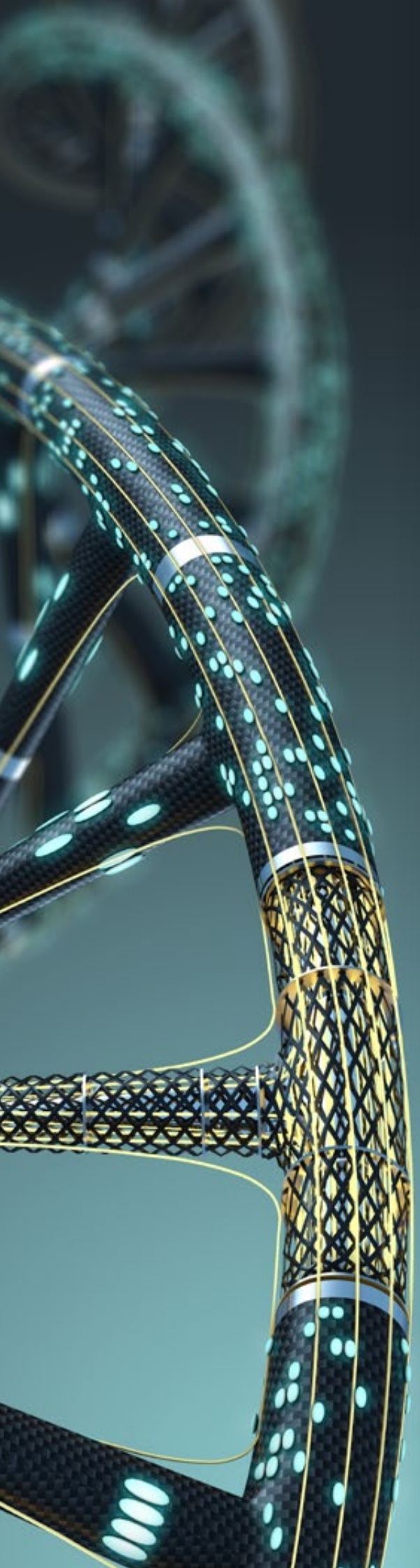

KPMG

Healthcare reimagined

Innovation trends, predictions and actions for healthcare leaders

KPMG.com.au

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Executive summary

Regulatory requirements, fierce competition, and rapidly emerging technologies are creating new complexities for those operating in the healthcare sector.

Many are working out how to deliver better health outcomes whilst managing evolving consumer needs, behaviours and treatments, along with the significant shifts required to the system. These changes cover all aspects of the ecosystem and operating models, providing a significant challenge for the entire healthcare industry.

In this paper we explore key trends and predictions in healthcare, particularly:

1. The rise of prevention and outcome based healthcare models – placing consumers firmly in control of their own health and wellness;
2. Advances in connected devices, including sensors, wearables and implantables that enable consumers and clinicians to pro-actively track and manage health, anywhere, anytime, and from any device;
3. Innovation in medical treatment – ranging from virtual reality training for rare surgeries, bio-printing synthetic organs, and early steps on the path to making aging a treatable condition;
4. The falling costs of genome-sequencing, coupled with advances in data science unlocking unprecedented levels of insight and precision medicine;
5. Advances in artificial intelligence, medical robotics and autonomous vehicles paving the way for hybrid healthcare workforces; and
6. A renewed understanding of how physical, spatial and digital environment design can improve patient healing, recovery time and the patient experience.

Facing this level of change is daunting. The role of leadership in embracing these shifts and influencing change is critical.

Drivers for change

Technology improvements

Expanding data, new technologies and the need for efficiency and demonstration of value

People & needs

Demographic shifts and trends are driving changing needs in care

Consumerism

Patients as consumers will grow in importance and demand best in class service

Market forces

New entrants and incumbents cause disruption and convergence

Costs

Continued growth in healthcare expenditures are putting more pressure on the current system and the need for change

Regulatory reform

Policy and funding changes – including early steps to move from a fee for service model towards bundled payments and an 'opt out' approach to the My Health Record – have the potential to accelerate innovation.

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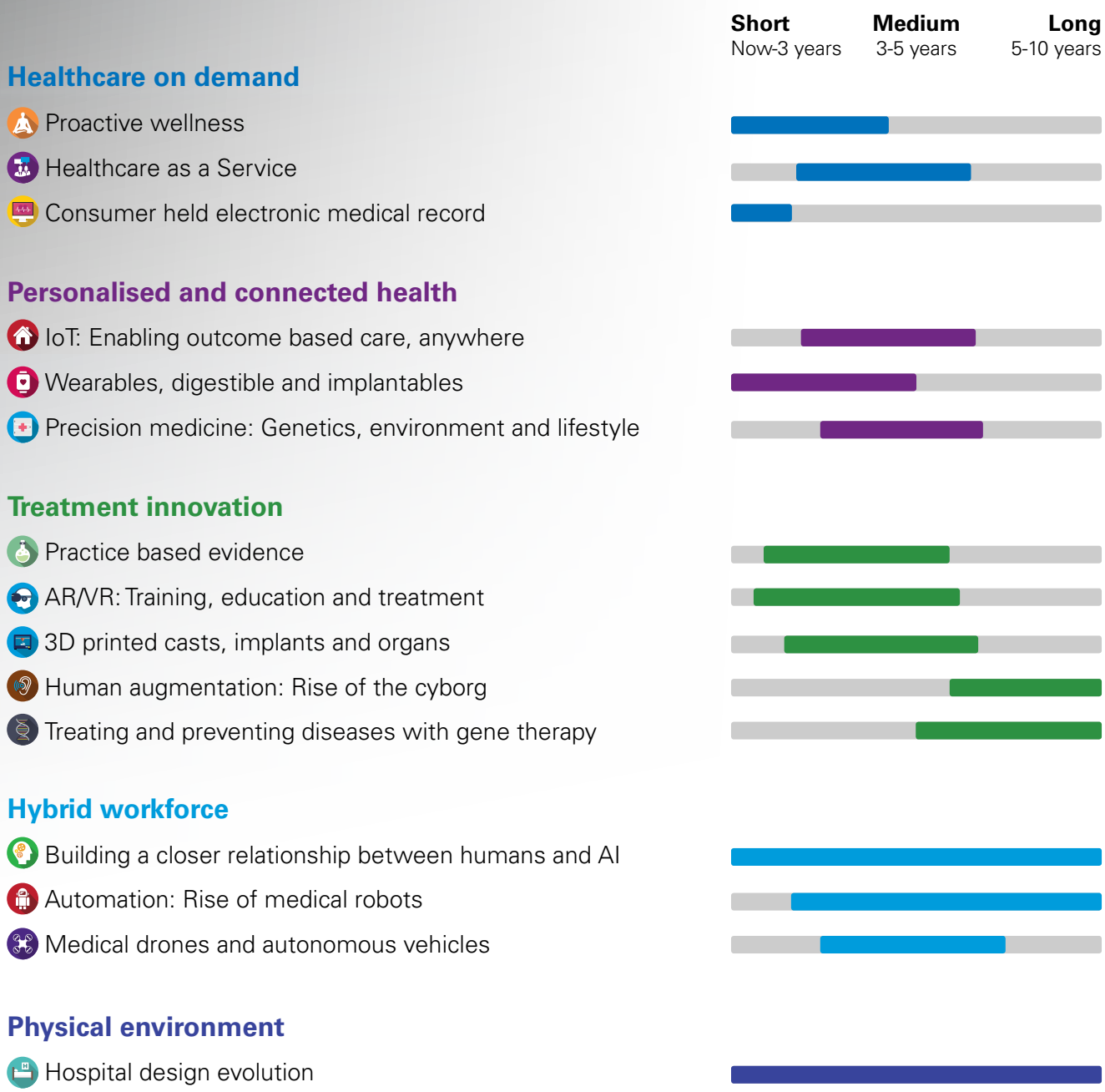
Snapshot of trends and predictions

