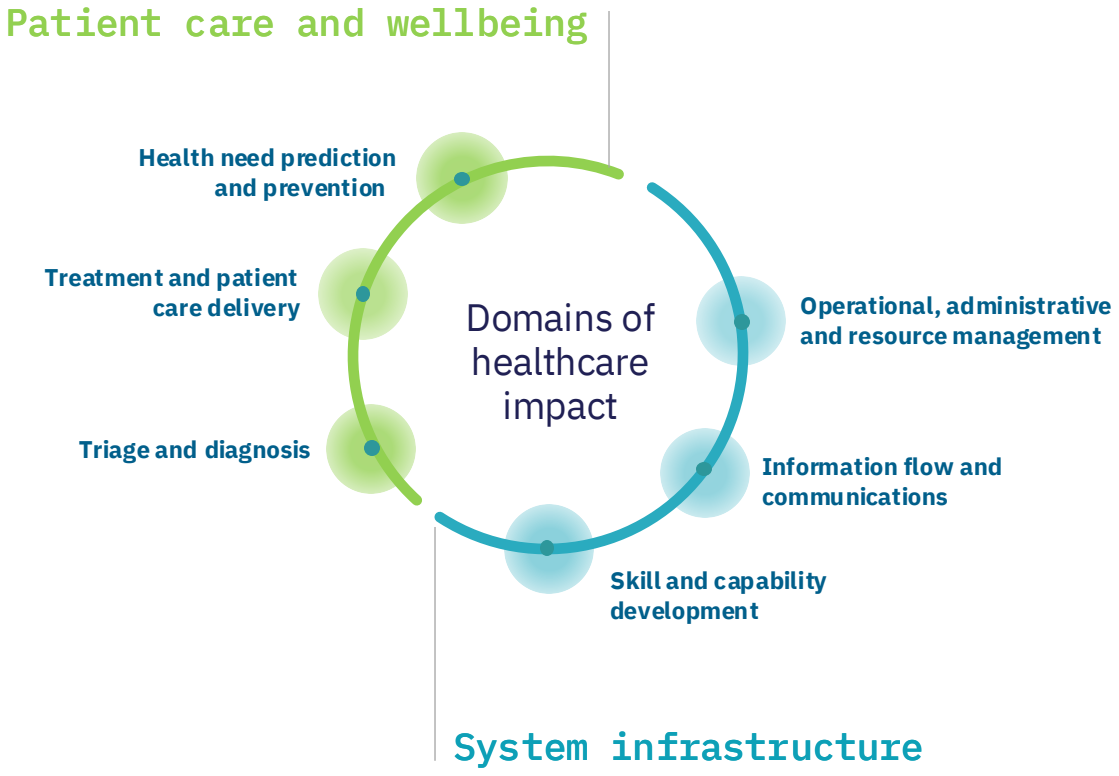
In considering the promise of RPC, it is crucial to recognise what remote technologies can and cannot achieve. Many health-adjacent cases, promoted for wearables, focus on behavioural change, such as reminders to stand, physical activity targets, sleep tracking, posture correction, and stress management alerts. However, more than 50 years of research shows that behavioural modification interventions, without addressing the socioeconomic context, are almost universally unsuccessful. While the health data captured by wearables and IoT devices can be valuable for clinicians monitoring patient recovery, simply moving healthcare to a wrist device, with reminders to exercise, will not impact individual and population health.

For RPC to fulfil its potential, it must be integrated deeply and systemically into the healthcare framework, not just a series of isolated technological add-ons. This holistic approach will ensure that RPC delivers the impact that it promises.

Applications and Implications

Remote patient care technologies – already emerging – hold the promise of significant transformation of our healthcare systems, especially at the patient level, and with significant implications for the infrastructural and operational elements of the system.

In this section, we set out some illustrative applications, possibilities and implications of RPC technologies across some of the key functions of the health system, using the system impact framework discussed above on page 16.



The table and pages that follow set out and describe these applications and implications, referring to and providing detail on illustrative case studies that help to demonstrate and bring this impact to life. Further case studies that have inspired us are contained in the Appendix on page 87.

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PATIENT CARE & WELLBEING

Health need prediction and prevention

Home diagnostic tools
Diagnostic tests previously required a laboratory but can now be used at home. A home pregnancy test is the longstanding exemplar, but tests today have greatly expanded to include blood pressure, blood sugar and infectious diseases like COVID-19 and HIV.

Who's doing it:
Home HIV test (Atomo)

Triage and diagnosis

Cardiac monitoring
Wearable heart monitors can provide near real-time arrhythmia detection. Coupled with automated hospital warning systems, they can provide timely diagnostic and effective treatment for cardiac patients.

Virtual emergency department
Utilising telehealth technology, Virtual Emergency Departments offer 24-hour triage and treatment of non-life-threatening conditions. These services make emergency departments more accessible, reduce crowding in waiting rooms, and provide rapid, high-quality medical advice to those who need it.

Who's doing it:
Mobile Cardiac Outpatient Telemetry (BioTelemetry-Philips)

Treatment and patient care delivery

Virtual clinics
Comprehensive healthcare services can be offered through virtual platforms. This provides healthcare services remotely, improving accessibility and reducing costs for patients and healthcare providers.

Telehealth + remote consultation
Medical consultations and check-ups can be conducted via video conferencing. This offers a range of patient access and satisfaction benefits, including increased access to healthcare, reduced travel time, and improved convenience for patients by allowing consultations from home.

Remote physical therapy
Guided physical therapy exercises are conducted remotely. Improves physical therapy outcomes through continuous guidance and monitoring, ensuring patients perform exercises correctly and consistently.

Remote patient education
Education of patients on their health conditions and management strategies through remote platforms. Increases patient knowledge and engagement, improving health outcomes and self-management of conditions, through remote educational resources.

Remote monitoring
Use of devices, wearable products and apps enables the background monitoring of health-relevant data for chronic conditions like heart disease and poor mental health as well as to follow post-surgery recovery and medication compliance. Can lead to enhanced outcomes through timely intervention.

Who's doing it:

Hybrid care delivery platform (Amwell)

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SYSTEM INFRASTRUCTURE

Operational, administrative and resource management

Transformation of clinical and organisational workflows
As RPC expands to become an integrated aspect of health provision, workflows and their management have to shift to take account of staff and patients being spread out through the community rather than being confined to one or two major healthcare sites with the potential to increase efficiency and effectiveness.

Differential use of and loads on infrastructure
RPC reduces the cost of, and reliance on, central sites of physical infrastructure. At the same time, it increases the importance of network infrastructure which must be able to cope with increased data flows across greater distances. For continuous monitoring of patient vital signs, integration of these networks with AI-based services will also be necessary.

Information flow and communications

Mobilisation of electronic medical records
RPC requires the collection of clinician notes and patient data across sites both inside and outside the traditional health care setting. For this to be possible, EMR systems must be able to intake and integrate patient records with new types data (including data from wearables etc.) from multiple sites.

Heightened importance of cybersecurity
With sensitive health data moving in to, out of, and between health services, the risk of breach becomes higher and the consequences more damaging. RPC requires high-level cybersecurity to maintain patient, clinician and public trust.

Skill and capability development

New skills and training for staff and patient training
RPC requires new skills of clinicians, patients, and health systems managers. Appropriate training for management on optimal implementations will be as essential as ensuring that users can access and navigate the RPC platform.

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Who is doing it

Atomo's remote HIV test

Who: Atomo

What: Atomo has a suite of user-friendly, integrated rapid diagnostic tests, including the Atomo HIV Self-Test, designed to improve accessibility and ease-of-use for patients globally. This self-test delivers accurate results within 15 minutes, offering a discreet and reliable alternative to traditional clinical HIV testing methods. The AtomoRapid™ series, are designed to support remote patient monitoring by enabling individuals to conduct tests accurately at home without the need for professional training. This capability becomes critical in remote and underserved regions where access to healthcare facilities is limited. By providing reliable, rapid diagnostic tests that can be used at home, Atomo supports the broader healthcare infrastructure, allowing for better disease management and monitoring remotely.

Links: Atomo HIV test, NSW Gov health blog

Mobile Cardiac Outpatient Telemetry (MCOT)

Who: BioTelemetry, a Philips Company

What: Philips' Mobile Cardiac Outpatient Telemetry (MCOT) system provides advanced cardiac monitoring using SmartDetectAI technology. This system offers near real-time arrhythmia detection, ensuring timely diagnosis and effective treatment for cardiac patients. MCOT continuously captures up to 30 days of ECG data, allowing physicians to detect atrial fibrillation and other arrhythmias with high sensitivity and positive predictivity. Clinically validated, MCOT enhances patient care by providing detailed, actionable reports that facilitate accurate diagnosis and treatment planning.

Links: Philips MCOT

Hybrid care delivery platform

Who: Amwell

What: Amwell has developed the Converge™ platform to digitally enable hybrid care delivery, integrating in-person, virtual, and automated care. This platform supports various healthcare services, including on-demand and scheduled visits, automated care programs, specialty consults, virtual nursing, and behavioural health. By partnering with providers, payers, and innovators, Amwell aims to create a seamless, coordinated healthcare experience. The platform's flexibility allows it to adapt to evolving needs, enhancing access to high-quality care regardless of location or resources.

Links: Amwell

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Webex in the Ambulance

Who: Cisco in collaboration with Skyehuset Innlandet

What: Webex in the ambulance is an innovative initiative designed to enhance emergency medical services through advanced communication technology. This project equips ambulances with Cisco's Webex platform, enabling real-time video communication between paramedics and doctors at the hospital. The main objective is to improve patient outcomes by allowing doctors to provide immediate medical consultations and decision-making support during patient transport. Key features include video conferencing for remote diagnosis and treatment guidance, instant messaging for quick information exchange, and enhanced coordination for seamless patient handoff. By facilitating access to specialist advice and optimizing resource allocation, this initiative aims to demonstrate the effectiveness and scalability of integrating telemedicine with emergency services, potentially serving as a model for similar projects globally.

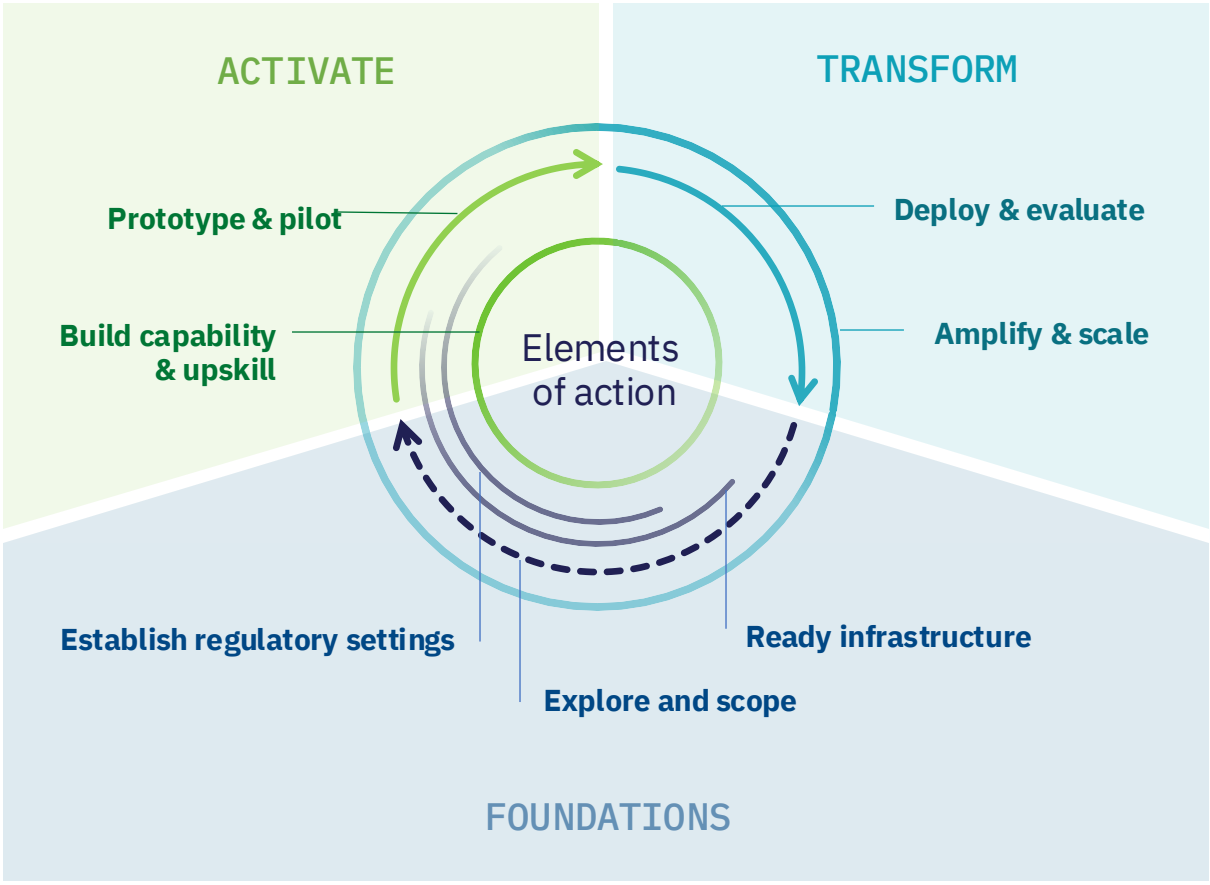
Links: Cisco Norway

CISCO

Actions for 2024-2025

Remote patient care technologies are ready to crest the wave of adoption – as we have discussed, many of these technologies are emerging, and many have been catalysed by recent healthcare and societal demands.

As such, we recommend that actors from across the health and technology ecosystems focus in 2024-25 on scoping and collaborating on the most strategic technologies for prototyping and then deployment and iteration, with an eye to building the technology infrastructure that will allow these technologies and models of care to scale. We would also note that policymakers and government actors can focus too on the kinds of incentives and settings that can enable hybrid healthcare at scale.



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Actions

		Healthcare Providers	Technologists	Government & Policy Makers	Researchers & Universities
FOUNDATIONS	**Establish regulatory settings:** • Develop regulations that support the implementation and use of RPC technologies. • Implement policies to ensure that remote patient care is accessible to all populations, including those in rural and underserved areas.			●	
FOUNDATIONS	**Explore & scope** • Fund research initiatives to explore the efficacy and best practices of RPC. • Investigate reimbursement policies for telehealth and remote monitoring services to support adoption. • Commence research on models of care integrating remote and in-person services.	●	●	●	●
FOUNDATIONS	**Ready infrastructure:** • Create solutions that are compatible with existing healthcare infrastructure and interoperable with other systems. • Implement advanced data storage, management, and retrieval systems to handle the vast amounts of data generated by remote patient care. • Create standards and protocols to ensure different systems can communicate and share data seamlessly. • Establish strong cybersecurity measures to protect patient data from breaches and ensure compliance with data protection regulations.	●	●		
ACTIVATE	**Build skills & capability:** • Educate patients on digital health tools and technologies to ensure effective use. • Provide training programs for healthcare and administrative staff on using remote care technologies effectively.	●	●		●
ACTIVATE	**Prototype & pilot:** • Design remote patient care technologies that are intuitive and easy for both patients and providers to use. • Prioritise patient needs and preferences in all aspects of remote care implementation.	●	●		●
TRANSFORM	**Deploy & evaluate:** • Incorporate remote monitoring and telehealth into routine clinical practice to enhance patient care. • Continuously monitor patient data and evaluate the effectiveness of remote care interventions. • Maintain clear and open communication with patients to ensure they understand how to use remote care technologies and feel supported. • Create dedicated teams to monitor and respond to remote patient data. • Utilise real-time data analytics to monitor patient health and provide timely interventions. • Establish a comprehensive contingency planning framework with input from all stakeholders.	●	●		●
TRANSFORM	**Amplify & scale:** • Expand existing telehealth services to include more services, focusing on convenience for patients and clinical appropriateness. • Form strategic collaborations and partnerships than can expand the scale, rigour and inclusivity of remote patient services.	●	●	●	●

Health system adaptability and dynamism

Resilience and sustainability in times of rapid change

Adaptation is not a **one-time event.**

What is it?

Adaptability in health involves creating systems that are flexible by default, that are designed with the anticipation of a need to adjust at some point in the future, and that have a range of features that can achieve the required shifts.

Whereas the Transformation Dimensions we have discussed to this point have been technologies or clusters of discrete technologies to be applied to health, this Dimension (and the one that follows) is somewhat different. Here we deal with a property of the system – in this case adaptability – that is made possible by technology, rather than a technology to be applied to healthcare per se.

As was highlighted across many health systems by the COVID-19 pandemic, the ability to cope with complex and fast-changing situations is not a hallmark of our contemporary health systems. The pandemic exposed significant gaps in the ability of healthcare systems to rapidly adapt to new and unprecedented challenges.

The need to make order out of complexity – to deal with co-morbidities and quality demands, with aging populations and high-acuity interventions, with individual care and population-level risks – has driven our health systems to seek scale, repeatability, and process-laden certainty. This is all crucially important and should not be undervalued.

However, what is equally crucial is the need for flexibility and dynamism – the ability of our systems to adapt to changing circumstances, demands, and stressors. Unfortunately, our healthcare systems have often become too rigid and unprepared for rapid change and adaptation.

The typical process of change in health systems – and they are not unique in this – is one of punctuation. Infrastructure is built, processes are created, workflows are settled, and they continue to operate statically for as long as they can. Then, when the gap between business as usual and the world outside becomes too great, the existing systems rupture and new ones are created. This process, where optimal efficiency is short-lived, rapidly declines, and is punctuated by large-scale reform. The weight of tradition, comfortable routines, and organisational inertia all insulate against change…until they don't.

The alternative is to make processes and workflows more amenable to adaptation, and infrastructure multi-purpose. The aim is to match the world as it changes, allowing for smooth and constant change, and avoiding the costly and disruptive fractures of major reorganisation. Thus, adaptation in health systems cannot be considered a one-time, or even sporadic, event. Pandemics might be the most high-profile stressors, driving the most significant changes, under the strictest time constraints, but they merely punctuate ongoing, inevitable, and – in many cases – foreseeable change.

It is a common refrain to say that the world is changing more quickly than ever before. It is essential that our health systems can change with it. Adaptability and dynamism must be built into the very fabric of healthcare, ensuring that it can respond not only to crises but to the everyday evolution of needs, technologies, and societal expectations.

Perhaps the clearest way to demonstrate the importance of adaptability is by considering its opposite: the consequences of static systems which do not respond to change in the world around them.

Consider the ubiquitous concern of demographic change, ageing population and health system burden. Health systems across the developed world are poorly prepared for this challenge; with systems overburdened, services mis-matched to demand and workforces and budgets straining to cope.

The urgency with which health systems are now being forced to address demographic transition belies just how long they have had to plan and adapt. The final report of the World Population Conference, held in Bucharest in 1974, outlines the dual demographic trends of increased life expectancy and decreased fertility rates and sets out the social, economic and health systems consequences that will result. What was first forewarned 50 years ago has now become an imminent catastrophe.

Side note: how systems deal with strain

When confronted by profound shifts in context or operational parameters, systems respond in different ways.

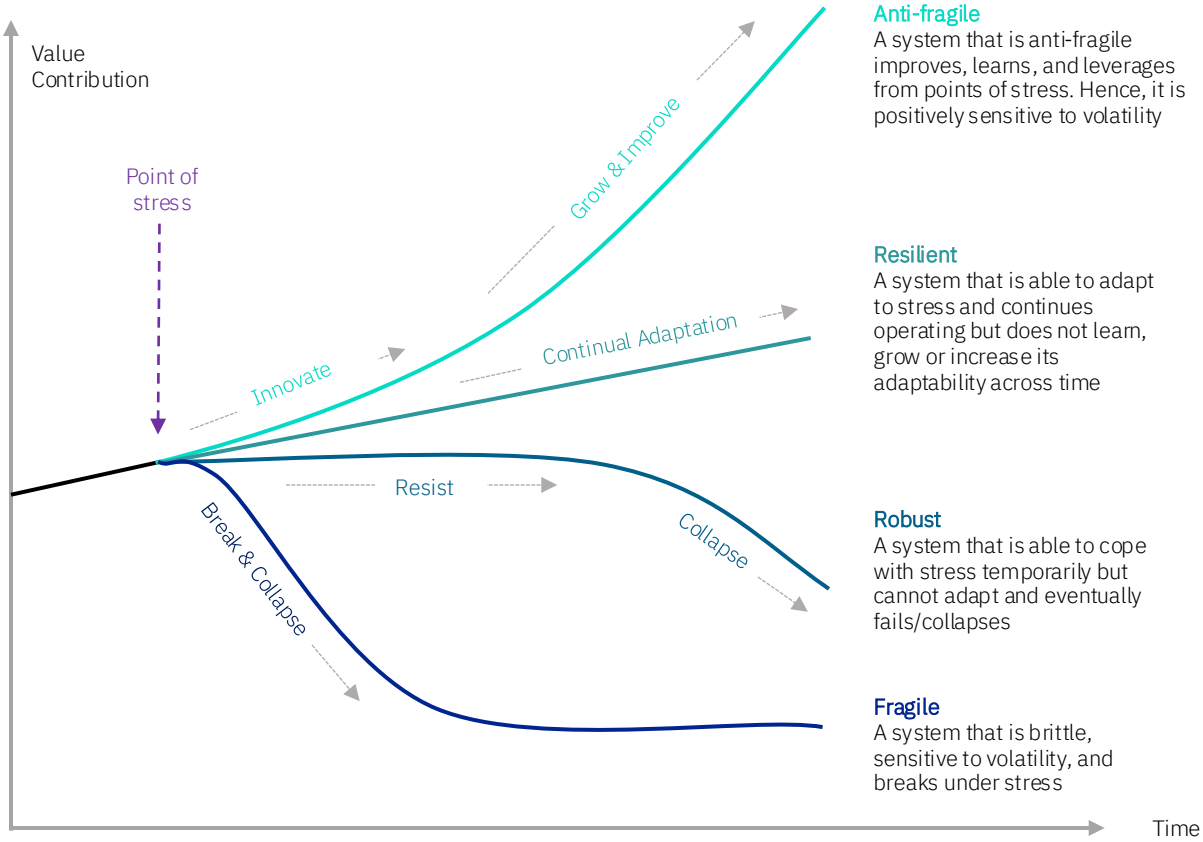
The diagram below sets out four such ways:

1. **Fragile systems** break under stress and erode value
2. **Robust systems** resist stress for a time before ultimately bowing to the strain over an extended period
3. **Resilient systems** maintain value generation by adapting to changed circumstances
4. **Anti-fragile systems** use innovation to thrive and improve in contexts of change and strain

Ultimately, in order to cope with strain, health systems must seek strong dynamics of robustness, resilience and anti-fragility, and especially the latter two.

To be clear, not every element, institution, or actor within a system needs to be able to withstand strain in specific ways; rather the system *as a whole* needs to be able to cope productively with change:

- in physical infrastructure,
- in digital infrastructure, and
- in organisations and processes.



Anti-fragile
A system that is anti-fragile improves, learns, and leverages from points of stress. Hence, it is positively sensitive to volatility

Resilient
A system that is able to adapt to stress and continues operating but does not learn, grow or increase its adaptability across time

Robust
A system that is able to cope with stress temporarily but cannot adapt and eventually fails/collapses

Fragile
A system that is brittle, sensitive to volatility, and breaks under stress

Types of change

Just as an individual's health is determined by a wide variety of factors – the social determinants of health include almost every aspect of social life – the influences, determinants, stressors on health systems, therefore, are similarly broad. Loosely categorised, the changes and challenges to which health systems may be called upon to adapt include:

Demand-side

- *Demographic changes:* Aging populations, migration patterns, and shifts in population demographics can alter healthcare needs and service demands.
- *Epidemiological change:* Emerging diseases, antibiotic resistance, and changes in disease prevalence can necessitate shifts in healthcare strategies.
- *Patient expectations:* Increasing patient demand for convenience, transparency, and personalised care can drive changes in service delivery models.
- *Global health dynamics:* International health issues, such as the spread of infectious diseases, can influence local healthcare practices.
- *Economic changes:* Factors such as income, education, housing, and access to healthy food can influence patient health outcomes and healthcare needs.
- *Environmental factors:* Climate change and environmental pollution can lead to new health challenges and impact healthcare infrastructure and resource needs.
- *Public health trends:* Government or NGO-led health campaigns can shift focus and resources towards specific health issues, impacting healthcare priorities. Can also be global health initiatives.
- *Cultural shifts:* Changes in cultural attitudes towards health and wellness can influence patient behaviour and expectations, requiring healthcare systems to adapt.

Supply-side

- *Technological advancements:* The introduction of new medical technologies and digital health tools can require system upgrades and staff training.
- *Cybersecurity threat and risk:* Increasing cyber-attacks and data breaches require robust cybersecurity measures to protect patient data and maintain system integrity.
- *Workforce change dynamics:* Changes in the availability, training, and distribution of healthcare professionals can impact service delivery.
- *Regulatory changes:* New laws, regulations, and policies can impact healthcare practices, requiring systems to adapt to comply with legal requirements.
- *Funding changes:* Modifications in insurance coverage, reimbursement rates, and payment models can affect financial sustainability and service provision.

The importance of sustainability

Whereas the external shock of the COVID-19 pandemic stands as an exemplar of a sudden, disjunctive challenge to health systems, the issue of sustainability presents a creeping, pervasive challenge that is yet to be fully addressed and cognised. It is impossible to talk about adaptability without factoring in the importance of sustainability. Without environmental sustainability, any adaptability in the health system is superficial and likely to be short-lived.

In Australia, the health system is responsible for 7% of carbon emissions, the same as the aviation industry.[33] At the same time, climate change is a key driver of both supply and demand-side changes in health. On the demand side, new diseases are emerging, and old diseases are appearing in new places. Malaria, for example, is creeping into higher altitude areas of Ethiopia where it was previously too cold for the *Plasmodium* parasites to be transmitted.[34] Similarly, heat-related deaths have increased by 85% between 2000 and 2021.[35] On the supply side, energy policy, carbon taxes, and population expectations all affect the ability of health systems to provide the highest quality of care.

Responding to catastrophe – or potential catastrophe – is now a constant.

Health systems are caught in a losing game, attempting to adapt to climate change while simultaneously contributing to its severity. The healthcare sector's significant carbon footprint exacerbates environmental degradation, which in turn increases the strain on health systems as they face the rising tide of climate-related health issues. This vicious cycle underscores the urgency of integrating sustainability into the core of healthcare operations.

Efforts to reduce the carbon footprint of health systems are gaining momentum. Hospitals and clinics are increasingly adopting green building standards, investing in renewable energy sources, and implementing waste reduction strategies. For example, the NHS in the UK has committed to reaching net-zero carbon emissions by 2040, with an interim target of an 80% reduction by 2028-2032. Similarly, initiatives such as Practice Greenhealth in the United States provide resources and support for healthcare organisations aiming to become more sustainable.

Sustainability in health systems also involves rethinking medical supply chains. The production, transportation, and disposal of medical supplies contribute significantly to carbon emissions. Innovations such as sustainable packaging, local sourcing of materials, and circular economy principles can reduce the environmental impact of healthcare delivery.

Sustainability is not just an adjunct to the concept of adaptability in health systems but a fundamental component. The dual pressures of mitigating their environmental impact and adapting to the health challenges posed by climate change necessitate a comprehensive, systemic approach. By embedding sustainability into their operations, health systems can ensure they remain resilient and capable of delivering high-quality care in a rapidly changing world.

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Forms of adaptation

In responding to such a broad range of background shifts and changes, health systems must be adaptable across multiple dimensions. To steal a term coined to explain the extraordinary neuroplasticity of human brains, the aim is 'multifaceted adaptability'. The brain is the most perfect example of a system that is strengthened by change. When confronted with new information, skills or contexts, our brains can update both their 'software' – our understanding of the world or some aspect of it – and, crucially, their 'hardware' – rewiring our neural connections / creating new synapses – to optimise its functioning.

Health systems must aim to be similarly versatile, able to adapt across the following dimensions:

Physical infrastructure

- *Make existing health spaces dynamic:* Make possible the repurposing of physical spaces to accommodate surges in patient numbers, control of novel pathogens, or changes to clinical workforce.
- *Convert non-health spaces:* When necessary, have the capability to rapidly repurpose non-health spaces.
- *Mobilise health spaces:* Utilising the strengths of remote patient care, create mobile health spaces. Particularly important in the event of natural disaster or conflict when there may be a large number of people requiring care outside urban centres.

Digital infrastructure

- *Invest in advanced technologies:* Adopt cutting-edge digital tools and infrastructure to enable better data management, real-time monitoring and enhanced patient care.
- *Cybersecurity without cyber-rigidity:* Combine a culture of security awareness with one of trust and collaboration between IT departments and the rest of the organisation. Overly rigid applications of security measures can spawn insecure 'shadow IT' practices.

Organisational structures and processes

- *Promote decentralised structures:* Keep decision-making power close to the point of action, allowing for rapid responses and avoiding unnecessary bureaucracy.
- *Encourage cross-functional teams:* Form teams with members from different disciplines and levels within the organisation, avoiding decision-making that narrowly focuses on only one part of the system.

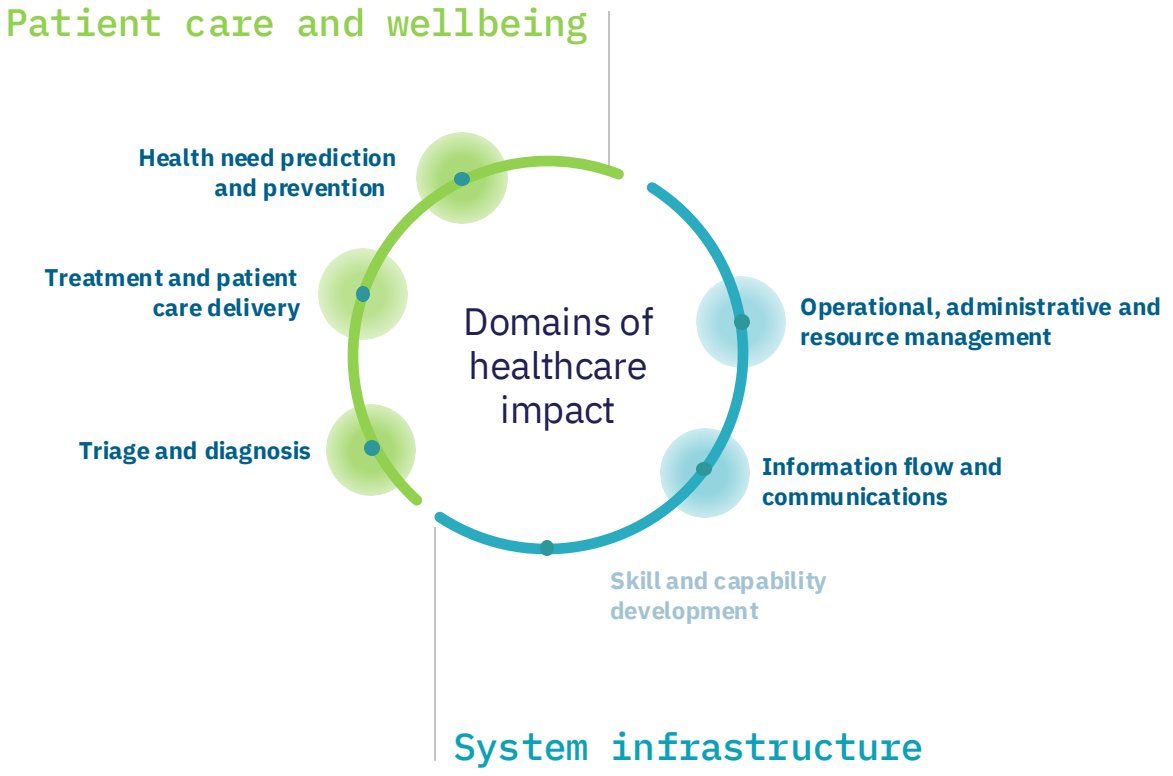
It is impossible to future-proof our health systems without embedding dynamism and adaptability. Indeed, we need urgently to act now, to safeguard tomorrow's performance.

> Dynamism and adaptability should not be considered the enemy of order. In a changing world, it is attempts to remain static that create the most strain.

Applications and Implications

Technologies to support health system dynamism and adaptability have significant applications and implications at both the patient level and the infrastructure and operational management of the health system.

In this section, we set out some illustrative applications, possibilities and implications of these technologies across some of the key functions of the health system, using the system impact framework discussed above on page 16.



The table and pages that follow set out and describe these applications and implications, referring to and providing detail on illustrative case studies that help to demonstrate and bring this impact to life. Further case studies that have inspired us are contained in the Appendix on page 87.

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PATIENT CARE & WELLBEING

Health need prediction and prevention

Proactive adaptation
Trends in population health are often visible years before they challenge health system functions. Proactive adaptation involves planning for the disruptions we know are coming (like ageing populations). Partnering with research institutions can help to prepare health systems in advance and avoid destabilising 'shocks'.

Who's doing it:
WHO Preparedness and Resilience for Emerging Threats Initiative

Triage and diagnosis

Flexible emergency services
Mobile operating theatres are the pinnacle of healthcare flexibility. Expandable structures stored in modular crates can be deployed, erected and operational (with a fully sterile surgical theatre) within hours. This is enabled by portable diagnostic tools, mobile power generators, and secure communications networks.

Who's doing it:
Dynamic Health Spaces and Triage in Natural Disasters (Médecins Sans Frontières (MSF))

Treatment and patient care delivery

Patient-centred care and personalised medicine
By tailoring healthcare to the patient (rather than delivering a 'one size fits all' service), health services are required to be less rigid in their approaches. Health services that are responsive to individual patient needs by default are insulated against sudden shocks when patient expectations shift.

Integrated care models
Integrated care models combine primary, secondary and tertiary level care with patients' social or other needs. Originally designed to reduce miscommunication and inefficiency between health services, the delivery of integrated care must also be responsive to individual patients. This responsiveness makes integrated care inherently flexible to changes in patient expectations.