Based on our analysis of changing demographics, consumer behaviour, market competition, and technology driven innovation in healthcare; we have outlined the impact over time; considering changes to consumers, healthcare professionals and public and private sector organisations.



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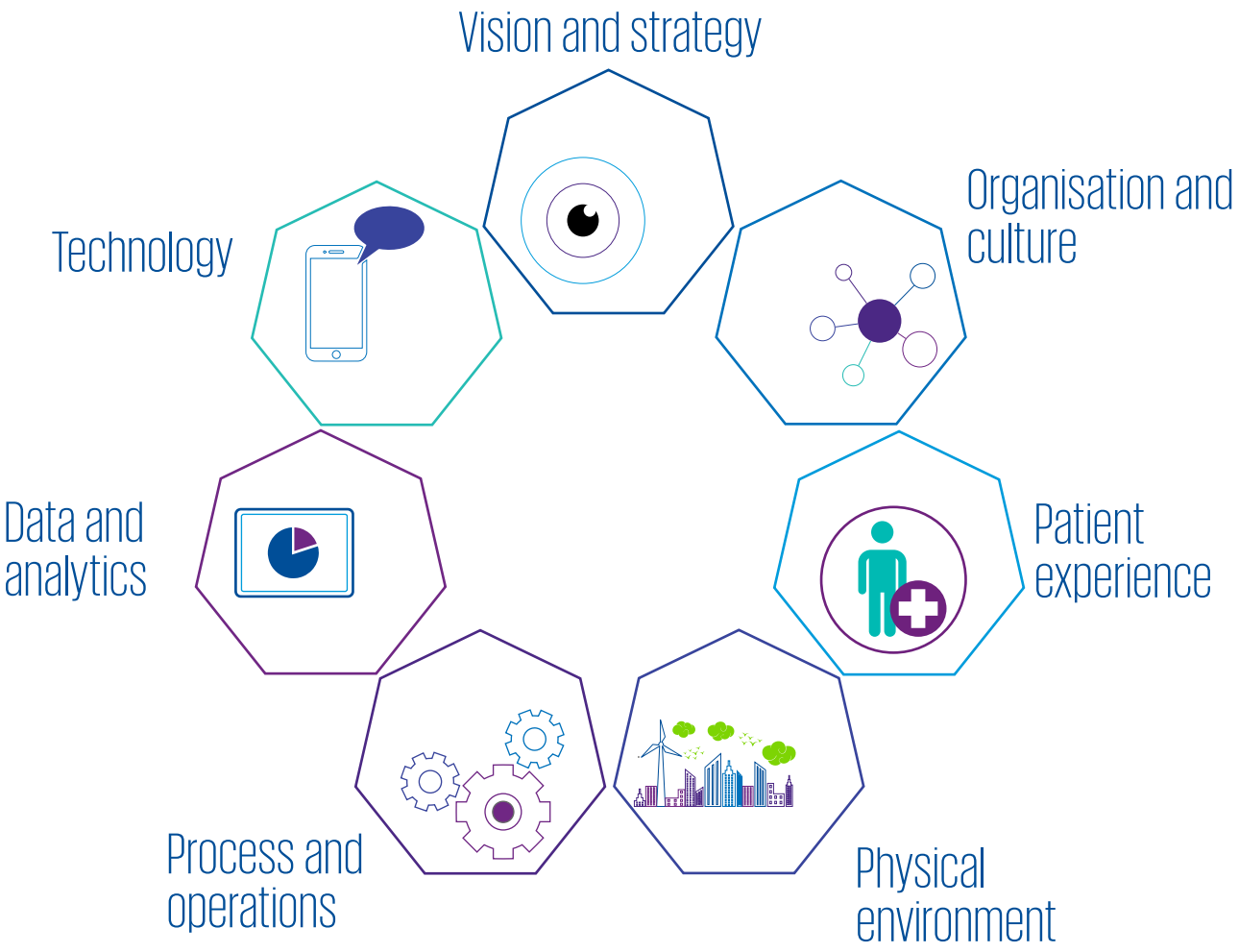
What can you do now?

There is no single route to success. In section three we have outlined a series of practical recommendations across vision and strategy, organisation and culture, patient experience, physical environment, process and operations, data and analytics, and technology domains; aimed at helping organisations build the foundation to rapidly adapt to key trends and predictions on the horizon, as they unfold.