Remote patient care
Leveraging digital technologies and telemedicine to provide care where patients want it gives health systems significant flexibility in the way they deliver care. Digital technologies scale more readily than physical infrastructure and can more easily expand and contract in step with demand for services.

Who's doing it:

Integrated Care Solutions by SingHealth

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SYSTEM INFRASTRUCTURE

Operational, administrative and resource management

Prototyping spaces
Innovating in safe spaces allows rapid failure and reiteration. Prototyping spaces can speed the pace of innovation and its effective translation into health systems.

Flexible organisational policy
For health systems to be responsive to broader social change, there must be adaptability in administrative and organisational policies and practices. Policies should allow for decentralised decision-making when necessary, avoiding strict hierarchies and rigid bureaucracy. Infrastructure adaptability will be under-utilised if it is not supported by similarly flexible management.

Mobile clinics
Capitalising on wireless connectivity and secure networking infrastructure to deliver healthcare across the community and wherever it is needed.

Adaptable spaces
Creating flexibility in spaces across the health system. Liminal spaces like hospital atriums can be configurable, allowing the hospital to expand when required.

Who's doing it:

RMIT-Cisco Sandbox (Health Transformation Lab)

Information flow and communications

Advanced data analytics
An essential aspect of adaptability comes from knowing what the system needs to adapt to: systems should be dynamic, but they should be dynamic in the right direction. Data analysis across the health system provides the crucial information, identifying where existing services are falling short and when external challenges arise.

Health information exchange and interoperability
Ensuring seamless data exchange and interoperability between different healthcare systems and providers, facilitates coordinated care and avoids duplication of effort and resources. When health information is available across different networks, it is possible to assign patients to the most appropriate service, avoiding unnecessary concentration and overburdening.

Adaptable digital infrastructure
Though digital infrastructure is inherently more easily scalable than its physical counterpart, failing to anticipate an organisation's future digital requirements can quickly lead to service bottlenecks. Planning for increased network speeds, data storage and cybersecurity ensures that digital infrastructure will remain adaptable into the future.

Who's doing it:

Intermountain Healthcare

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Who is doing it

WHO's PRET Initiative: enhancing global pandemic preparedness

Who: World Health Organization (WHO)

What: WHO has launched the Preparedness and Resilience for Emerging Threats (PRET) initiative to bolster global readiness for future pandemics, focusing initially on respiratory pathogens like influenza and coronaviruses. PRET leverages lessons from COVID-19 and other health emergencies to provide integrated planning guidance. It emphasises a mode of transmission approach, fostering multi-sectoral coordination, community engagement, and equity. The initiative aims to enhance countries' operational capacities through updated preparedness plans, stakeholder connectivity, and sustained investments, ensuring readiness for emerging infectious disease threats.

Links: Read more about WHO's PRET initiative

Dynamic health spaces and triage in natural disasters

Who: Médecins Sans Frontières (MSF)

What: MSF implements dynamic and adaptable healthcare spaces in response to natural disasters and crises. Their approach ensures efficient triage and treatment in challenging environments, often characterised by overcrowding and limited resources. By setting up mobile clinics and flexible health posts, MSF addresses immediate medical needs while ensuring that their healthcare delivery can adapt to changing conditions and patient volumes. This dynamic approach is critical for providing effective and timely medical care in disaster-stricken and conflict areas. MSF's ability to mobilise and establish adaptable health spaces significantly enhances their capacity to deliver urgent medical assistance, thereby improving outcomes in some of the world's most vulnerable regions.

Links: Tackling overcrowded facilities, MSF health facilities for refugees

Enhancing healthcare through data analytics and EHR systems at Intermountain healthcare

Who: Intermountain Healthcare

What: Intermountain Healthcare leverages advanced data analytics and comprehensive electronic health record (EHR) systems to significantly enhance decision-making, patient outcomes, and operational efficiency. By integrating EHRs with data analytics tools, Intermountain Healthcare enables healthcare providers to access real-time patient data, track health trends, and predict potential health issues before they become critical.

Links: Intermountain Healthcare

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Integrated care solutions by SingHealth

Who: SingHealth

What: The integrated care solutions by SingHealth demonstrate a commitment to creating a dynamic and adaptable health system that addresses the needs of patients at every level of care. By leveraging a network of hospitals, community partners, and specialised centres, SingHealth ensures that patients experience seamless transitions and receive continuous, coordinated care throughout their healthcare journey.

SingHealth's model incorporates several key programs and facilities:

- SingHealth Community Hospitals: These hospitals, such as Outram Community Hospital and Sengkang Community Hospital, are co-located with acute hospitals and specialist clinics.
- Regional Health System (RHS): SingHealth collaborates with various community partners, including social service organisations and primary care providers, to deliver care beyond hospital settings.
- SingHealth Duke-NUS Disease Centres (SDDCs): These centres bring together specialist expertise across SingHealth institutions, offering integrated and multidisciplinary care.

Links: SingHealth Community Hospitals, Regional Health System, SDDCs

RMIT-Cisco Sandbox: prototyping and robotics in digital innovation spaces

Who: Health Transformation Lab

What: The "Sandbox" housed at RMIT-Cisco's Health Transformation Lab is a digitally-enabled mock care setting where researchers, startups and health system professionals work together on prototypes for the future of health. Powered by Cisco's Meraki network and supported by a variety of healthcare partners, the Sandbox enables a frictionless pipeline from idea to implementation. The inclusion of autonomous robotics, in the form of Boston Dynamics' Spot, has created a space where the most futuristic visions for health can be trialled, tested, and translated into practice.

Driving accessible healthcare: the Medibus initiative in rural Germany

Who: Deutsche Bahn, Cisco

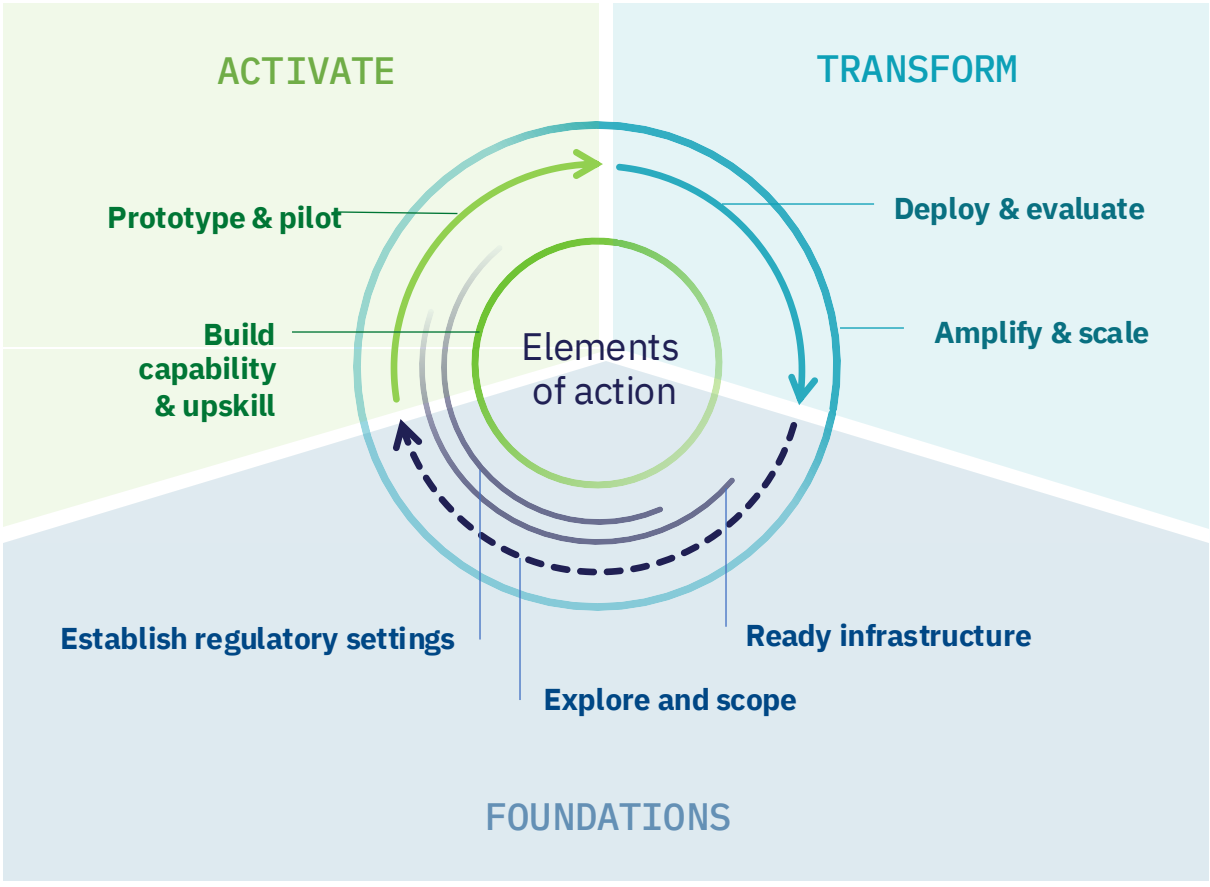
What: The Medibus initiative, a partnership between Deutsche Bahn and Cisco, addresses the challenge of accessible healthcare in rural Germany. This mobile medical unit travels to towns across the Hesse region, providing vital healthcare services where traditional medical practices are scarce or absent. Powered by Cisco technology, the Medibus integrates mobility, IoT, security, and collaboration tools to deliver advanced medical care directly to communities in need. Recognised with the German Mobility Award 2019, the Medibus exemplifies innovation in healthcare delivery, leveraging digital capabilities to bridge healthcare gaps and enhance community well-being.

Links: Cisco Medibus

Actions for 2024-2025

Fostering greater adaptability and dynamism in the health system is an urgent requirement – we do not know when the next system challenge will come, but we can rest assured that it will. We also know that the sustainability dimension of healthcare are going to remain a focus in public policy and beyond

As such, we recommend that actors from across the health and technology ecosystems focus in 2024-25 on building the technology infrastructure of dynamism, carefully calibrating to provider and health system strategic goals and key areas. This work we recommend be undertaken collaboratively, with a focus on prototyping and learning.



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	Actions	Healthcare Providers	Technologists	Government & Policy Makers	Researchers & Universities
FOUNDATIONS	**Establish regulatory settings:** • Create policies that allow for- and make easier- rapid adaptation to health threats. • Allocate funding to upgrade digital and physical infrastructure with adaptability features. • Allocate resources for developing new technologies and practices that deliver dynamic capacity.			●	
	Explore & scope • Maintain up-to-date 1-3year plans for the most likely stressors or shocks to the health system and the required adaptability response. • Explore collaboration across the health system with a view to providing overflow capacity or workforce support in times of crisis.	●	●	●	●
	Ready infrastructure: • Check, maintain and protect patient data and system integrity from cyber threats. • Conduct an audit of existing infrastructure functionality to identify options for multi-purpose use. • Ensure different data systems can seamlessly share information. • Establish clear policies and responsibilities for data management. .	●	●		
ACTIVATE	**Build Skills & capability:** • Incorporate adaptable and resilient healthcare practices into continuing medical education requirements. • Stay up-to-date with the latest medical research and technologies for remote patient care and mobile health delivery	●	●		●
	Prototype & pilot: • Proactively pilot or test flexible infrastructure configurations or functionalities that can deliver multi-purpose use or provide surge capacity. • Design facilities that can be reconfigured quickly for different needs. • Use patient data to continuously inform and adjust treatment plans.	●	●		●
TRANSFORM	**Deploy & evaluate:** • Budget for technical staff to improve data analysis and predictions, data management and integrity and cyber resilience. • Maintain a rolling 1-3 year plan for the adaptability response that can be deployed in the event of emergencies or unforeseen surges in demand, that leverages the most up-to-date technologies and practices. • Expand existing infrastructure to include mobile and remote assets	●	●		●
	Amplify & scale • Extend existing integrated care programs to include more patients and conditions. • Expand remote, mobile and other dynamic care capabilities.	●	●		●

Harnessing biotechnology breakthroughs

The digital foundations of future healthcare

The **digital backbone** that can unleash deep science breakthroughs.

What is it?

The previous section of this report considered and explored the question of how health systems can inculcate characteristics of adaptability, dynamism and flexibility to respond to challenges and system threats. Now we consider a related, though distinct question: how can health systems harness the most transformational breakthroughs being made in areas of deep science and innovation? Again, in this, digital has a core role to play.

Throughout history, healthcare has made leaps forward through groundbreaking scientific discoveries rather than digital innovations.

- The development of antibiotics revolutionised the treatment of bacterial infections. Penicillin, discovered by Alexander Fleming in 1928, marked the beginning of the antibiotic era, drastically reducing mortality rates from infectious diseases and saving countless lives.
- The discovery of the structure of DNA by James Watson and Francis Crick in 1953 laid the foundation for modern genetics and has led to significant advances in understanding hereditary diseases, genetic disorders, and the development of gene therapy. This understanding of genetic structure has enabled advancements in genetic testing, gene therapy, and personalised medicine. These innovations have had a far-reaching impact on diagnosing, treating, and even preventing genetic disorders, showcasing the power of biotechnological advancements.
- Vaccine development, such as the polio vaccine by Jonas Salk in the 1950s which virtually eradicated a debilitating disease, highlighting how non-digital scientific breakthroughs can lead to monumental health improvements.
- More recently, the advent of monoclonal antibodies has revolutionised the treatment of various diseases, including cancer and autoimmune disorders. These biologics, developed through breakthroughs in immunology and molecular biology, have provided targeted therapies unimaginable a few decades ago.

The next wave: biotech and deep science innovations poised to transform health

It is impossible to gaze into the future of health – and perhaps even more impossible to prepare for and take action in respect of that future – without understanding the deep science trends that are on the edge of transforming our health systems; and what our systems need to do to get ready for them.

As we look to the future, several biotech innovations are poised to bring about the next wave of transformation in healthcare. These include:

Biotech Innovations

Breakthrough	Impact
CRISPR gene editing	This precise gene-editing technology has the potential to cure genetic disorders, fight cancers, and prevent hereditary diseases. By allowing scientists to modify DNA sequences with high accuracy, CRISPR opens up new possibilities for treating previously untreatable conditions. Could lead to the eradication of diseases such as cystic fibrosis, sickle cell anaemia, and certain types of cancer, fundamentally transforming medicine and treatment strategies.
Personalised genomics	Customised healthcare based on individual genetic profiles. Enables tailored treatments and preventive care, improving outcomes and reducing adverse effects. By understanding an individual's genetic predisposition to certain diseases, healthcare providers can offer customised prevention plans and treatments, leading to more effective and efficient care, and reducing the incidence of adverse drug reactions and other effects.
Nanobots	Tiny robots designed to perform precise medical tasks at the cellular level. Can target drug delivery, perform microsurgeries, and monitor health in real time. Nanobots could revolutionise treatments by delivering drugs directly to diseased cells, performing repairs at the cellular level, and providing continuous health monitoring from within the body, leading to early detection and treatment of diseases.
Advanced pharmaceuticals	Development of novel drugs like Ozempic for chronic diseases such as diabetes and obesity. Improves disease management and patient quality of life. New pharmaceuticals can provide more effective treatment options with fewer side effects, significantly improving the management of chronic conditions like diabetes, cardiovascular diseases, and neurodegenerative disorders, potentially reducing the burden of these diseases on patients and healthcare systems.
Regenerative medicine	Techniques like stem cell therapy to regenerate damaged tissues and organs. Can potentially heal injuries and cure degenerative diseases. Regenerative medicine holds the promise of restoring function to damaged organs and tissues, which could lead to breakthroughs in treating conditions such as spinal cord injuries, heart disease, and Parkinson's disease, offering hope for cures where none currently exist.

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Balancing the sources of transformation: the digital and the deep science

The information technology revolution, marked initially by the rise of the internet and personal computers and now by the proliferation of smartphones, cloud computing, and AI, has fundamentally transformed the way that individuals and societies understand and experience themselves. This transformation spans all aspects of the economy and society – from communication and commerce, with the advent of social media and e-commerce platforms, to education and entertainment, with online learning and streaming services. Innovations such as big data analytics and the Internet of Things (IoT) have further revolutionised industries, enabling unprecedented levels of connectivity, efficiency, and personalised experiences.

And the information technology revolution has absolutely come to healthcare. Many aspects of healthcare, from patient management to diagnostic capabilities, have been profoundly transformed through this revolution. The rise of the internet, the proliferation of smartphones, and the integration of AI into everyday life have undeniably revolutionised many aspects of healthcare. Electronic health records, telemedicine, and digital diagnostics have transformed patient management and care delivery. This digital revolution dominates much of our current technological horizon, shaping expectations about the future of healthcare.

The rapid pace of information technological advancement often leads us to overemphasise the digital, assuming that the next transformative waves in healthcare will emerge largely – or perhaps even solely – from information technology and digital innovation.

However, digital and IT innovation is only part of the grand story of health innovation. At times this part is a starring one in the story. At other times, it is more of a supporting role. The focus on digital innovation can overshadow the profound impact of fundamental scientific discovery and biotechnological advancements in the future of health. History demonstrates that some of the most significant leaps in healthcare have come not from digital technologies, but from groundbreaking scientific research. But even in these areas, we will see, digital has a role to play.

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The role of digital infrastructure in enabling biotech and deep science innovations

While these biotech breakthroughs are not digital in nature, digital continues to have a role to play in bringing them to health. Each breakthrough requires a robust digital infrastructure to be effectively implemented and integrated into healthcare systems. The convergence of digital and biological advancements creates a synergy that enhances the potential of each domain. In this context, digital technologies act as the handmaiden of innovation, facilitating the application and scaling of groundbreaking biotech and deep science discoveries.

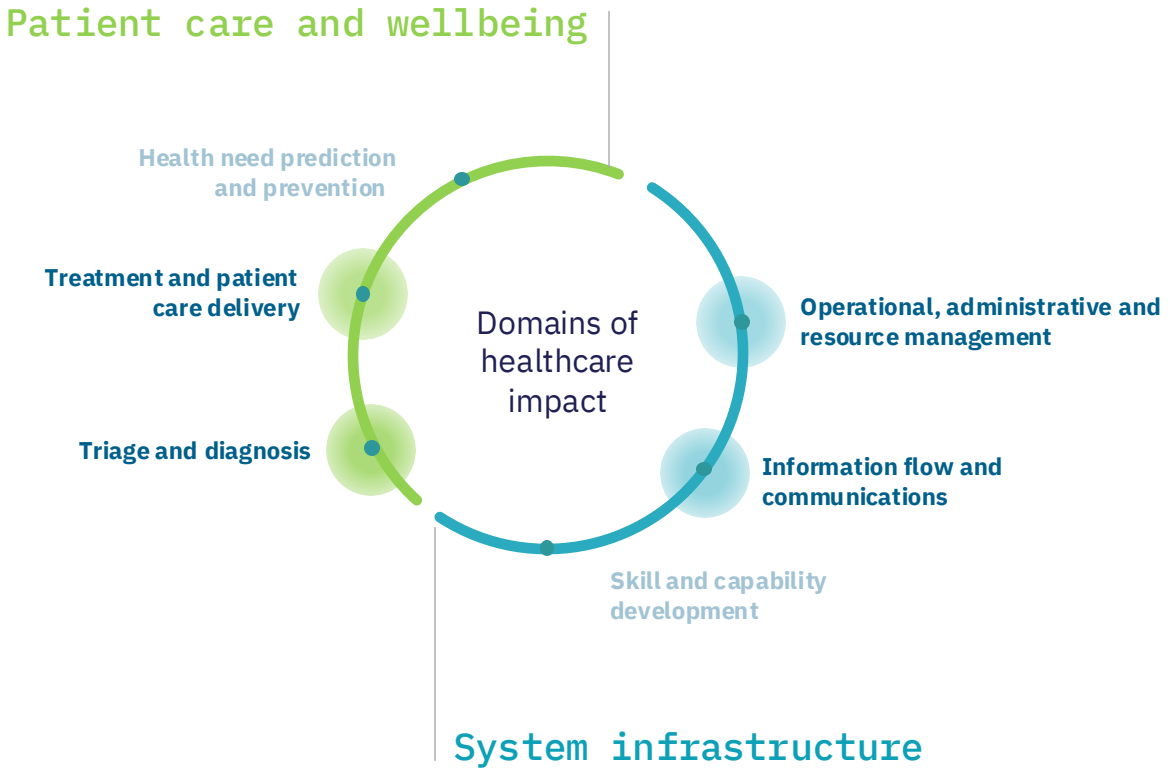
To fully leverage the impact of these biotech breakthroughs, a comprehensive digital backbone is essential. This digital backbone includes advanced data management systems, powerful computational tools, and secure communication networks. For example, the vast amounts of data generated by genomic sequencing, CRISPR gene editing, and nanobot monitoring need to be stored, processed, and analysed efficiently. Cloud computing platforms and data warehouses enable researchers and clinicians to handle these large datasets, ensuring that critical information is accessible and actionable.

In essence, the digital backbone acts as the foundational support structure that allows biotech innovations to thrive. By investing in robust digital infrastructures, we can unlock the full potential of biotech breakthroughs. This synergy between digital and biological realms promises a future where healthcare is not only more effective but also more equitable and human-centred.

Applications and Implications

Digital backbone technologies that can harness biotechnology and deep science breakthroughs hold very real potential to drive step change across our health systems, and most specifically at the patient treatment and care levels but with profound implications for system infrastructure.

In this section, we set out illustrative applications, possibilities and implications across some of the key functions of the health system, using the system impact framework discussed above on page 16.



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PATIENT CARE & WELLBEING

Triage and diagnosis

Translating new diagnostic techniques into practice
Organisational systems to speed implementation of new discoveries. Collaborative innovation between health services and biotech startups.

Who's doing it:
Mass General Brigham Innovation

Treatment and patient care delivery

Telemedicine and remote monitoring
Technologies for continuous patient monitoring and remote consultations. Supports personalised treatment plans and real-time health monitoring.

Artificial intelligence and machine learning
AI and ML algorithms to analyse complex datasets and extract insights. Accelerates discovery, enhances precision, and personalises treatment.

Secure communications networks
Data from major areas of biotech investigation need to be cleaned, transmitted and stored safely. This is particularly important when analysis relies on cloud-based solutions.

Who's doing it:
Mayo Clinic's integration of digital health and biotech research

SYSTEM INFRASTRUCTURE

Operational, administrative and resource management

Supply chain optimisation
Advanced systems for managing and optimizing the flow of materials, information, and finances involved in the production and delivery of biotech products.

Who's doing it:
Supply chain case management for cell and gene therapies (Catalent)

Information flow and communications

Data integration and management
Advanced systems for collecting, storing, and managing large volumes of biological and patient data. Ensure accessibility and usability of vast datasets generated by biotech research.

Interoperability and standards
Standardised data formats and protocols to enable seamless data exchange across different systems. Facilitates integration of biotech innovations into clinical workflows.

Cybersecurity
Robust security measures to protect biotech data and patient information. Safeguards data integrity and maintains public trust in biotech applications.

High-performance computing
Advanced computing infrastructure to process large-scale biological data and run complex simulations. Enables rapid analysis and simulation required for biotech research and application.

Who's doing it:
100,000 Genomes Project (Genomics England)

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Who is doing it

Mayo Clinic's integration of digital health and biotech research

Who: Mayo Clinic

What: Mayo Clinic has heavily invested in telemedicine and digital health technologies to enhance patient care and support biotech research. Their integrated digital platform incorporates electronic health records (EHRs), remote monitoring devices, and AI-driven diagnostics, ensuring readiness to integrate new biotech developments into patient care protocols. The Department of Biochemistry and Molecular Biology focuses on understanding molecular and biochemical mechanisms in health and disease, including cancer biology, cardiovascular diseases, and genetics. Utilizing advanced technologies and model systems, researchers drive medical breakthroughs while managing critical core facilities that support Mayo Clinic's research community and educate future biomedical leaders through specialised tracks within the Mayo Clinic Graduate School of Biomedical Sciences.

Link: Mayo Clinic's Department of Biochemistry and Molecular Biology

Supply chain case management for cell and gene therapies

Who: Catalent

What: Catalent's Case Management Service utilises advanced technology and comprehensive oversight to manage the complex supply chains of cell and gene therapies. Each therapy is assigned a dedicated Case Manager who oversees the entire process—from material collection to manufacturing, and finally, to delivery—ensuring chain of custody and identity are meticulously maintained. The service includes continuous status monitoring, proactive updates, and 24/7 support, reducing risks and ensuring timely administration of therapies. This system leverages Catalent's global manufacturing and distribution network, enhancing efficiency and scalability for biotech companies.

Link: Catalent

Preparing for the future of health systems

Who: Stanford Medicine's Digital Health

What: The Centre for Digital Health (CDH) at Stanford University actively invests in research and development to drive continuous improvement and innovation in healthcare delivery. Projects funded by CDH include the development of AI-based approaches to support adherence behaviours in psychiatric care, and virtual therapists for stroke recovery, demonstrating the integration of advanced technologies to enhance patient outcomes and streamline care processes. Innovative digital health clinical trials, such as those focusing on improving anticoagulation adherence and digital cardiac rehabilitation, exemplify the use of digital tools and mobile health applications to enhance clinical trial design and patient care.

Link: Stanford BioTech

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The Impact of Genomics England's 100,000 Genomes Project

Who: Genomics England

What: Genomics England's landmark initiative, the 100,000 Genomes Project, involves sequencing genomes from 85,000 NHS patients affected by rare diseases or cancer. This project aims to integrate genomics into routine healthcare, create a global genomic data resource, and provide actionable insights for participants. Initial findings have already led to significant breakthroughs, including new diagnoses for 25% of early participants through whole genome sequencing (WGS). Notably, 14% of these diagnoses were in genomic regions missed by other testing methods. The project continues to yield valuable data for research, contributing to the development of new treatments and diagnostics. Participant consent governs data sharing with approved researchers, ensuring ethical use and ongoing benefits from this vast genomic dataset.

Link: Genomics England

Enhancing biotech diagnostics: Mass General Brigham's innovation and the cobas® EGFR Mutation Test v2

Who: Mass General Brigham

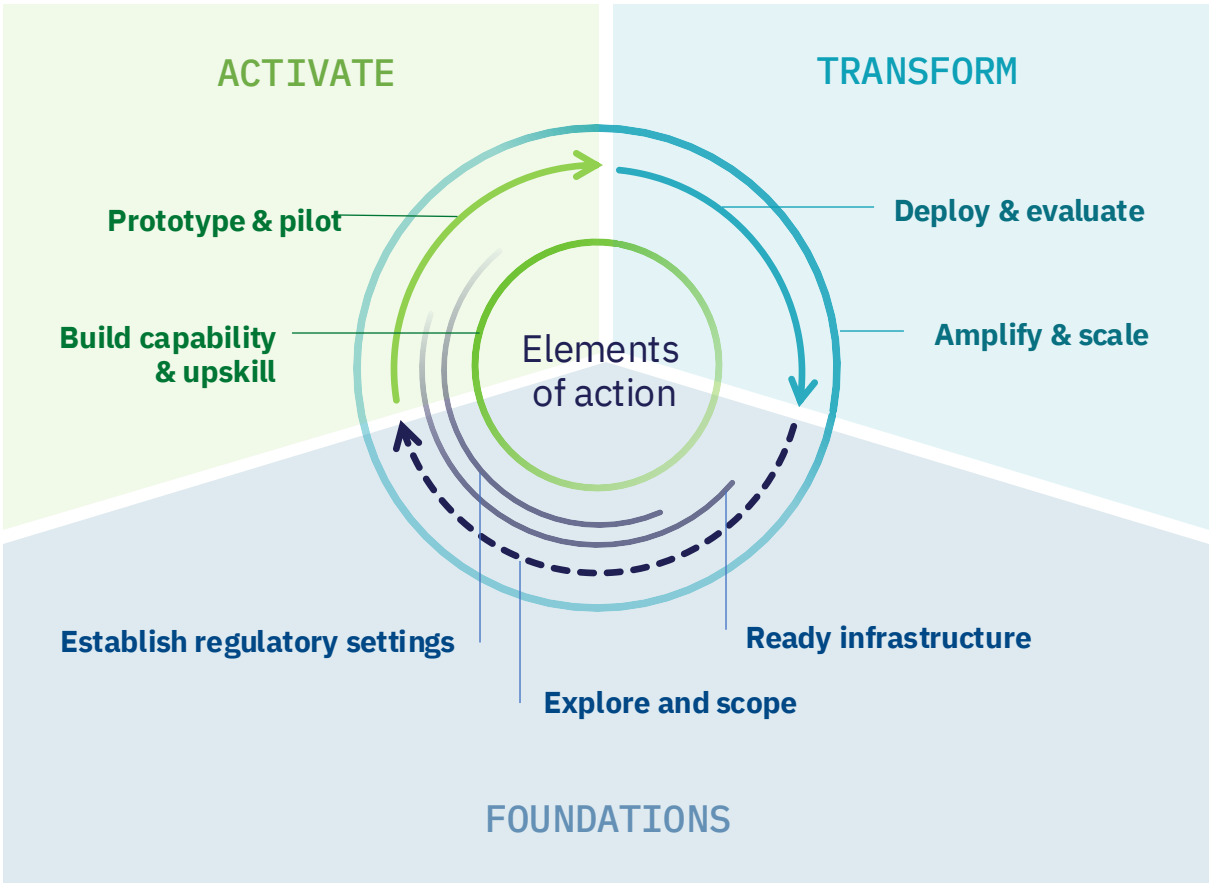
What: Mass General Brigham's Innovation Office is pioneering advancements in biotech diagnostics through strategic collaborations and cutting-edge research. Partnering with industry leaders like Roche Diagnostics, they facilitate the integration of advanced diagnostic tools into clinical practice. A notable example is Roche's cobas® EGFR Mutation Test v2, which identifies mutations in non-small cell lung cancer (NSCLC) patients, enabling targeted and personalised treatment strategies. The Innovation Office at Mass General Brigham ensures these developments translate into real-world clinical applications, improving patient outcomes through precision medicine. By leveraging the cobas® EGFR Mutation Test v2, clinicians can make informed decisions about the most effective therapies, highlighting the critical role of advanced diagnostics in modern healthcare. This collaboration underscores Mass General Brigham's commitment to enhancing diagnostic capabilities and delivering superior patient care through innovative biotech solutions.

Link: Roche's cobas® EGFR Mutation Test v2, Mass General Brigham's Innovation

Actions for 2024-2025

Readiness to harness constant innovation in biotechnology and deep science breakthrough needs to be hardwired into the 'systemic skeleton' – developed and maintained over time. The digital backbone, as we have discussed is central to this. But at present, that spine is – at points – weak, and – at others – missing.

As such, we recommend that actors from across the health and technology ecosystems focus in 2024-25 on building the technology infrastructure of dynamism, carefully calibrating to provider and health system strategic goals and key areas. This work we recommend be undertaken collaboratively, with a focus on prototyping and learning.



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Actions

		Healthcare Providers	Technologists	Government & Policy Makers	Researchers & Universities
FOUNDATIONS	**Establish regulatory settings:** • Develop and enforce standards for the use of digital technologies in biotech and healthcare to ensure safety, efficacy, and ethical use. • Strengthen regulations around data privacy and security with a view to novel contexts. • Provide incentives for collaboration between healthcare providers, tech companies, and research institutions.			●	
	Explore & scope • Strategically build partnerships across the health system to keep informed about key areas of innovation and the steps required to implement them.	●	●	●	●
	Ready infrastructure: • Ensure different data systems can seamlessly share information. • Build redundant capacity into data management systems to handle influxes of biological and patient data. • Protect sensitive biotech data and information with robust security measures.	●	●		
ACTIVATE	**Build Skills & capability:** • Ensure all stakeholders have access to ongoing education and training, particularly on the digital technologies that can have the greatest impact on access to- and deployment of- the latest biotech advances. • Update training programs to include new and imminent biotechnologies.	●	●		●
	Prototype & pilot: • Integrate AI algorithms to analyse complex datasets and extract actionable insights. • Run future-proof preparedness training with senior staff, simulating new developments and assessing the effect they might have on existing systems. • Work with technology developers to provide clinical insights and advocate for necessary resources and support.	●	●		●
TRANSFORM	**Deploy & evaluate:** • Run cybersecurity simulations on existing systems to determine any risks associated with collecting new types of data. • Use advanced computing infrastructure to process large-scale biological data and run complex simulations.	●	●		●
	Amplify & scale: • Expand existing research relationships with a view to being prepared for new discoveries. • Invest in other strategic partnerships and formal collaborations to amplify distribution and scale of biotech solutions.	●	●	●	●

Conclusion by way of call-to-action

Potential realised through action

Imagining a future of potential health impact **– realised**

Imagine a future where healthcare is not confined by the walls of hospitals but is seamlessly integrated into our daily lives through digital technologies. A future where AI augments human intelligence, enabling clinicians to make more accurate diagnoses and more effective treatment plans. A future where simulation technologies allow for risk-free training and personalised care, and where remote patient care ensures that everyone has access to high-quality healthcare, no matter where they are.

This is not a distant dream—it is a future within our grasp. It is not falling into hyperbole to state that we stand on the potential brink of a new era in healthcare.

However, we use the term potential purposefully: as we have seen, the scope of technologies that are moving into the health space create opportunities for vast transformation and deep impact across our systems. But in almost every case, the path to that impact remains to be fully articulated and determined.

The strategic scoping and prioritisation questions are sharp. The technology development questions demand attention. The clinical and operational aspects require further work. Policy frameworks are often yet to be formulated. Perhaps most urgently, the technology infrastructure in our health systems require strengthening in order to leverage much of what is starting to emerge.

Moving from understanding to action

In this report, we have detailed five Transformation Dimensions which have the potential – and the imperative – to deliver real, systemic health impact in the future. We have explored in depth the potential for each to redefine health systems, described proven applications in health, and offered a clear roadmap for actionable change in the next 12 months. On the next page, we summarise this journey – from understanding, to impact, to action – across the five Dimensions.