Framework for change



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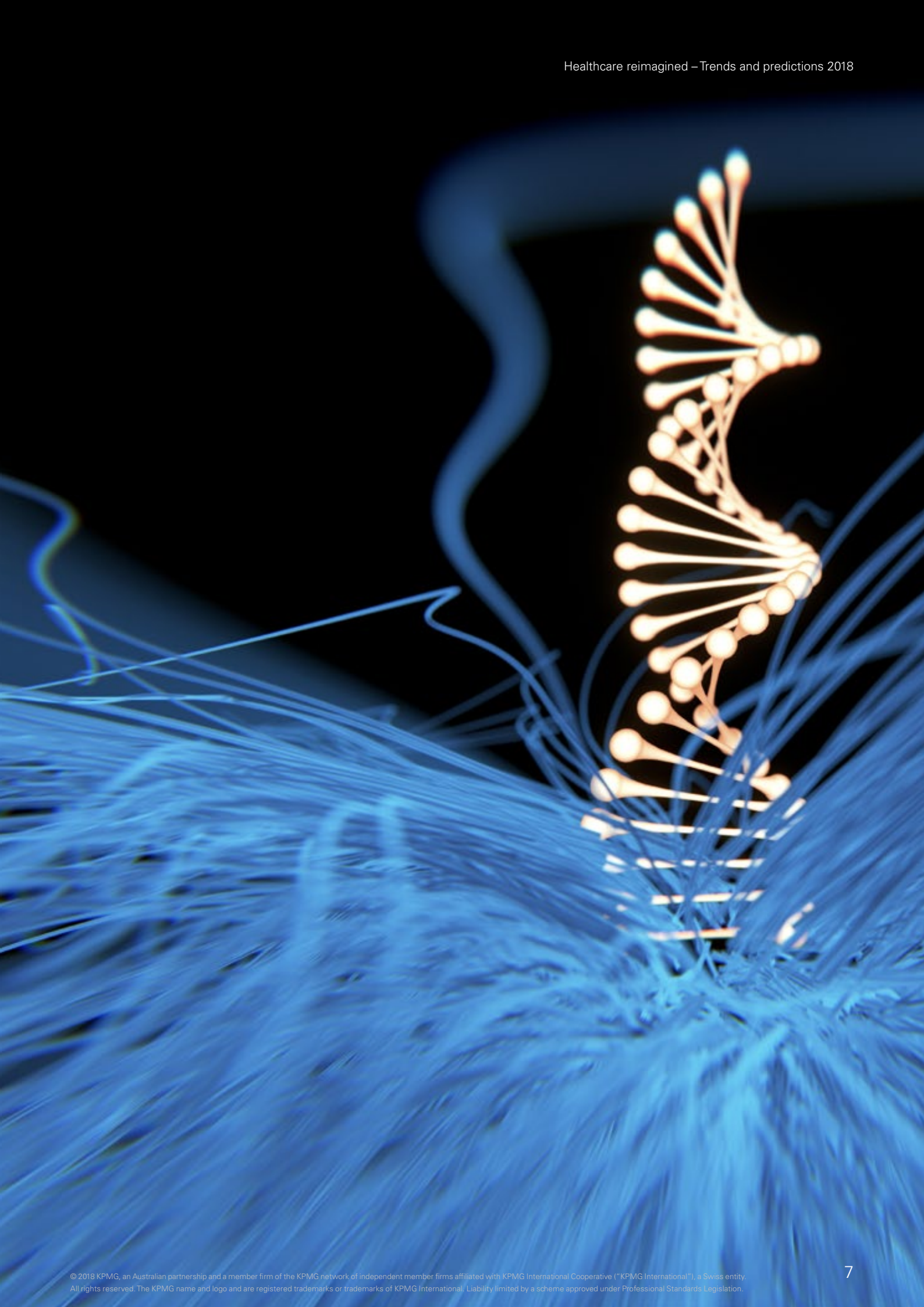

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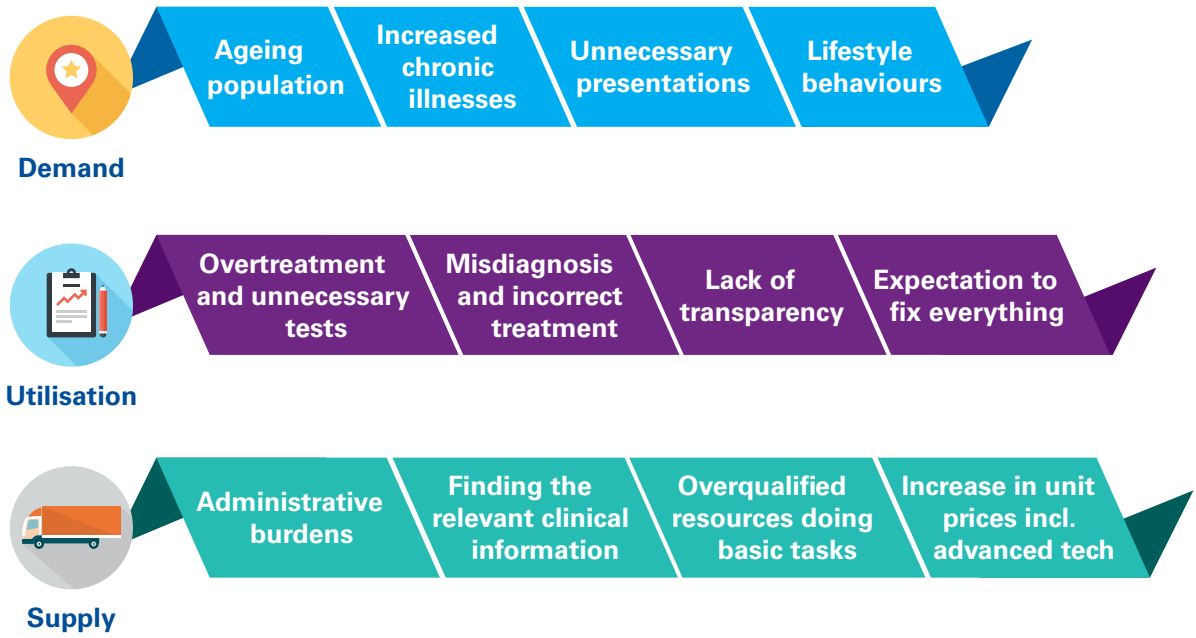
Section 1: Context for change

Healthcare and life sciences are facing major challenges – technological change with vast disruptive potential, a constrained funding environment, changing population needs and consumer sentiment all create drivers and opportunities for transformation in the industry and adjacent markets (e.g. aged care and smart home solution providers).