Grasping the Trend What is it?	Understanding impact Applications and implications	Taking action Actions for 2024-25
Augmented intelligences		
Artificial intelligence is 2024's most hyped trend. Powered by neural networks and the ingestion of enormous quantities of data, AI identifies statistical trends in the data that can be applied to new contexts.	Potentially revolutionary across almost every major element of the health system, from diagnostics and care, to operational decision making and resource management. However, impact is dependent on the sophistication of digital infrastructure, data collection and management, and cybersecurity.	• Build robust data pipelines for high-quality data for AI training and operation. • Invest in skills around AI and potential uses. • Establish partnerships to explore prerequisites to implementation.
Simulation and simulacra		
Simulation technologies allow testing, prototyping and experimenting without the costs or consequences associated with the physical world. Includes Extended Reality, digital twins and 3D Printing.	Extensive potential impact, touching elements of the system across both patient care and system infrastructure. However, most technologies are still broadly in early stages of deployment, in even the most advanced health systems and providers.	• Build the technology foundations that simulation technologies need to work. • Collaboratively scope, prototype, and pilot these technologies to learn and plan for more fulsome deployment.
Remote patient care		
Involves utilisation of an array of communication technologies and network-connected sensors to provide care to an individual in circumstances where the carer and patient are not in the same physical space.	Potential for significant transformation, especially at the patient level, and with implications for the infrastructural and operational elements of the system. While the pandemic has driven exponential growth in RPC deployment, realising impact at scale will require more sophisticated data processing and cybersecurity.	• Scope and collaborate on the most strategic technologies for prototyping, deployment and iteration. • Building the technology infrastructure for scale. • Incentivise and enable hybrid healthcare at scale via policy and regulatory settings.
Health system adaptability and dynamism		
Involves creating systems that are flexible by default, designed with the anticipation of the need for future adjustment, and with a range of features that can achieve the required shifts – across physical and digital infrastructure, and organisational structures and processes.	Adaptation is not a choice. As the world changes, health systems can decide to build dynamism into their structures or be forced to change in periodic ruptures. Crafting flexible policy and building dynamic structures allows health systems to keep pace with the rest of society and respond to challenges confidently as they arise.	• Build the technology infrastructure of dynamism, calibrating to strategic goals and key areas across organisations and the health system more broadly. • Embed a focus on collaboratively prototyping and learning.
Harnessing biotechnology breakthroughs		
The great breakthroughs in health have come from breakthroughs in biotechnology deep scientific research. Today, the implementation of such breakthroughs is enhanced by appropriate digital infrastructure - or hampered by its absence.	Biotech research into gene editing, personalised genomics and regenerative medicine appear set to transform medical practice. Each is powered by AI and data analytics and will require robust digital systems for implementation.	• Build partnerships across health, biotech and research institutions to prepare for new technologies as they become available. • Build redundant capacity into data management systems to handle influxes of biological and patient data.

The demand for collaboration and the NIIN Health Alliance

These pathways and questions need to be explored to transform potential impact into real impact. And given the breadth, the multi-dimensional nature, and the complexity of many of these issues, the need for collaborative action across our system has never been more critical. No single entity can address these issues alone. It is through collaboration that we can leverage diverse perspectives, share resources, and accelerate innovation.

The NIIN Health Alliance, with its unique amalgamation of expertise, infrastructure, and innovative spirit, is ideally positioned to support this drive for inclusive transformation. The challenges we face are multifaceted and complex, but through collaboration, we can overcome them and create a healthcare system that is more efficient, effective, and equitable.

The NIIN Health Alliance brings together government, industry, and academic partners to form a dynamic ecosystem that fosters innovation. With six innovation centres, eight Research Chairs, two health-focused labs, and specialised technology hubs, NIIN provides the ideal environment for tackling healthcare challenges through digital transformation. Our network is not just about technology—it's about people, partnerships, and a shared commitment to revolutionising healthcare.

Join us in driving the transformation

The NIIN Health Alliance is ready to lead the way, but we cannot do it alone. We need your expertise, your innovation, and your commitment to join us in this endeavour. Together, we can turn this vision into reality.

We invite healthcare providers, policymakers, technologists, and researchers to join us in this transformative journey. By engaging with the NIIN Health Alliance, you can be part of a pioneering effort to reshape healthcare. Together, we can harness the power of digital transformation to improve patient outcomes, streamline operations, and create a more resilient healthcare system.

If you are ready to explore any of these dimensions of transformation, we are ready to stand with you. Let's stride forward into this new era together, leveraging the power of digital transformation to achieve unprecedented advancements in patient care and operational excellence.

Don't just read this report – reach out.

Don't sit alone thinking of the future – join us.

Don't wait for tomorrow – let us act together today.

The future of healthcare is now — engage with the NIIN Health Alliance and help us shape it.

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Appendix: additional case studies

1. Augmented intelligences
The promise of genuinely smart healthcare

2. Simulation and simulacra
Using digital replicas to hack the real world

3. Remote patient care
Care that meets the patient where they need it

4. Health system adaptability and dynamism
Resilience and sustainability in times of rapid change

5. Harnessing biotechnology breakthroughs
The digital foundations of future healthcare

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Additional case studies: Augmented Intelligences

AI-driven clinical navigation for health insurance

Who: Healthily

What: Healthily revolutionises health insurance with its AI-powered virtual health assistant, Dot™. This platform uses smart symptom navigation to provide members with medically validated information, guiding them to the most appropriate next steps for their health concerns. Dot™ helps reduce unnecessary and inefficient pathways, improving patient outcomes while saving costs for insurers. By automating symptom assessment and signposting, Dot™ minimises the burden on healthcare professionals and call centres, allowing for more efficient resource utilisation. Since 2015, Healthily has ensured that safety and medical accuracy are paramount, enhancing the overall healthcare experience for users.

Links: Healthily

AI-powered knee cartilage assessment

Who: CSIRO and the University of Queensland

What: Successfully commercialised in 2023 after 15 years of development and testing, the assessment algorithm takes 2D magnetic resonance (MR) images and converts them into the much more expensive (and thus less commonly ordered) 3D versions. By automating this process, the algorithm can increase the quality of scans, provide earlier detection of knee osteoarthritis, and save healthcare costs. The CSIRO algorithm has the additional benefit of creating images that can be more accurately analysed by diagnostic AI algorithms. By presenting the images in AI-readable forms, it further expands the possibilities for rapid AI-powered diagnoses at a time when the demand for radiologist reviews is outstripping supply.

Links: CSIRO

AI for predicting drug development success

Who: Intelligencia AI

What: Intelligencia AI uses artificial intelligence to improve the probability of success in drug development. The platform leverages machine learning to assess the probability of technical and regulatory success (PTRS) of drug candidates, making use of vast and diverse datasets. By providing data-driven insights, Intelligencia helps pharmaceutical companies make informed decisions, prioritise promising candidates, and reduce development costs. Intelligencia AI's algorithm analyses patterns and interdependencies in extensive datasets, offering accurate PTRS predictions and enhancing decision-making at critical stages.

Link: Intelligencia AI

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AI-powered breast and lung cancer screening

Who: Intelerad medical systems and PenRad technologies

What: In 2022, Intelerad acquired PenRad Technologies to enhance their breast and lung cancer screening capabilities. PenRad's software, including PenRad for breast imaging and PenLung for lung cancer screening, integrates with Intelerad's imaging platform. This combination optimises radiologist workflows, improves diagnostic accuracy, and helps manage the increased demand for cancer screenings. This acquisition aims to provide efficient, scalable imaging solutions that support healthcare professionals in delivering better patient care and outcomes.

Links: Intelerad

AI-integrated pathology workflow

Who: PathAI

What: PathAI's AISight™ platform integrates with Laboratory Information Systems (LIS) to enhance pathology workflows. It ensures HIPAA-compliant data transmission of case details and whole slide images (WSI) from the lab to AISight™. The platform allows users to launch AISight™ directly from the LIS for both onsite and remote image analysis. It supports the deployment of AI algorithms, including AIM PD-L1 and AIM HER2, which assist in the detailed analysis of pathological samples. This integration aims to optimise diagnostic accuracy and efficiency in pathology labs.

Links: PathAi

Multiomics-based cancer detection

Who: Freenome

What: Freenome detects cancer using a multiomics platform that integrates molecular biology with advanced computational biology and machine learning. This approach analyses tumour and non-tumour signals from a routine blood draw, detecting cancer at its earliest stages. Freenome's flagship study, PREEMPT CRC, aims to validate their blood test for colorectal cancer (CRC) screening. With over 35,000 participants, this study seeks to demonstrate the test's sensitivity and specificity across diverse populations. Additionally, the Vallania Study expands this technology to multiple cancers, including lung and pancreatic cancers, striving to enhance early detection and optimise patient care pathways.

Links: Freenome, Case study

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AI-powered chest pain triage

Who: TIIM Healthcare aiTriage™

What: aiTriage™ offers a device-agnostic chest pain triage solution that combines speed, accuracy, and ease of use. It predicts the patient's risk of 3- and 30-day Major Adverse Cardiac Events (MACE) non-invasively within minutes, seamlessly integrating into existing workflows in emergency departments and primary care settings. aiTriage employs patented AI technology to provide rapid and accurate risk stratification for MACE. This assists healthcare professionals in prioritizing patients who need urgent care and reassuring those at low risk. Utilizing short electrocardiogram tracings, aiTriage measures cardiac autonomic regulation, reflecting the balance between the sympathetic and parasympathetic nervous systems, which is crucial for assessing MACE risk.

Links: TIIM Healthcare aiTriage

AI-powered oncology data integration

Who: Oncora Medical

What: Oncora Medical specialises in transforming oncology data into actionable insights to enhance cancer treatment and research. Their solutions, such as Oncora Patient Care and Oncora Registry, integrate seamlessly with existing EHRs and other software systems to unify data from various sources including electronic health records (EHRs), treatment planning systems, oncology information systems, and tumour registries. This data integration engine enables oncologists and researchers to visualise and analyse registry data in a secure, web-based platform, driving research, identifying patient cohorts, and confirming clinical trial feasibility.

Links: Oncora Medical

Fundamental surgery

Who: FundamentalVR

What: FundamentalVR offers advanced virtual reality solutions for surgical training. Key products include HapticVR™, StandaloneVR, and CollaborationVR, which provide immersive, tactile training experiences. These platforms enable surgeons to enhance their skills with realistic simulations, track performance with AI-driven data, and collaborate globally. Fundamental Surgery's technology aims to improve surgical accuracy, accelerate skill acquisition, and support various medical and sales teams in training and development.

Links: FundamentalVR

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AI-powered care delivery

Who: Biofourmis

What: Biofourmis offers advanced AI-powered solutions for personalised and scalable care delivery. Their platform integrates cloud-based infrastructure, AI-enabled analytics, and continuous monitoring to deliver care across various acuity levels and conditions. This system allows for seamless transitions between care programs, supported by licensed health providers and navigators. The technology enables remote patient management, coordination of in-home services, and interoperability with existing EMRs. By providing real-time data and insights, Biofourmis enhances patient outcomes, reduces hospital readmissions, and lowers healthcare costs, making it a leader in virtual and in-home care solutions.

Links: Biofourmis

AI-powered care-at-home platform

Who: Current Health

What: Current Health has developed an enterprise care-at-home platform that integrates continuous vital signs monitoring, telehealth services, and AI-powered analytics to provide comprehensive remote patient management. This platform supports various care models including hospital-at-home, transitional care, and chronic disease management. By delivering acute care at home, it helps healthcare providers reduce hospital admissions, improve patient outcomes, and lower costs. The technology is designed to integrate seamlessly with existing healthcare systems, enhancing care delivery through real-time data and patient engagement tools.

Links: Current health

FitBit health solutions for enterprise

Who: FitBit Enterprise

What: FitBit Enterprise offers comprehensive health solutions aimed at improving population health through data-driven insights and wearable technology. Their solutions encompass a wide range of applications including chronic condition management, behaviour change, and foundational health behaviours. Fitbit devices collect extensive health data such as activity levels, heart rate, and sleep patterns, which can be leveraged to enhance health outcomes and support wellness programs.

Links: FitBit Enterprise

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AI-powered patient engagement

Who: Corti

What: Corti offers an advanced AI solution for enhancing patient consultations. Developed with extensive research and practical application, Corti's AI assists in real-time decision support, triaging, documentation, and quality assurance. By analysing virtual and face-to-face patient engagements, the AI provides actionable insights, streamlines workflows, and improves patient outcomes. Trusted by major healthcare providers, Corti integrates seamlessly into existing systems, increasing productivity by over 10% and ensuring comprehensive quality assurance. This AI-powered platform supports healthcare professionals in delivering efficient, accurate, and empathetic care.

Links: Corti

AI-powered emergency response

Who: RapidSOS

What: RapidSOS provides an intelligent safety platform designed to enhance emergency response by connecting critical data from various devices and systems directly to first responders. The platform aggregates data such as location, health information, and sensor alerts to improve the speed and accuracy of emergency responses. RapidSOS integrates with over 5,700 911 centres across the U.S., supporting emergency professionals with real-time information and reducing response times. This technology is pivotal in transforming emergency services by ensuring that first responders have access to vital information when it matters most.

Links: RapidSOS

Comprehensive health data mapping

Who: Healthmap by Healthdirect Australia

What: Healthmap is an initiative by Healthdirect Australia aimed at consolidating key health data into an accessible, user-friendly format. This tool integrates various datasets related to the Australian health sector, promoting greater accessibility and innovation. Healthmap's goal is to facilitate evidence-based decision-making by providing comprehensive data that supports healthcare professionals, planners, researchers, and the general public.

Links: Healthmap

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AI-powered symptom assessment

Who: Ada Health

What: Ada Health offers an AI-driven symptom assessment tool designed to enhance diagnostic accuracy and healthcare efficiency. The Ada app, used by millions globally, allows users to input their symptoms and receive potential condition insights. With a database containing numerous conditions and symptoms, Ada's algorithm provides personalised health assessments and actionable next steps. The system is validated by clinical studies and incorporates feedback from over 50 in-house medical experts. Ada supports primary care by improving patient triage, offering detailed clinical handovers, and integrating seamlessly with existing healthcare systems to enhance patient outcomes and operational efficiency.

Links: AdaHealth

AI-powered health and wellness platform

Who: Healthily

What: Healthily provides an AI-driven health and wellness platform designed to empower individuals to manage their health proactively. The platform offers various tools and resources, including a symptom checker, health trackers, and personalised health plans. Using AI algorithms, Healthily analyses user input to provide accurate health assessments and advice, helping users make informed decisions about their health.

Links: Healthily

mySugr: simplifying diabetes management

Who: mySugr

What: mySugr offers a comprehensive diabetes management app, developed by and for people with diabetes. The app includes features such as personalised logging screens, easy connection with blood glucose meters via Bluetooth, blood glucose graphs, estimated HbA1c, and clear reports for doctor visits. Users can access motivating challenges and secure, encrypted data. The PRO version adds functionalities like multi-device syncing, a bolus calculator, meal photos, and blood sugar reminders. The app integrates with Apple Health and Google Fit and is compatible with various Accu-Chek devices.

Links: MySugr

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Propeller Health: Enhancing respiratory care with digital precision

Who: Propeller Health

What: Propeller Health has developed an FDA-cleared digital therapeutic platform aimed at improving the lives of patients with asthma and COPD. The platform includes sensors that track medication usage, a mobile app or online portal for data access, and personalised support and coaching. Clinically proven to reduce rescue inhaler use and hospital visits, Propeller's system helps identify triggers, enhances care management, and enables data-driven prevention of exacerbations. It unifies value for patients, health systems, payers, and life sciences by improving outcomes and reducing healthcare costs.

Links: Propeller health

Woebot Health: AI-driven mental health support

Who: Woebot Health

What: Woebot Health offers an AI-powered platform providing scalable mental health care through a chat-based digital companion. Woebot delivers evidence-based techniques like Cognitive Behavioural Therapy (CBT), personalised support, and real-time interventions. The platform is designed for enterprise use, helping clinicians identify and engage patients, capture health insights, and improve care quality. With 1.5 million users and 70 million minutes of support provided, Woebot is transforming mental health care by making it more accessible and effective.

Links: Woebot Health

Lark Health: AI-driven chronic disease management

Who: Lark Health

What: Lark Health provides a digital health platform that uses AI and connected devices to offer personalised coaching and support for managing chronic conditions such as diabetes, hypertension, and obesity. The platform delivers real-time, 24/7 health guidance through a mobile app, incorporating behavioural science and clinical guidelines. With programs recognised by the CDC, Lark helps reduce healthcare costs, improve outcomes, and enhance patient engagement. It integrates seamlessly with health plans and employers, offering scalable solutions to improve population health management.

Links: Lark Health

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LeanTaaS: AI-driven healthcare capacity optimisation

Who: LeanTaaS

What: LeanTaaS leverages AI, machine learning, and predictive analytics to enhance healthcare operations. Their iQueue platform optimises capacity for operating rooms, infusion centres, and inpatient flow, reducing wait times and improving resource utilisation. The platform helps hospitals increase efficiency, reduce staff burnout, and enhance patient care. LeanTaaS partners with over 1,200 hospitals and centres, offering solutions that generate significant ROI and streamline workflows. Their approach combines data science with lean principles to maximise healthcare capacity and improve operational performance.

Links: LeanTaaS

Syft analytics: Comprehensive financial analytics platform

Who: Syft Analytics

What: Syft Analytics offers a robust platform for financial analysis, reporting, and forecasting. The tool integrates with various accounting software to provide dashboards, consolidations, and detailed financial reports. It enhances decision-making through features like multi-company reporting, cash flow forecasting, and financial modelling. The platform is designed for accountants, CFOs, and business owners to streamline financial processes, improve accuracy, and save time. Syft's advanced analytics capabilities allow users to gain deeper insights into their financial data, driving better business outcomes.

Links: Syft Analytics

ZocDoc: Simplifying healthcare appointments

Who: ZocDoc

What: ZocDoc is an online healthcare platform designed to streamline the process of finding and booking doctor appointments. Established in 2007 and headquartered in New York, Zocdoc connects patients with local doctors and specialists across various fields, including primary care, dentistry, and mental health. Patients can search for healthcare providers based on their insurance network, location, and availability. The platform supports both in-person and telehealth appointments, though in-person visits remain more popular. Zocdoc is free for patients to use, offering 24/7 customer service and a comprehensive database of healthcare professionals. It aims to improve access to care, enhance patient-provider relationships, and incorporate AI to automate administrative tasks, thereby freeing up providers' time.

Links: ZocDoc

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Oracle health

Who: Oracle

What: Oracle Health leverages connected technologies and unified data to revolutionise healthcare. It provides a comprehensive suite of tools for clinical applications, financial operations, population health, and consumer experience. Key solutions include Oracle Health EHR, clinical digital assistant, and cloud-based infrastructure, aiming to streamline operations, enhance patient care, and promote global health. Oracle Health collaborates with partners like Accenture and Deloitte to create a modern, connected healthcare ecosystem.

Link: Orcale

Health Catalyst

Who: Health Catalyst

What: Health Catalyst provides advanced data and analytics technology and services to healthcare organisations. Key offerings include data platforms, population health management, patient engagement, clinical quality improvement, patient safety, and revenue cycle management. Their solutions aim to drive measurable improvements in clinical, operational, and financial outcomes. Health Catalyst's tools are designed to harness healthcare data to deliver actionable insights, enhance patient care, and optimise financial performance.

Link: Health Catalyst

Qure4u digital health platform

Who: Qure4u, founded by Dr. Monica Bolbjerg

What: Qure4u offers an all-in-one digital health platform designed to automate workflows, improve patient access, and enhance satisfaction. Key features include digital check-in, self-scheduling, telehealth, remote patient monitoring, and secure texting. The platform integrates seamlessly with existing EHR systems, helping healthcare providers reduce staff shortages and burnout while increasing efficiency and revenue. Qure4u aims to streamline administrative tasks, allowing healthcare teams to focus on delivering high-quality patient care.

Link: Qure4u

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Darktrace cybersecurity

Who: Darktrace

What: Darktrace offers advanced cybersecurity solutions powered by Self-Learning AI. Key products include Darktrace PREVENT™, DETECT™, RESPOND™, and HEAL™, providing comprehensive protection across email, cloud, network, endpoint, and operational technology. The AI adapts to unique business operations, enhancing threat detection and response. Darktrace's platform ensures proactive cyber resilience, integrating seamlessly with existing infrastructure to protect organisations from evolving cyber threats.

Link: Darktrace

Flatiron health

Who: Flatiron Health

What: Flatiron Health reimagines cancer care through innovative technology and data solutions. Key offerings include electronic health records (EHR), real-world evidence (RWE), clinical decision support, and clinical trial optimisation. Their products enhance patient care, streamline clinical trials, and accelerate drug development. By integrating and analysing oncology-specific data, Flatiron enables faster, data-driven decisions for clinicians, researchers, and life sciences companies, ultimately improving cancer treatment and outcomes.

Link: Flatiron Health

AI-enhanced pathology diagnosis (prostate cancer)

Who: Paige AI

What: Paige AI's applications leverage deep learning on a vast dataset of tens of thousands of whole-slide images sourced globally. Paige's AI is finely tuned with a sensitivity of 97.7% and specificity of 99.3%. It is designed to recognise and prioritise potential cancerous regions while respecting pathologists' preferences to overlook common mimickers like high-grade prostatic intraepithelial neoplasia. This precision aids in enhancing diagnostic accuracy and efficiency, supporting pathologists in delivering more reliable results and optimizing pathology workflows.

Link: Paige AI

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Advanced AI in pathology: Ibex's technological framework

Who: Ibex

What: Ibex utilises cutting-edge technologies including computer vision, big data analytics, and machine learning. These tools enable Ibex to provide insights crucial for diagnosis and precision medicine, covering a wide range of cancers, including rare sub-types, and grading various malignancies. The AI can also detect over a hundred clinically relevant diagnostic features across multiple tissue types.

Link: Ibex

Speech Movement and Acoustic Analysis Tracking (SMAAT)

Who: Curtin University

What: SMAAT is a novel software application that provides Speech Movement and Acoustic Analysis Tracking (SMAAT). It is a user-friendly, downloadable desktop application tailored to provide speech pathologists with objective and reliable digital data that can be used to inform the diagnosis of speech sound disorders and subsequent selection of the most appropriate intervention, as well as show treatment progress over time. With access to objective measures and data-driven diagnosis, we are focused on impacting service delivery efficiencies that will contribute to the right intervention being delivered at the right time

Link: SMAAT

Healthy Connections

Who: Curtin University, Cisco, and Optus

What: Healthy Connections is aimed at improving health service delivery and bridging health inequity in the Pilbara. Healthy Connection's Proof of Concept is the mobile Medi-Kit, a briefcase-sized preventative health screening device for chronic diseases designed to provide on-Country care for remote Aboriginal communities, minimizing the need for long-distance travel and supporting health worker capability and capacity. The Medi-Kit supports Remote Area Nurses, Aboriginal Healthcare Workers, and Practitioners by using AI for point-of-care testing analysis, educational resources, follow-up guidance, and medical reports.

Healthy Connections aims to improve health outcomes by offering accessible, culturally sensitive healthcare to remote Aboriginal communities. It reduces travel barriers and supports healthcare workers with advanced AI tools, promoting early intervention and health education. The project's scalability is ensured by its adaptability to various remote areas across Australia.

Link: Healthy Connections

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Additional case studies: simulation and simulacra

Advancing medicine with 3D Bioprinting: CollPlant's rhCollagen innovation

Who: CollPlant Biotechnologies Ltd.

What: CollPlant pioneers 3D bioprinting with their rhCollagen-based BioInks, revolutionizing regenerative medicine and tissue engineering. These BioInks offer optimal rheology, increased safety profiles, biocompatibility, and customisable physical properties essential for creating complex scaffolds in tissue and organ generation. 3D bioprinting holds promise in addressing the critical shortage of organs for transplantation, with CollPlant's technology aiming to provide an unlimited supply of life-saving organs. United Therapeutics has already demonstrated the bioprinting of a trachea using CollPlant's BioInk, showcasing its potential in creating functional soft tissue implants.

Links: CollPlant Biotechnologies Ltd.

SimX virtual reality medical training

Who: SimX

What: SimX offers immersive virtual reality medical training, providing high-fidelity simulated patient encounters for healthcare professionals. Key solutions include VR for EMS, nursing, and military medical training. The platform features customisable scenarios, dynamic patient interactions, and patented multiplayer technology. SimX aims to improve critical thinking, clinical judgment, and overall patient care by simulating complex clinical situations. Their marketplace hosts the largest library of virtual patient encounters.

Links: SimX

Virtual reality for chronic pain relief

Who: Karuna Labs

What: Karuna Labs offers KarunaHOME, an innovative program using virtual reality (VR) combined with personalised behavioural coaching to treat chronic pain. The non-pharmacological and non-surgical approach aims to rewire the brain's perception of pain through immersive VR experiences, helping patients manage conditions like low back pain, shoulder pain, and neuropathic pain. Over a 12-week program, patients engage with VR scenarios designed to reduce pain and improve functionality. The program is flexible, convenient, and has shown promising results in enhancing patients' quality of life.

Links: Karuna Labs

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3D Printing for paediatric heart surgery

Who: SSM Health Cardinal Glennon Children's Hospital

What: SSM Health Cardinal Glennon Children's Hospital utilises advanced 3D printing technology to enhance surgical planning for infants with complex congenital heart disease (CHD). By converting MRI datasets into precise 3D models, the hospital enables surgeons to better visualise and strategise for intricate procedures. A notable case involved an infant with a rare form of transposition of the great arteries and severe subaortic stenosis. The 3D model allowed the surgical team to plan a successful neonatal atrial switch and other necessary corrections with confidence, significantly improving the patient's prognosis. This innovative approach underscores the potential of 3D printing in improving outcomes for complex paediatric surgeries.

Links: Cardinal Glennon Children's Hospital

Personalised Cranio-Maxillofacial surgery solutions

Who: Materialise

What: Materialise utilises cutting-edge 3D printing technology to enhance cranio-maxillofacial (CMF) surgery. By creating patient-specific surgical guides, orthognathic splints, and implants, the company significantly improves surgical accuracy and outcomes. The process involves interactive planning sessions between surgeons and Materialise's clinical engineers using the SurgiCase software to design tailored surgical plans. These designs are then 3D printed to produce precise surgical tools. This personalised approach ensures higher accuracy in procedures, reduced operation times, and greater predictability compared to standard implants. Materialise's solutions have been applied successfully in over 30,000 cases since 2006, demonstrating their efficacy in improving patient outcomes for complex craniofacial surgeries.

Links: Materialise

Enhancing medical education with HoloLens

Who: Case Western Reserve University

What: Case Western Reserve University has integrated Microsoft HoloLens into their medical education program to transform how anatomy is taught. Using HoloLens, students can interact with 3D holograms of human anatomy, providing a more immersive and interactive learning experience. This technology allows for better visualisation of complex structures and spatial relationships, which are difficult to achieve with traditional cadaver-based methods. The HoloLens application not only improves understanding and retention but also makes learning more engaging and accessible, paving the way for advancements in medical education.

Links: Microsoft Customer Stories

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Augmented reality for manufacturing training

Who: PBC Linear & Magic Leap

What: PBC Linear, a leader in linear motion technologies, partnered with Magic Leap to implement Taqtile's manifest augmented reality (AR) platform. This collaboration addresses challenges like an aging workforce, high turnover, and lengthy training times. The AR solution provides digital work instructions, 3D models, and real-time remote collaboration, enabling new employees to become productive within days. This approach has reduced training time by 80%, saved substantial onboarding costs, and decreased mistakes and scrap by 20%, significantly improving operational efficiency.

Links: Magic Leap Case Study

Pioneering digital neurotherapeutics for brain Health

Who: MindMaze

What: MindMaze is at the forefront of digital neurotherapeutics, providing innovative solutions for brain health and recovery. Their portfolio includes the MindMotion™ GO program, which offers tele neurorehabilitation for patients with neurological conditions, allowing them to access therapy from home. MindMaze combines advanced motion analytics, cloud and AI technologies to create immersive, interactive experiences that enhance neurorehabilitation. Their technologies are deployed in leading centres worldwide, demonstrating significant improvements in motor, cognitive, and cardiovascular functions post-neural injuries and degeneration.

Links: MindMaze

Digital twins in healthcare

Who: Siemens Healthineers

What: Siemens Healthineers is advancing the concept of digital twins in healthcare to enhance patient outcomes. A digital twin is a virtual replica of a physical entity or process, allowing for precise simulation and analysis. In medical applications, digital twins can personalise treatment plans, predict disease progression, and improve surgical outcomes by leveraging real-time data. This technology aims to humanise medical technology by making patient care more personalised and efficient. However, challenges such as data privacy and integration need to be addressed for widespread adoption.

Links: Siemens Healthineers

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Whole body digital twins for metabolic health

Who: Twin Health

What: Twin Health leverages Whole Body Digital Twin™ technology to combat metabolic diseases such as diabetes and obesity. This technology creates a digital replica of an individual's metabolism, offering personalised guidance on nutrition, sleep, activity, and stress management through an intuitive app. By continuously monitoring real-time data, the program adapts to provide precise recommendations, which has led to significant improvements in reversing chronic conditions, reducing medication usage, and enhancing overall metabolic health. The success of this program underscores the potential of digital twins in personalised healthcare.

Links: Twin Health

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Additional case studies: remote patient care

Digital care programs for chronic conditions

Who: Doctors On Demand

What: Doctors On Demand offers a comprehensive telehealth service, providing patients in Australia with 24/7 access to online doctor appointments via video consultations. This platform allows users to book appointments, receive prescriptions, obtain medical certificates, and get referrals from the convenience of their homes. The service aims to enhance accessibility to healthcare, reduce wait times, and provide immediate care for various conditions. With a user-friendly interface, the platform ensures secure, private consultations with registered Australian doctors, promoting efficient and effective healthcare delivery.

Links: Omada Health

Comprehensive telehealth solutions

Who: HealthTap

What: HealthTap provides a robust telehealth platform offering affordable, accessible healthcare through online consultations with board-certified doctors. Members can book video appointments, receive prescriptions, and access personalised care plans. The service supports a wide range of health needs, from primary care and chronic condition management to mental and sexual health. HealthTap emphasises continuous care with features like unlimited texting with doctors and 24/7 availability, ensuring comprehensive and convenient medical support for individuals and families.

Links: HealthTap

Simplified medication management by PillPack

Who: PillPack, an Amazon company

What: Launched in 2013, PillPack simplifies the management of medications by sorting them by date and time, delivering them monthly, and coordinating with doctors and insurance providers. This service ensures patients have their medications without the hassle of frequent pharmacy visits, enhancing adherence and health outcomes. PillPack also offers automatic refills and behind-the-scenes support, organizing all medication, billing, and prescription details in one place.

Link: PillPack

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Continuous ambulatory cardiac monitoring with Zio

Who: iRhythm Technologies

What: iRhythm Technologies offers the Zio service, a user-friendly, continuous ambulatory cardiac monitoring solution. The Zio ECG monitor, worn by patients for up to 14 days, captures uninterrupted heart rhythm data, enabling accurate arrhythmia detection and diagnosis. The device is designed to minimise disruption to patients' lives, providing a comfortable, reliable monitoring experience. Data collected is analysed and presented in actionable reports for physicians, enhancing patient care through timely, informed decision-making.

Links: iRhythm Technologies

Medication management solutions by Medisafe

Who: Medisafe

What: Medisafe, established as a leading medication management platform, leverages AI and digital tools to improve medication adherence and patient support. Key solutions include:

- Digital Drug Companion: provides personalised medication management and reminders.
- Just-in-Time Interventions (JITI)™: offers real-time, behaviour-based interventions to enhance adherence.
- Medisafe Maestro: integrates with healthcare systems to streamline patient support and coordination.

These solutions ensure patients adhere to their medication schedules, improving health outcomes and compliance.

Links: Medisafe

AI-Powered Musculoskeletal (MSK) health solutions by Phzio

Who: Phzio

What: Phzio provides comprehensive MSK health solutions through its MSK360 platform, launched to offer unlimited virtual physical therapy, ergonomic assessments, and conditioning programs. The platform integrates care workflows and automation, facilitating seamless coordination and treatment for members and dependents. With a network of 175,000 Canadian providers, Phzio ensures accessible, high-quality care, enhancing overall physical health and preventing MSK disorders. This approach not only improves patient outcomes but also optimises healthcare costs for organisations.

Links: Phzio

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Digital health and telehealth solutions by Physitrack

Who: Physitrack

What: Physitrack offers a robust suite of digital health solutions, including remote patient engagement, telehealth services, and personalised exercise prescriptions. Key features include:

- Exercise Prescription & Education: Delivers clear, narrated exercise videos and printouts to patients.
- Client Onboarding: Provides pre-appointment questionnaires and care coordination.
- Outcomes Analysis: Collects real-time data to track patient progress.
- Security: Ensures data safety with extensive security controls and compliance with privacy regulations.

These solutions enhance patient care, improve adherence, and streamline clinical workflows.

Links: Physitrack

Digital therapeutics for respiratory health

Who: Propeller Health

What: Propeller Health provides a digital therapeutic platform designed for patients with chronic respiratory diseases such as asthma and COPD. The platform includes FDA-cleared, CE-marked sensors that attach to inhalers, a mobile app, and an online portal. These tools help patients track their medication use, identify triggers, and receive personalised support and coaching. Clinically proven to reduce rescue inhaler use and improve overall health, Propeller Health aims to enhance patient outcomes through data-driven insights and proactive management of respiratory conditions.

Links: Propeller Health

Advanced sleep solutions

Who: ResMed

What: ResMed offers innovative solutions for sleep apnea, insomnia, and snoring, including CPAP machines, masks, and accessories. Their technology integrates advanced diagnostics and personalised treatment plans, improving sleep quality and overall health. ResMed provides comprehensive support through free online sleep assessments and extensive resources, ensuring effective management of sleep disorders. By focusing on individual needs, ResMed empowers users to achieve better sleep and enhanced well-being, contributing to improved health outcomes and quality of life.