The fundamental problem is how to sustainably deliver high quality, accessible care to the people who need it at the right time, in the right place and with the right intervention. Solutions that have worked well in the past, like reducing length of stay and increasing workforce productivity, are not sufficient for this challenge. However, new technology, service and business models create the opportunity to influence the demand, utilisation and supply levers outlined below.

Healthcare levers



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The changing consumer

Consumer expectations, regardless of age or industry, are higher now than ever. Consumers expect immediate gratification, as they have become accustomed to 24/7 access to personalised and on-demand services – whether it be ordering a pizza, booking a cab or managing finances. As a result, patient's and the community's expectations regarding the healthcare experience are changing.

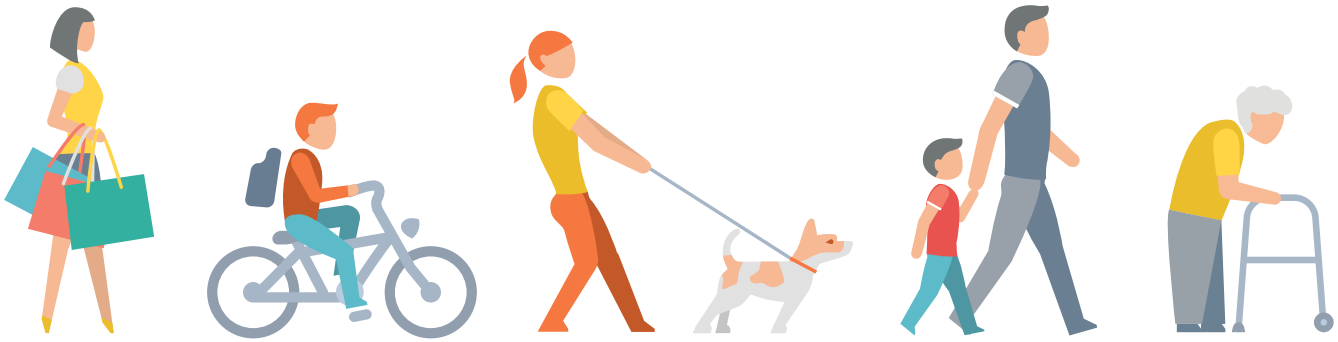
Millennials and Baby Boomers are entering new life stages, fuelling a different set of future needs.

Millennials are the largest group entering their prime spending years and hold different views on health and wellness. Most require less healthcare services and are not fully engaged yet, but will become more important consumers that drive new needs, preferences and expectations.

The ageing population (65+) is forecast to grow substantially to be in excess of 8 million, or 22 percent of the total population by 2054.[1] As Baby Boomers reach retirement, they are living a longer, healthier life than previous generations, but also have a higher rate of chronic illness, requiring more complex care.

Older Australians are expressing a desire for independent living rather than aged care, with over 60 percent strongly preferring to "age in place" in their own homes.[2] We expect this trend to be magnified as Millennials age.

A provider's ability to engage with consumers according to their needs and preferences – depending on their current place in life and their health – will result in a better experience for both the consumer and clinician.



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The changing workforce

A key challenge for the Australian healthcare system is ensuring that the numbers, distribution and skill set of the healthcare workforce are adequate to meet the health needs of an ageing population with increasingly high expectations of healthcare.

The current ageing workforce and resourcing model won't sustain future demand for services. For example the Commonwealth Department of Health has forecast a projected shortfall of about 85,000 nurses by 2025 and 123,000 by 2030.[3] At the same time, the health workforce is ageing faster than other workforces in Australia.

Australian healthcare organisations need to attract and retain a workforce. An important factor to consider is that new workforce members are more digitally engaged and have higher expectations of how technology should be used to help them achieve better patient outcomes.

Rising cost of healthcare

The rate at which healthcare costs are rising suggests that it will become difficult to finance our current health systems and medical advances with public resources without major reforms. Over the last half century, public health spending in OECD countries has grown so rapidly that healthcare costs could become unaffordable by mid-century if changes aren't made.

According to the Australian Institute of Health and Welfare, the share of the economy represented by health has increased to 10.3 percent of GDP.[4] Despite this being linked to a slowing increase in GDP, passing the 10 percent level is important, intervention is needed to avoid a spending and funding crisis – particularly as the increase was driven by price rises in the health sector than by the volume of goods and services provided.

Disruptive market forces

At global and domestic levels, new entrants from adjacent sectors, start-ups, technology players, as well as incumbent providers are disrupting the traditional market. Many are focused on providing niche solutions that address specific problems and unmet needs. But it's important to note that solving broader issues pervasive across the value chain (e.g. significantly influencing demand, utilisation and supply levers) will require extensive integration and collaboration – it's unlikely that a solution in isolation will move the needle.