Links: ResMed

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Continuous glucose monitoring for diabetes management

Who: Dexcom

What: Dexcom's G6 Continuous Glucose Monitoring (CGM) system offers an innovative solution for diabetes management. The G6 system includes a small sensor placed under the skin, a transmitter, and a display device, which can be a smartphone or a receiver. This system continuously monitors glucose levels, providing real-time data every five minutes without the need for fingerstick calibrations. The G6's alerts help users manage their glucose levels by notifying them of impending highs and lows, enabling proactive diabetes management. The system is approved for patients aged two years and older, and the sensor's auto-applicator ensures easy and painless insertion. With its ability to integrate with other digital health tools, the Dexcom G6 enhances the overall management and quality of life for individuals with diabetes.

Links: Dexcom G6 CGM System

Online therapy

Who: Talkspace

What: Talkspace provides an online therapy platform connecting users with licensed therapists via text, audio, and video messaging. This service offers individual therapy, couples counselling, and psychiatric services, allowing users to communicate with their therapists throughout the day without appointments or commutes. The flexibility of Talkspace ensures continuous support, addressing issues as they arise. It's recognised for its affordability and accessibility, often costing less than traditional therapy sessions and being covered by many insurance plans. Talkspace aims to make mental health support more accessible and convenient for everyone.

Links: Talkspace

Online counselling

Who: BetterHelp

What: BetterHelp offers a comprehensive online counselling service, providing access to licensed therapists via text, audio, and video communication. Users can engage in therapy sessions at their convenience, making it easier to integrate mental health care into their daily routines. The platform covers a wide range of issues, including depression, anxiety, and relationship problems, ensuring personalised care for each user. BetterHelp is known for its broad accessibility and flexibility, with affordable pricing and support for various insurance plans. This service aims to remove barriers to mental health care, making it accessible to a larger population.

Links: BetterHelp

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Engineering impact: Medtronic's leadership in healthcare technology

Who: Medtronic

What: Medtronic is a global leader in healthcare technology, renowned for its innovative solutions that address complex medical conditions worldwide. With over 95,000 employees in 150+ countries, Medtronic focuses on expanding healthcare access, promoting diversity, equity, and sustainability.
Medtronic recently launched Luminaite in ANZ, integrating AiBLE™ for personalised care. They initiated the Blue Balloon Challenge, supporting Type 1 Diabetes awareness. Partnering with AMRA, Medtronic enhanced robotic-assisted surgery with the Hugo system.
These efforts exemplify Medtronic's commitment to pioneering healthcare solutions, leveraging technology to improve patient outcomes and advance global health initiatives.

Links: Medtronic

Remote monitoring for maternal health

Who: Bloomlife

What: Bloomlife offers a comprehensive connected care platform for maternal health, featuring remote patient monitoring with FDA-cleared devices. The platform simplifies the maternal care journey by providing digital health assessments, real-time clinical oversight, and smart notifications based on clinical protocols. This approach helps identify at-risk pregnancies earlier, reducing in-person appointments and administrative tasks, and improving outcomes for mothers and babies.

Links: Bloomlife

Digital maternity care platform

Who: Babyscripts

What: Babyscripts offers a comprehensive digital platform for maternity care, focusing on risk detection and patient engagement. The program includes remote patient monitoring, mental health assessments, and perinatal education, all designed to improve maternal health outcomes. Babyscripts' tools provide real-time data to healthcare providers, enabling early identification of risks like preeclampsia and hypertension. The platform aims to enhance equity and access to care by offering culturally competent resources and ADA-accessible content. This solution supports both providers and payers in delivering personalised, efficient maternity care.

Links: Babyscripts

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Online dermatology consultations

Who: DermatologistOnCall

What: DermatologistOnCall provides asynchronous online visits with board-certified dermatologists. Patients can create an account, select a dermatologist, and submit photos of their skin, hair, or nail concerns. The dermatologist reviews the information and responds with a diagnosis and treatment plan within 48 hours, with most visits completed in under 24 hours. Patients can pick up prescriptions from local pharmacies or receive them via mail order. The platform allows ongoing communication with the dermatologist for 30 days post-visit for follow-up and additional advice.

Links: DermatologistOnCall

AI-Powered dermatology consultation

Who: First Derm

What: First Derm offers online dermatology consultations, providing expert evaluations for various skin conditions. Users submit photos and descriptions of their skin issues through the platform, receiving a diagnosis and treatment plan from board-certified dermatologists within 48 hours. The service ensures privacy and anonymity, requiring no account creation. It addresses common skin concerns, including acne, eczema, and potential skin cancers, with many cases resolved using over-the-counter treatments. First Derm's teledermatology aims to offer quick, accessible care globally.

Links: FirstDerm

Digital Musculoskeletal (MSK) care

Who: Hinge Health

What: Hinge Health provides a digital platform for musculoskeletal care, combining advanced technology with expert clinical support. The program offers personalised exercise therapy, education, and 1:1 coaching through its app. Users can manage chronic pain, recover from injuries, and prepare for surgeries at home. The app includes features such as goal setting, progress tracking, and video demonstrations of exercises. The service is available through many employers and health plans, aiming to improve access to effective MSK care.

Links: HingeHealth

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AI-powered musculoskeletal therapy

Who: Kaia Health

What: Kaia Health delivers a digital-first approach to musculoskeletal (MSK) care, utilizing AI-powered technology and human coaching. The platform offers personalised exercise programs, real-time motion tracking, and access to licensed physical therapists. Users benefit from tailored therapy plans for back, joint, and chronic pain, supported by the Motion Coach™ for feedback and safety. The service aims to reduce pain, enhance mobility, and improve overall quality of life through convenient, accessible digital care.

Links: Kaia Health

Kinsa health overview

Who: Kinsa Health

What: Kinsa Health provides advanced illness tracking and predictive solutions using machine learning, epidemiological models, and generative AI. Their systems forecast healthcare demand and manage product supply for organisations like hospitals and retail pharmacies. For families, Kinsa offers smart thermometers and health apps to track symptoms and guide care. Their early warning systems help communities prevent the spread of infectious diseases, providing insights weeks ahead of traditional methods.

Links: Kinsa Health

Online speech therapy for children

Who: Sproutling Speech Therapy

What: Sproutling Speech Therapy specialises in early intervention for children aged 0-5 with communication challenges. They offer online speech therapy sessions, focusing on late talkers, Global Developmental Delay, and autistic children. Services include the Hanen Programs “It Takes Two to Talk” and “More Than Words”, which support language development and social communication skills. Evening and weekend consultations are available to accommodate various schedules.

Links: Sproutling

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Remote patient education by MyChart

Who: MyChart by Epic

What: MyChart enhances remote patient education by providing a centralised platform where patients can access comprehensive health information. Features include:

- Educational Resources: access personalised health education materials and resources.
- Secure Messaging: communicate with healthcare providers for educational support and clarifications.
- Interactive Tools: utilise tools for understanding medications, test results, and treatment plans.

These features empower patients with knowledge, improving their health literacy and engagement in their care.

Links: MyChart

HealthWISE remote patient education

Who: HealthWISE

What: HealthWISE provides a comprehensive range of services emphasizing remote patient education. Their offerings include Aboriginal health services, mental health support, and allied health services. The focus on remote patient education ensures that individuals can access quality health information and care regardless of location. This approach helps manage health needs efficiently, reduces hospital visits, and promotes continuous patient engagement and self-management through telehealth and other remote resources.

Links: HealthWISE

Pain management and tracking solutions

Who: PainScale by Boston Scientific

What: PainScale is an online platform and mobile application designed to help individuals manage chronic pain through personalised tracking, education, and treatment options. Includes: PainScale, developed by Boston Scientific, is an online platform and mobile application designed to assist individuals in managing chronic pain. The platform offers a variety of tools to track pain levels, treatments, medications, activities, mood, and sleep. Users can identify patterns and triggers over time, helping them manage their condition more effectively. Additionally, PainScale provides educational resources on pain management, with content reviewed by reputable organisations such as the Mayo Clinic and Stanford Medicine. This includes information on various pain management techniques, treatments, and wellness tips. The platform also features a pain quiz that helps users identify suitable therapies for their specific pain conditions. Furthermore, PainScale generates comprehensive reports that improve communication between patients and healthcare providers, facilitating faster and more accurate diagnosis and treatment adjustments.

Links: PainScale

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Comprehensive chronic condition management

Who: Livongo

What: Livongo, now part of Teladoc Health, offers an innovative approach to managing chronic conditions such as diabetes, hypertension, and weight management. The platform provides members with smart devices like blood glucose meters and blood pressure monitors, which are connected to a mobile app for real-time data tracking and insights. Along with these tools, Livongo offers unlimited supplies and 24/7 expert coaching to support patients in managing their health. This integrated system aims to simplify chronic condition management, improve health outcomes, and reduce healthcare costs.

Links: Livongo

Digital health innovations at Cleveland Clinic

Who: Cleveland Clinic

What: Cleveland Clinic has embraced digital technologies and telemedicine to enhance patient care, accessibility, and engagement. Virtual Visits: Cleveland Clinic offers virtual visits for various conditions, allowing patients to consult healthcare providers from home. Express Care Online: their Express Care Clinics provide virtual visits for non-emergency conditions like colds, flu, minor injuries, and skin rashes. Virtual Second Opinions: Cleveland Clinic's virtual second opinion service allows patients to get expert opinions on serious conditions, surgical recommendations, or complex treatments.

Links: Virtual Visits, Express Care Online, Virtual Second Opinions

Cisco multi-content solution for brain cancer

Who: Cisco in collaboration with Oslo University, Norway

What: The Cisco Multi-Content Solution for brain cancer is part of Cisco's broader initiative to enhance healthcare through advanced digital technologies. This solution leverages Cisco's Webex platform to create Multi-Content Video Rooms, enabling simultaneous sharing of multiple content sources in high-definition video meetings. This setup allows medical teams to collaborate more effectively, viewing and discussing high-fidelity images and patient data in real-time from various locations . A notable application of this technology is seen at Oslo University Hospital in Norway, where it significantly reduced care-plan waiting times for cancer patients from seven weeks to one week. This was achieved by creating multidisciplinary meeting rooms where experts could come together virtually to review cases, ensuring that all participants had access to the same high-quality information simultaneously . Cisco's approach integrates secure and flexible collaboration tools, ensuring that medical data is shared safely and efficiently. This not only improves patient care but also enhances the productivity and satisfaction of healthcare professionals by reducing their administrative burden.

Links: Cisco multi-content solution for brain cancer

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Additional case studies: adaptability and dynamism in health systems

Victorian Virtual Emergency Department: A model of healthcare adaptability

Who: Victorian Department of Health

What: The Victorian Department of Health, in collaboration with La Trobe University, has established the Victorian Virtual Emergency Department (VVED). This innovative solution allows patients to access emergency care remotely, thereby reducing the burden on physical emergency departments. As part of Victoria's Virtual Care Strategy, the VVED provides real-time consultations, ensuring timely diagnoses and treatments. La Trobe University played a significant role as a partner in the VVED's development and implementation. During the COVID-19 pandemic, the VVED offered an essential alternative to in-person visits, maintaining continuity of care and minimizing exposure risks. This virtual care model has effectively reduced wait times and optimised resource allocation, demonstrating remarkable adaptability in healthcare delivery. The initiative sets a new standard for integrating technology into healthcare, highlighting the benefits of virtual care.

Links: ANMF, Health Vic, La Trobe, La Trobe News

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Geisinger's digital transformation for enhanced patient care

Who: Geisinger Health

What: Geisinger Health leverages digital technologies and telemedicine to improve patient care, access, and engagement. Through the My Geisinger portal and MyChart app, patients can manage appointments, view test results, request prescription renewals, and communicate with their care team. The integration of billing with electronic health records in MyChart streamlines financial interactions, allowing for real-time balance updates and various payment options. Geisinger also offers virtual care options, such as telehealth consultations and a nurse triage line, ensuring patients can receive medical advice and support remotely.

Links: Patient Portal, Primary Care

Integrated healthcare solutions by Clalit Health Services

Who: Clalit Health Services in collaboration with The Clinician

What: Clalit Health Services, one of Israel's leading healthcare providers, offers a comprehensive model that integrates primary, secondary, and tertiary care. The organisation leverages advanced digital health tools and value-based care initiatives to streamline patient management across all care levels. This model includes coordinated care pathways that allow for better tracking of patient progress and more efficient use of healthcare resources. Clalit's approach includes the implementation of digital care pathways in collaboration with The clinician, aimed at improving value-based care delivery.

Links: Clalit Health Services' blog

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Advancing sustainability in healthcare: Australia's climate resilience module

Who: Australian commission on safety and quality in health care

What: The Australian commission on safety and quality in health care's environmental sustainability and climate resilience healthcare module promotes integrating sustainability into healthcare practices. This initiative provides guidelines for healthcare facilities to adopt energy-efficient systems, sustainable procurement, and waste reduction. The module aims to reduce carbon footprints and enhance resilience against climate-related disruptions, ensuring healthcare providers maintain care continuity during extreme weather events. By implementing these strategies, healthcare facilities can reduce their environmental impact while improving their operational efficiency and sustainability.

Links: Safety and Quality

Data analytics and comprehensive EHR systems at Mayo Clinic

Who: Mayo Clinic

What: Mayo Clinic leverages advanced data analytics and comprehensive Electronic Health Record (EHR) systems to enhance decision-making, improve patient outcomes, and boost operational efficiency. By integrating extensive data from various sources, Mayo Clinic's EHR system supports personalised patient care, enabling clinicians to make informed decisions based on comprehensive patient histories and predictive analytics. This system aids in early diagnosis, treatment planning, and monitoring of chronic diseases, ultimately enhancing patient outcomes. The EHR system at Mayo Clinic streamlines workflows, reducing administrative burdens and allowing healthcare providers to focus more on patient care. This integration of data analytics into the EHR system not only enhances clinical decision-making but also supports research by providing valuable insights into patient care trends and outcomes.

Links: Mayo Clinic

Leveraging data analytics and EHR systems

Who: Aarhus University Hospital (AUH)

What: By integrating vast amounts of patient data into their EHR systems, AUH enables healthcare professionals to access comprehensive patient histories, improving diagnosis accuracy and personalised treatment plans. Additionally, their involvement in European Reference Networks (ERN) like EURACAN enhances the treatment of rare diseases by pooling data and expertise across borders, facilitating better clinical guidelines and patient care.

Links: AUH

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Precision medicine at Mayo Clinic

Who: Mayo Clinic

What: By leveraging detailed patient data and advanced genetic testing, Mayo Clinic tailors treatments to meet the unique needs of each patient. For example, the RENEW system helps diagnose rare genetic disorders by integrating the latest scientific discoveries, leading to precise and effective treatment plans for patients with complex conditions. Additionally, Mayo Clinic's collaboration with Epic's MyChart Virtual Care integrates care plans directly into a mobile app, providing patients with accessible, expert guidance to manage chronic conditions like asthma, diabetes, and heart failure.

Links: Mayo Clinic

Apollo's precision medicine approach

Who: Apollo Hospitals

What: Apollo Hospitals has integrated individualised care plans, patient preferences, and precision medicine to enhance treatment outcomes and patient satisfaction. Through its Apollo ProHealth program, the hospital offers personalised health checkups designed by expert doctors and powered by AI. These health checks include comprehensive laboratory tests, imaging scans, and consultations with specialists, tailored to the unique health needs of each patient. This approach allows for early detection of potential health issues and a more personalised treatment plan. Apollo's focus on precision medicine involves leveraging genetic information and advanced data analytics to tailor treatments to individual patients. Additionally, Apollo utilises a Personal health record system, which securely stores all patient data, making it accessible to both patients and healthcare providers.

Links: Apollo Hospitals

Sustainable healthcare facilities

Who: Practice Greenhealth

What: Practice Greenhealth, a nonprofit membership organisation, is pioneering sustainable health care by promoting environmental solutions across hospitals and health systems in the United States and Canada. Their initiatives focus on creating dynamic health spaces that are not only environmentally friendly but also foster restorative and sustainable healing environments. Green building design: encouraging green and healthy facility design, construction, and renovation to minimise environmental impacts and promote sustainable operations. Energy efficiency: promoting energy efficiency and clean, renewable energy to reduce the healthcare sector's environmental footprint and advocate for a healthy energy future. Water conservation: implementing strategies to reduce water consumption in healthcare facilities as a starting point for broader sustainability practices. Sustainable procurement: embedding sustainability into purchasing processes and engaging suppliers to offer innovative, sustainable products with reduced health and environmental impacts. Waste management: promoting zero waste policies and sustainable disposal options to minimise the volume and toxicity of waste produced by healthcare facilities.