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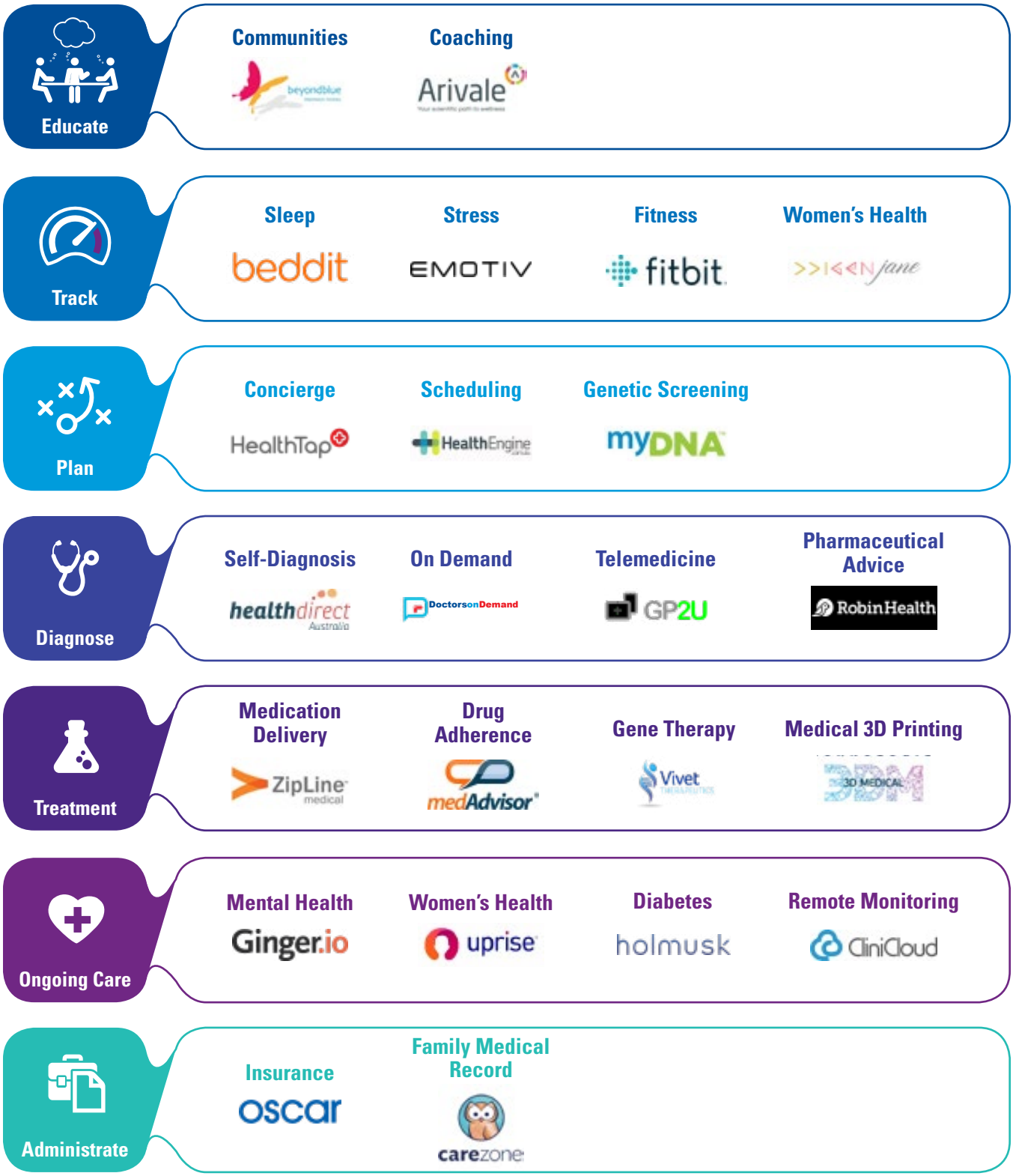
Snapshot of healthcare start-ups and services:



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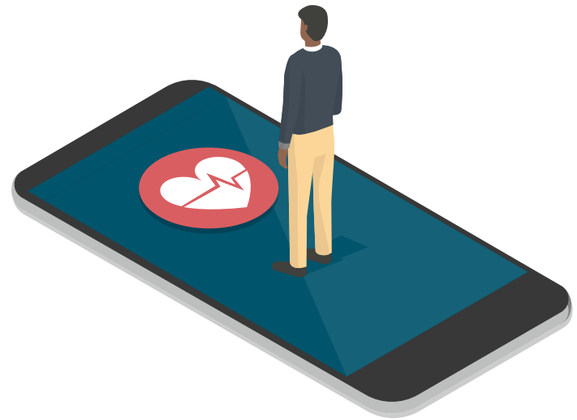
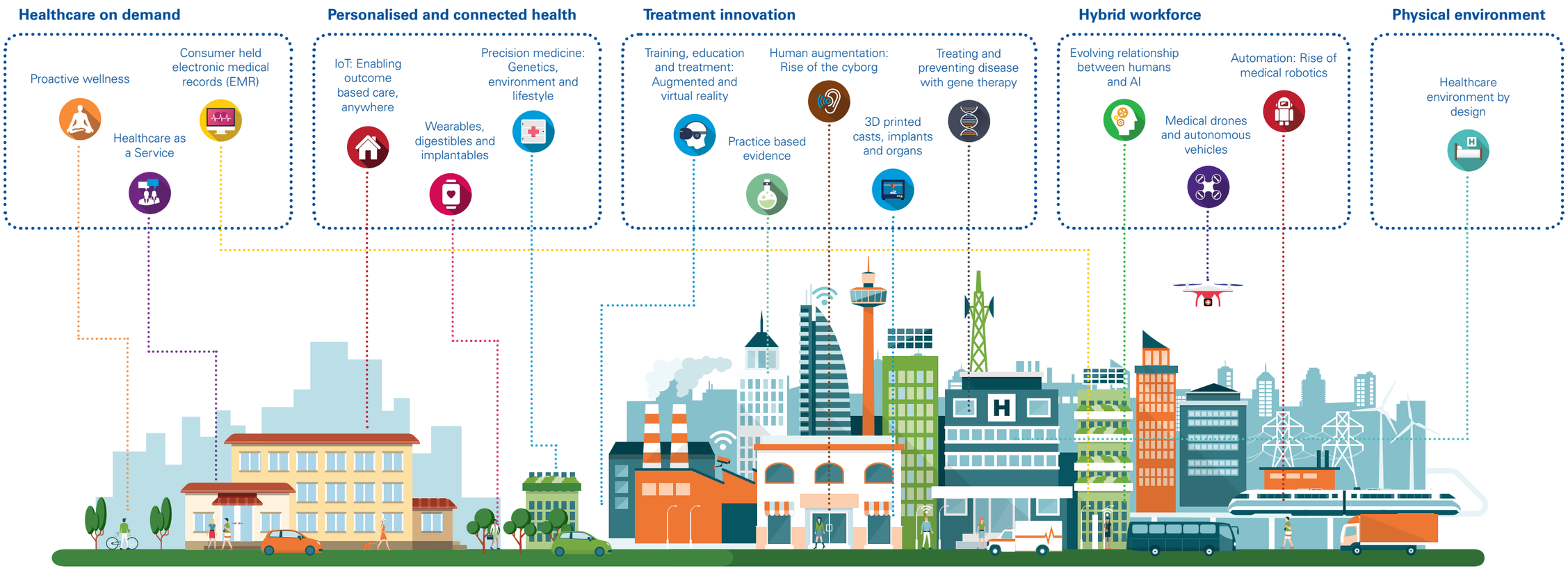
Section 2: Trends and predictions



We have outlined a range of key trends and predictions, along with their potential impact to the healthcare industry over time; considering changes to consumers, healthcare professionals and public and private sector organisations.

This point of view was formed by analysing changing demographics and human behaviour, cross-industry trends, and technology driven innovation in healthcare and adjacent industries.



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Healthcare on demand

Short Medium Long

Proactive wellness

A combination of factors is driving a renewed focus on health and wellness.

Links between behaviours and health outcomes are better understood	The science behind the linkage of food, exercise, behaviours and health has improved – creating a mandate at individual, community and system levels, to improve health outcomes.
Understanding of the social determinants of health and wellbeing	Evidence on the close relationship between living and working conditions and health outcomes has led to a renewed appreciation of how human health is sensitive to the social environment. Income, education, conditions of employment, power and social support act to strengthen or undermine the health of individuals and communities.
A shift to proactive interventions to promote wellness	Aspects of wellness have always been part of the definition of health – the shift is that we are looking to intervene in the promotion of wellness. This includes nutrition, exercise, sleep patterns, energy levels and stress management.
How we are influenced is changing, we are often overwhelmed with conflicting information	We are overwhelmed with conflicting sources of information telling us what to do. As a result, influencers such as social media,[5] educational sources and traditional marketing play an important role in defining our view of health and wellness and combating poor health through promoting greater awareness of the benefits of a healthy lifestyle.

Solutions that aim to improve individuals' health in a holistic way over greater periods of time and provide sustained improvement are more likely to gain traction with consumers. While this is already ingrained in private and public healthcare sector strategies, and is increasingly being incentivised by healthcare funders, it is important to note that the pressure to change is accelerating with the digital revolution. We anticipate an increasing focus on self management while well, and an increase in complementary and alternative therapies (e.g. naturopathy, acupuncture, meditation) being integrated into conventional medical treatment programs.

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Forward – futuristic doctor office

Forward is a futuristic doctor's office in San Francisco that aims to create a new operating model for healthcare. It reimagines the end-to-end consumer experience – from following an 'Apple like' design aesthetic, through to providing a seamless experience across traditional and digital channels.

Founder Adrian Aoun says Forward is not designed to dazzle tech-savvy Millennials with cool gadgets, but to change the model of primary healthcare from "once-and-done" to an ongoing relationship between patient and healthcare provider, with an emphasis on prevention and wellness.

Members are paired with a physician who uses proprietary technology including Artificial Intelligence (AI), Forward Body Scanner, real-time onsite blood testing and genetic testing to build a complete picture of patient health and a plan for helping them to lead a healthier and happier life. Members have 24/7 access to Forward's nurses and doctors via the app.

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ReachOut

ReachOut is an online mental health and wellbeing service which provides youth with support to get through challenging issues. ReachOut delivers information via podcasts, online forums, fact sheets and stories, enabling people to develop resilience, coping skills and positive problem-solving behaviour. The 24/7 service is currently accessed by 110,000 Australians monthly.

Healthcare as a Service

There are growing possibilities for connected tools to empower consumers, to provide greater transparency and choice, as well as fulfilling consumer expectations around the desire for 'anywhere, anytime' monitoring, diagnosis and treatment.

New market entrants and established providers are creating platforms that enable consumers to access information, advice and treatment when and where it suits them. This trend coincides with pressure by healthcare funders to ensure greater transparency in relation to quality of care.

Digital engagement

Digital platforms can engage consumers in a variety of ways including tracking medical progress, treatment adherence, reminders and scheduling, and communications, as well as providing the ability to capture more comprehensive data for analysis and ongoing optimisation.

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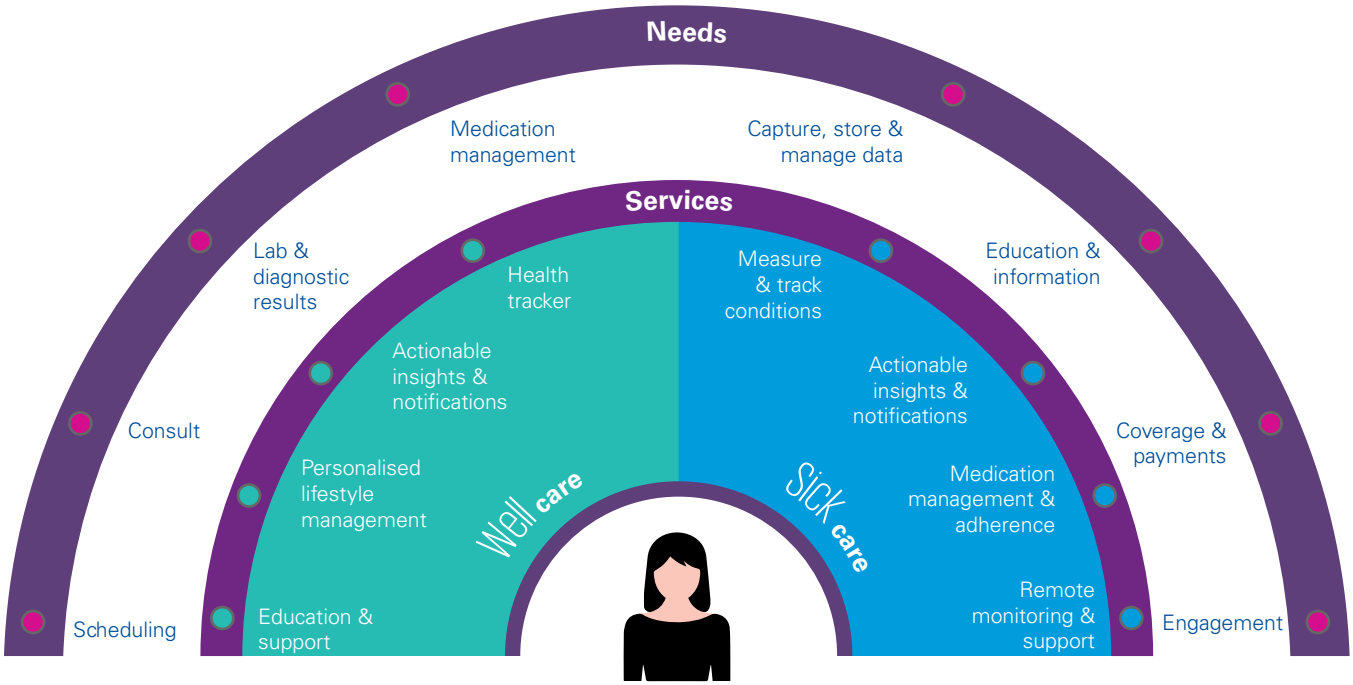
Our vision for future digital engagement models is a network of integrated on-demand services:



The healthcare value chain does not have to be linear but could be seen as a network where patients have access to on-demand personalised services, for their specific needs, when they need it.