Links: Practice Greenhealth, Sustainable buildings, Free cooling case study, Reduced emissions case study

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Value-Based care and population health strategies

Who: Geisinger

What: Geisinger emphasises value-based care models and population health strategies to improve health outcomes and reduce costs. Their Steele Institute for health innovation leads initiatives like ProvenCare®, which standardises best treatments for specific conditions, reducing costs and enhancing care quality. The Fresh Food Farmacy® provides food-insecure patients with healthy meals to manage diabetes, while the MyCode® Community Health Initiative utilises genomic data to personalise treatments. Programs like ProvenHealth Navigator® promote preventive care, reducing the need for more intensive interventions and supporting long-term health improvements.

Links: Geisinger

Emphasizing value-based care at Intermountain Healthcare

Who: Intermountain Hospitals

What: Intermountain Healthcare has been a leader in adopting value-based care models and population health strategies to enhance health outcomes and reduce costs. These efforts include a focus on preventive care, patient education, and coordinated treatment plans that prioritise long-term health over short-term interventions. Population health management, integrated care models, preventive care initiatives, Patient-Centred Medical Homes (PCMH) are some of the ways Intermountain Hospitals achieve this.

Links: Intermountain Hospitals

Sustainable healthcare facilities

Who: Health Spaces

What: Health Spaces collaborates with various NHS Trusts to create sustainable, dynamic healthcare environments. By integrating modern methods of construction and repurposing existing spaces, they focus on energy efficiency and achieving BREEAM & Net Zero standards. Projects include: 28 bed hospital ward, James Paget University hospitals NHS Foundation Trust - Enhanced space utilisation and energy efficiency. Ward & Critical Care Unit, Barts Health NHS Trust - Focused on operational efficiency and patient care. Urgent treatment centre, northwest Anglia NHS foundation Trust - implemented sustainable construction practices.

Links: Health spaces case study

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Continuous innovation in healthcare delivery

Who: Cleveland Clinic Innovations

What: Cleveland Clinic Innovations is dedicated to driving continuous improvement in healthcare delivery through significant investments in research and development. By fostering a culture of innovation, the clinic encourages its caregivers to explore radical ideas and integrate clinical care with research. This approach has led to numerous breakthroughs, including the first coronary angiography and genome sequencing for cancer patients. The clinic also identifies top medical innovations annually, informing and inspiring the broader healthcare community to adopt advancements that improve outcomes and reduce costs.

Links: Cleveland Investment, Cleveland Innovation, Top Investments

Continuous healthcare innovation at Aarhus University Hospital

Who: Aarhus University Hospital (AUH)

What: AUH prioritises research and development to drive continuous improvement and innovation in healthcare delivery. This initiative underpins a comprehensive research strategy, leveraging clinical health science to enhance patient outcomes. The hospital's approach to innovation integrates advanced technologies and interdisciplinary research, emphasizing personalised medicine and data-driven healthcare solutions. Key initiatives include the CONNECT research support unit, which combines health data for personalised medicine, and the BETA HEALTH national innovation platform aimed at fostering sustainable and value-based healthcare systems.

Links: AUH Research, AUH Innovation

Continuous healthcare innovation at Froedtert Health

Who: Froedtert Health

What: Froedtert Health actively invests in research and development to drive continuous improvement and innovation in healthcare delivery. This commitment is exemplified through partnerships with the Medical College of Wisconsin and initiatives like the Froedtert & MCW Cancer Network. The organisation focuses on cutting-edge treatments such as novel cell therapies for advanced melanoma and collaborative projects like the All of Us Research Program.

Links: Froedtert Health

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Transforming healthcare: The National Electronic Health Record (NEHR) in Singapore

Who: Synapxe Pte Ltd

What: Synapxe Pte Ltd oversees Singapore's NEHR, integral to the "One Patient, One Health Record" vision. NEHR aggregates health data from diverse healthcare settings, offering clinicians a unified view of patient histories since 2011. It enhances care coordination, diagnosis accuracy, and treatment efficacy by providing comprehensive insights such as allergies, medical procedures, and test results.

NEHR supports public and progressively private healthcare providers, ensuring secure data sharing through system integration. This promotes seamless healthcare delivery, reduces redundancies, and mitigates errors, ultimately improving patient safety and healthcare outcomes. Future enhancements aim to foster deeper data collaboration across sectors, aligning with national healthcare initiatives for integrated and patient-centric care.

Links: Synapxe Pte Ltd

Enhancing healthcare coordination: Hong Kong's eHealth initiative

Who: Hong Kong Government

What: The electronic health record sharing system (eHealth) by the Hong Kong Government facilitates seamless access and sharing of electronic health records (eHR) among authorised healthcare providers. Since its launch, eHealth has improved diagnostic accuracy, treatment efficiency, and patient safety by integrating comprehensive health data from public and private sectors.

eHealth supports patient-centric care across diverse healthcare settings through secure data exchange and system integration, aligning with Hong Kong's healthcare strategy for enhanced care delivery and outcomes.

Links: Hong Kong's eHealth initiative

Transforming NHS financial oversight

Who: NHS England

What: NHS England implemented an oversight framework to streamline financial oversight and improve performance across Integrated Care Systems (ICSs) and their constituent organisations. This framework was established to address fragmented oversight mechanisms, inconsistent performance assessments, and inefficient resource allocation. It emphasises the role of Integrated Care Boards (ICBs) in managing NHS resources, quality of care, and population health. The framework introduced a segmentation model to categorise ICBs and trusts based on their performance. This model allows for targeted support and intervention, ensuring efficient use of resources and enhanced governance. By providing clear performance expectations and support mechanisms, the NHS oversight framework aims to drive improvements in healthcare delivery and financial management.

Links: NHS Oversight Framework

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Nuka System of Care: A comprehensive approach to healthcare

Who: Southcentral Foundation

What: The Nuka System of Care, developed by Southcentral Foundation, is an innovative, relationship-based healthcare delivery model designed to improve patient outcomes and community health. Originating in Alaska, this system integrates medical, behavioural, dental, and traditional care into a holistic approach tailored to individual needs. Key features include patient-centred care teams, extensive community engagement, and continuous quality improvement practices. By focusing on building strong, trust-based relationships between providers and patients, the Nuka System of Care enhances patient satisfaction, reduces healthcare costs, and improves health outcomes across the population it serves. This model has gained international recognition for its effectiveness and sustainability.

Links: Nuka System of Care

Apollo Telehealth: Revolutionizing healthcare access

Who: Apollo Hospitals

What: Apollo Telehealth is transforming healthcare access through innovative telemedicine solutions. By leveraging technology, Apollo Telehealth provides remote consultations, diagnostics, and monitoring services, making healthcare accessible to patients in remote and underserved areas. The platform supports a range of specialties, enabling patients to receive expert medical advice without traveling long distances. This initiative addresses the healthcare gap by ensuring timely medical intervention, continuity of care, and reducing the burden on physical healthcare facilities. Apollo Telehealth exemplifies how technology can bridge healthcare disparities, enhancing patient outcomes and accessibility.

Links: Apollo Telehealth

Kaiser Permanente: Specialty training program

Who: Kaiser Permanente

What: Kaiser Permanente's Specialty Training Program aims to enhance the skills of nurses through targeted education and practical training in specialised fields. This program supports nurses in gaining expertise in areas such as critical care, oncology, and paediatrics, addressing the demand for specialised nursing care. By investing in nurse education, Kaiser Permanente ensures high-quality patient care and professional growth for its nursing staff. The program includes classroom instruction, simulation training, and clinical practice, fostering a comprehensive learning environment that prepares nurses for advanced roles in healthcare.

Links: Kaiser Permanente

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Cleveland Clinic Improvement Model (CCIM)

Who: Cleveland Clinic

What: The Cleveland Clinic has developed the Cleveland Clinic Improvement Model (CCIM) to engage every caregiver in achieving organisational goals. The model focuses on four key areas: Organisational alignment, visual management, problem solving, and standardisation. Leading leaders and teams are encouraged to set clear goals, manage through visual tools, foster problem-solving skills, and maintain standard processes. This comprehensive approach ensures that every caregiver understands their role in contributing to the Clinic's success and continuous improvement. Tools such as the visual management tutorial and the PDCA (Plan-Do-Check-Act) process support this initiative, promoting a culture of safety, quality, and efficiency.

Links: Cleveland Clinic Improvement Model

NHS urgent community response services

Who: NHS England

What: NHS England's urgent community response services provide rapid, multidisciplinary care to patients in their homes, reducing hospital admissions and supporting timely intervention for urgent health needs. This service targets individuals with acute medical conditions, frailty, or complex care needs, offering a coordinated approach involving healthcare professionals from various fields. By delivering care in the community, these services enhance patient comfort, promote recovery, and ensure continuity of care. This initiative aligns with NHS England's commitment to integrated, patient-centred healthcare, improving outcomes and resource efficiency.

Links: Urgent Community Response Services

Emergency preparedness at Mayo Clinic

Who: Mayo Clinic

What: The Mayo Clinic's emergency preparedness program is a comprehensive initiative designed to ensure readiness for various emergency situations, including natural disasters, pandemics, and mass casualty events. This program involves detailed planning, regular training, and simulations to prepare medical professionals for rapid response. Key components include establishing clear communication channels, stockpiling necessary medical supplies, and creating contingency plans for different scenarios. By integrating these elements, the Mayo Clinic aims to minimise the impact of emergencies on patient care and hospital operations, ensuring that medical staff can effectively manage crises and continue providing high-quality care under challenging circumstances.

Links: Emergency Preparedness at Mayo Clinic

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Consumers Health Forum of Australia: Empowering health consumers

Who: Healthdirect Australia

What: The Consumers Health Forum of Australia, in partnership with Healthdirect Australia, works to empower health consumers through advocacy, information, and support services. This partnership aims to enhance health literacy, ensuring consumers can make informed decisions about their healthcare. By providing accessible information and resources, the forum promotes patient engagement and participation in healthcare decision - making. This collaborative effort addresses health disparities, improves access to healthcare services, and fosters a patient-centred approach to healthcare delivery.

Links: Consumers Health Forum of Australia

Fitbit Health Solutions: Proven impact on health outcomes

Who: Fitbit Health Solutions

What: Fitbit Health Solutions provides evidence-based wellness programs that leverage wearable technology to improve health outcomes. Through the use of Fitbit devices, users can monitor their physical activity, sleep patterns, and overall health metrics. The platform supports corporate wellness programs, helping organisations promote healthier lifestyles among employees. Studies have shown that Fitbit users experience increased physical activity, weight loss, and improved health indicators such as reduced resting heart rate and better sleep quality. By offering real-time data and personalised insights, Fitbit Health Solutions empowers individuals to make informed decisions about their health, contributing to long-term wellness and reduced healthcare costs..

Links: Fitbit Health Solutions

Sustainable patient hotel design

Who: Rigshospitalet

What: The Copenhagen patient hotel aims to reduce the stress of hospital stays through sustainable and dynamic design. The hotel offers a tranquil environment with features like ample natural light, green spaces, and private rooms. The design integrates energy-efficient systems and materials, prioritizing patient comfort and environmental sustainability. This innovative approach not only enhances the patient experience but also supports the hospital's operational efficiency and sustainability goals.

Links: Patient Hotel

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Cisco's support for displaced populations: A case study in humanitarian aid

Who: Cisco Systems, Inc.

What: Cisco has committed over US$16 million since 2015 to support displaced populations globally, focusing on providing essential technology and resources. This includes critical connectivity and security services during humanitarian crises like in Ukraine. Partnering with organisations such as Mercy Corps, NetHope, Norwegian Refugee Council (NRC), International Rescue Committee (IRC), and UNHCR, Cisco establishes digital platforms and community hubs for refugees. Their US$10 million partnership with Mercy Corps uses technology for humanitarian impact, while programs like Cisco Networking Academy and Talent Bridge offer digital skills training and employment opportunities across Europe, the Middle East, and Africa. Cisco's deployment of the Medibus for Ukrainian refugees further exemplifies their commitment to leveraging technology and corporate social responsibility to empower displaced communities globally.

Links: Cisco Refugee Centre

Cisco Meraki Powered - COVID Clinics

Who: Cisco and WA Health

What: In response to the COVID-19 pandemic, Cisco and WA Health collaborated to rapidly expand testing capacity by setting up a drive-through COVID Clinic-in-a-Box. This innovative solution used Cisco Meraki technology within shipping containers to create additional testing facilities. Additionally, a COVID-19 Pop-Up Medical Clinic was established at the Southwest Regional Health Alliance (SWARH), which is supported by Cisco Meraki technology. Within its first week of operation, the pop-up clinic conducted over 7,000 screenings. This deployment demonstrated the efficiency and effectiveness of temporary infrastructure in alleviating the burden on permanent healthcare facilities during mass testing programs.

Links: Dynamic Health Capacity

Inspiren dynamic health space

Who: Massachusetts General Hospital and Inspiren

What: Inspiren's AI-driven AUGi platform transformed patient care in a 27-bed Med-Surg unit with hybrid COVID-19 rooms. The dynamic health space was enhanced by smart lanyards, mobile apps, and central nursing station tablets, reducing patient falls by 50%. This hybrid approach enabled remote monitoring, virtual check-ins, and targeted AI alerts, streamlining staff workflow and bolstering patient safety..

Links: Inspiren case study

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Emergency preparedness and flexibility at Rush University Medical Centre

Who: Rush University Medical Centre

What: Rush University Medical Centre in Chicago, USA, boasts a versatile emergency department with three 20-bed units that can rapidly expand to 120 beds each during surges. Its main atrium transforms into a makeshift medical unit, ensuring efficient patient management under crisis conditions. Similarly, London's ExCel Centre swiftly converted into the NHS Nightingale with scalable bed capacity from 500 to 4,000, utilizing Cisco Webex for collaborative construction and Wi-Fi connectivity for bedside patient care. These examples underscore innovative crisis response strategies in healthcare, leveraging adaptable infrastructure and advanced technology to enhance patient care delivery and operational flexibility during emergencies.

Links: Rush Medical Centre

Digital NHS services and innovations

Who: NHS Digital

What: NHS Digital provides a wide range of digital services and innovations aimed at improving healthcare outcomes, operational efficiency, and data security within the NHS. Here are some key initiatives:

- NHS App: The NHS App offers a secure and straightforward way for users to access various NHS services via their smartphone or tablet. It enables users to book appointments, order repeat prescriptions, check symptoms, and view their medical records.
- NHS 111 Online: is a digital extension of the NHS 111 phone service, aimed at people aged 5 and over with urgent, non-life-threatening medical needs. It allows users to receive quick assessments and appropriate care guidance through an online platform.
- COVID Oximetry @home: As part of the COVID-19 response, NHS Digital developed the COVID Oximetry @home service. This initiative enables patients with coronavirus symptoms to be monitored remotely from their homes using digital tools and data services.

Links: NHS App, NHS 111 Online, COVID Oximetry @home

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Additional case studies: harnessing biotechnology breakthroughs

Pfizer: AI on a mission to make clinical drug development faster and smarter

Who: Pfizer pharmaceuticals

What: Pfizer pharmaceuticals utilises artificial intelligence (AI), including machine learning and natural language processing (NLP), to revolutionise clinical drug development. AI predicts drug efficacy and side effects, manages extensive data, and automates regulatory submissions and drug labelling. Supervised by human experts, AI accelerates the drug development cycle by identifying patterns in large datasets. Predicting regulatory queries in advance, AI streamlines submissions, reducing time-to-market delays and optimizing resource allocation. It enhances document accuracy and efficiency throughout the drug lifecycle, ensuring compliance with regulatory standards and dynamic data updates. Pfizer aims to integrate AI further to enhance decision-making and expedite global delivery of innovative medicines, promising more effective and patient-centred drug development processes.

Link: Pfizer

Data-driven innovation in drug development: Novartis' bold transformation

Who: Novartis pharmaceuticals

What: Novartis is at the forefront of leveraging big data analytics to revolutionise drug development and operational efficiency. Recognizing the transformative potential of advanced analytics, Novartis embarked on a journey to consolidate its vast data resources into a unified platform called Nerve Live. Spearheaded by Dr. Luca Finelli, this initiative integrates data from global clinical trials, previously siloed within different departments, into a centralised cloud-based system. By employing machine learning and cognitive computing through platforms like AWS and Microsoft Azure, Novartis accelerates insights generation and decision-making across functions. This multi-cloud approach not only enhances data processing speed by 20% but also facilitates the development of over 200 analytics use cases. These include tools like the Trial Footprint Optimizer and DESIRE, which optimise clinical trial planning and monitor site performance in real time. Moreover, Novartis' commitment to data democratisation ensures that these insights empower teams globally, fostering collaboration and innovation to deliver life-changing therapies more swiftly and efficiently.

Link: Novartis, Case Study

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Future-ready health systems through biotech innovations

Who: Roche Diagnostics Australia

What: Roche Diagnostics Australia is focused on understanding and integrating cutting-edge biotech trends to revolutionise healthcare systems. By prioritizing scientific rigor and innovation, Roche develops diagnostic solutions that address today's challenges while anticipating future needs. This approach includes advancements in cardiac biomarkers like NT-proBNP for heart failure and cTnT-hs for acute myocardial infarction, enabling earlier detection and improved clinical decisions. These innovations highlight Roche's commitment to transforming patient care and preparing healthcare systems for upcoming biotech advancements.

Link: Roche, Roche Cardiology