Social Connectivity

Due to increased connectivity, patients are privy to a wide knowledge base driven by their friends, family and accessibility to people 'in the know'. Patients and their families are seeking support communities where they receive insights and leads for new treatments. A recent study found that social media in healthcare can improve self-management and control and enhance psychological well-being, while also leading to more equal communication between patients and healthcare professionals.

NHS Choices

NHS Choices is a UK Government website which aims to put consumers in charge of their healthcare. It publishes comprehensive health information, service directories, and the ability to transact online with healthcare providers, including booking appointments and requesting referrals. The website attracts a quarter of all health related web traffic in the UK.

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Short Medium Long

Consumer held electronic medical records

Historically, a patient's medical history has been fragmented across a range of different healthcare providers, requiring patients to repeat or carry with them important health information.

A long held view that providers owned the patient record is slowly changing with consumers demanding control over their own health information and a realisation that quality and safety is improved and waste and duplication eliminated when every clinician involved in patients' care can access the same information.

Already, some shared electronic health records such as the Australian My Health Record are providing clinicians (and consumers) with a consolidated view of summaries of important health information.

Recent developments see general practitioners enabling patients to download key elements of their EMR and shared care plan to their mobile device and synching changes – truly putting up to date clinical information in the hands of the consumers.

Over time patients will also gain the ability to contribute relevant information directly into their record and share this with their treating clinician. This may involve exercise or diet information or data from home health monitoring.

Transparency and choice

Consumers are increasingly demanding greater control and transparency, and will seek to understand and influence treatment and referral decisions. We expect that healthcare providers will step up their commitment to provide access to information that improves transparency.

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Personalised and connected health

IoT: Enabling outcome based care, anywhere

Advances in medical technology and connected devices are also changing the physical environment at home. Innovations like electronic pills that track medication compliance, sleep monitors, personal electrocardiogram devices and other standalone digital sensors create a bridge between individuals and healthcare professionals, providing flexibility of care and greater insight into patients.

Affordable and user-friendly telehealth platforms and in-home monitoring devices will make in-home patient monitoring the norm, allowing remote caregivers to be notified in real-time of any incidents and improving access of healthcare services to regional areas.

Next wave: medical treatment anywhere

Many sensors and connected devices are established for use in the home. Although, it is important to note that the ageing population and those with chronic diseases still enjoy, and can benefit from, leaving the home. Developing mobile sensors will be the next wave of focus in order to provide greater flexibility to patients.

Qualcomm Tricorder X PRIZE

Qualcomm's Tricorder XPRIZE[6] ran a five-year-long competition with a challenge to build a working prototype of a device that weighs five pounds or less, that can continuously monitor five vital signs, diagnose 13 disease states, and be used by anyone (mimicking the fictional Star Trek Tricorder). In April 2017, Final Frontier Medical Devices developed the winning prototype and was awarded the cash prize of USD $2.6 million. A network of strategic partners are now committed to support these teams in their attempt to increase the impact and continued evolution of the Tricorder device.

Great call – Lively Mobile

Lively Mobile is designed to enable people to live actively and independently through providing mobile medical sensing and alerting while at home or away. They have developed a small device which can be clipped onto a pocket that has built in GPS positioning, fall detection and one-button access to emergency assistance response agents.

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Smart tattoo

VivaLNK has developed eSkin™ technology which is a discreet tattoo embedded with micro sensors. VivaLNK's Fever Scout can continuously measure temperature and transmit medical information discreetly. This can be viewed as a building block for future advances in medical technology – leading into ingestibles and implantables etc.

Wearables, digestible and implantables

The rise of wearable, digestible and implantable sensors helps form the basis to engage and encourage patients to lead a healthy lifestyle, where the treating clinician can continuously track both health and wellness in real-time. Some wrinkles still to be ironed out in terms of the relevance and frequency of information feeds, but there is huge promise. Emotion sensors are tipped to be next, with the potential to change the way devices, clinicians and the environment interacts with a patient based on their emotional state of mind.

myDNA

myDNA provides pharmacogenomic testing in Australia which determines how an individual's genetic makeup can affect their response to certain medications. The results can guide the prescription of drugs and may identify patients at risk of adverse side effects or treatment failure. It can also help individuals receive the right medication sooner.

GeneSight

GeneSight uses cutting-edge technology to measure and analyse clinically important genomic variants in the treatment of psychiatric disorders. This insight can help a clinician understand the way a patient's unique genomic makeup may affect certain psychiatric medications.

Oxford Nanopore

Oxford Nanopore have developed a palm-sized, "MinION" sequencer, costing around $1,000, designed to analyse DNA to help track disease outbreaks, check food, and offer "the democratisation of sequencing".

Precision medicine

Precision medicine is now the generally preferred term for personalised medicine, and it takes into account individual variability in genes, environment and lifestyle when considering disease treatment and prevention. Precision medicine draws in data from external sources to build a more comprehensive picture of circumstance.

Precision medicine enables clinicians to select a treatment protocol based on the patient's data that may not only avoid harmful side effects and ensure a better outcome, but also avoid the cost of unsuccessful treatments.

A key enabler of precision medicine is the dramatic decrease in cost. With the cost of genome sequencing significantly outpacing Moore's Law (which says overall processing power for computers will double and the cost will halve every 2 years), this has resulted in a rapid increase in utilisation.[7] Immediate benefits are being realised, but fully exploiting this data and tailoring a broader range of health solutions remains a long-term proposition.

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Treatment innovation

Practice-based evidence

The increasing use of electronic medical records in acute care opens an alternative to evidence-based practice for clinicians when the evidence doesn't exist. Randomised controlled trials giving rise to evidence-based practice remain the gold-standard, but there are innumerable instances where – for ethical reasons, due to the rarity of the condition, complex co-morbidities or in paediatrics – research hasn't been undertaken.[8]

Data analytics is opening up the information stored in the unstructured clinical notes, deep within the medical record, to allow clinicians to draw conclusions on the best treatment for their patient when there is no published best practice.

Quantum computing is another key enabler in the medium term horizon, that has the power to dramatically improve protein folding and drug discovery through probabilistic modeling of how the human body reacts to stimuli. We predict that Quantum Computing will mature, and become mainstream in the next 5-8 years.

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Augmented and Virtual Reality

Augmented Reality (AR) and Virtual Reality (VR) are being used across multiple points in the healthcare industry, including training, patient education and treatment. The technology provides a safe environment to simulate realistic scenarios with little or no risk. Although it's still early days, the potential benefits are significant – improved training, patient outcomes and reduced costs. We anticipate that the value of VR/AR in healthcare will continue to grow – particularly as integration with AI, sensors and bio-feedback becomes more sophisticated.

Training

VR can be used with clinicians to assist with training. This is helpful for performing 'hands on' procedures in a safe and controlled setting, and to interact with a virtual patient and learn practical skills.

Education

VR can be used with patients to aid in the explanation of diseases. For example educating patients about positive lifestyle choices, such as stopping smoking. It can also be used to connect consumers to medical expertise through apps.

Treatment

AR can be used to aid surgery and medical incisions e.g. nurses use this to support the identification of veins. It can also be used as a form of exposure therapy e.g. phobia treatment where the sufferer is able to learn skills and build confidence in a virtual environment. Other bespoke treatment applications include using VR for social cognition training in patients with autism, and in pain management for burn victims.

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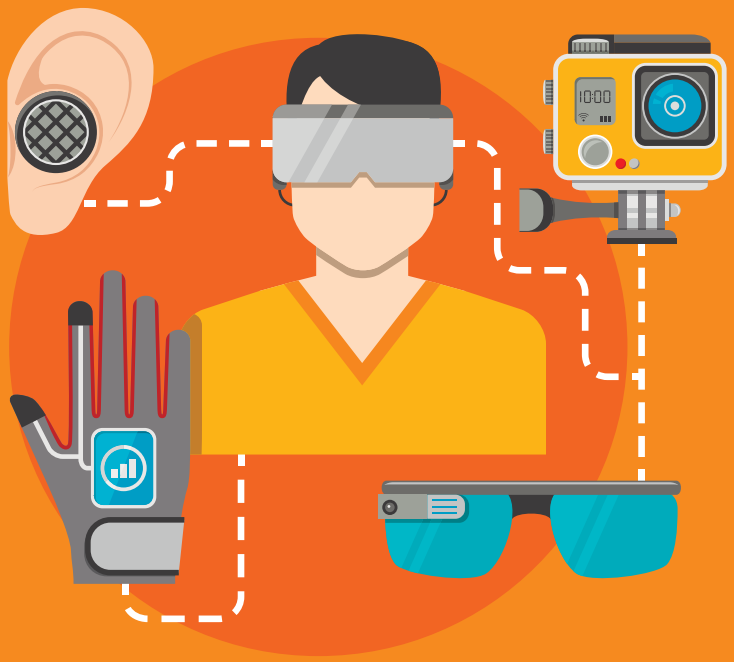

VR pain relief

"Cool!" is a VR experience focused on providing pain relief to patients. This is achieved by immersing the patient into a beautiful landscape of changing seasons. There have been studies that show that chronic pain patients who used "Cool!" had pain reductions of 60-70 percent during treatment with the effect lasted up to 48 hours.

The body VR training

Surgeons can stream operations globally and allow medical students to experience being the operating room using their VR goggles. The team is also creating educational VR simulations for radiologists, surgeons and physicians.

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Exovite immobilisation and rehabilitation casts

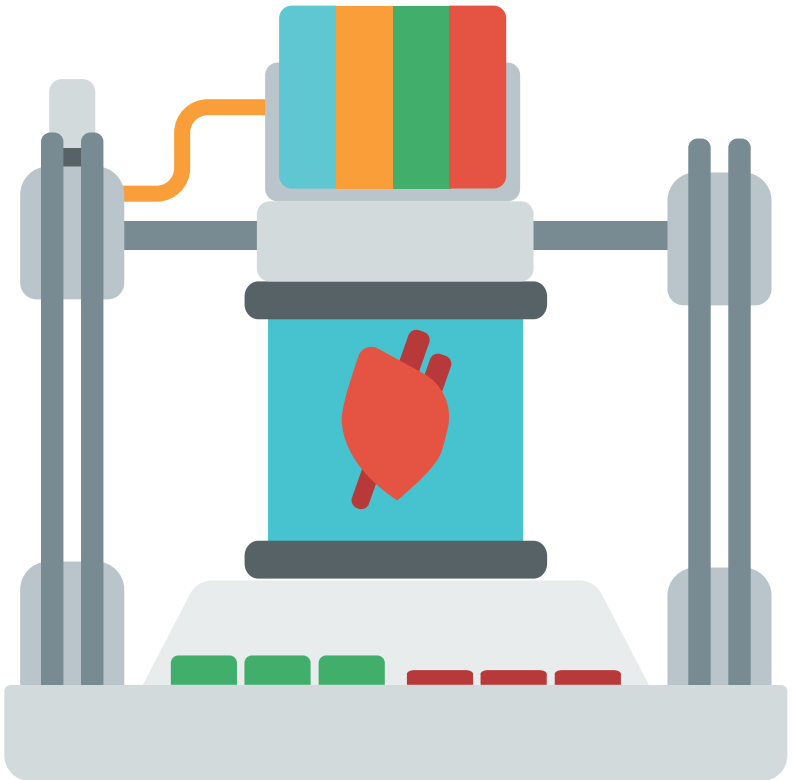
Spanish 3D printing start-up Exovite has developed a system that consists of a 3D scanner capable of modelling a patient's limb precisely, and generates a personalised custom-made splint printed by a 3D printer. Printing the cast only takes 30 seconds. The system includes a rehabilitation module that stimulates the muscles below the cast with electric signals, speeding up recovery and preventing muscle atrophy.

Short Medium Long

3D printed casts, implants and organs

Medical 3D printing gives clinicians the ability to deliver timely treatment with unprecedented levels of customisation. 3D-printed casts and pills had encouraging success rates. The 3D-printed cast can heal bones 40–80 percent faster than traditional casts. 3D-printed pills allow for interesting new pill shapes that completely alter the drugs' release rates. 3D printing is already becoming a critical tool in surgical procedures that require customised prosthetic and implant devices, including synthetic organs.

3D printing will play a more central role in mainstream medical practice, as the technology becomes more accessible and mature and the cost continues to drop (particularly for bioprinting). A potential future is for universal 3D scanning and printing devices to be available in the home – for example to print a cast for a child's fracture on demand.



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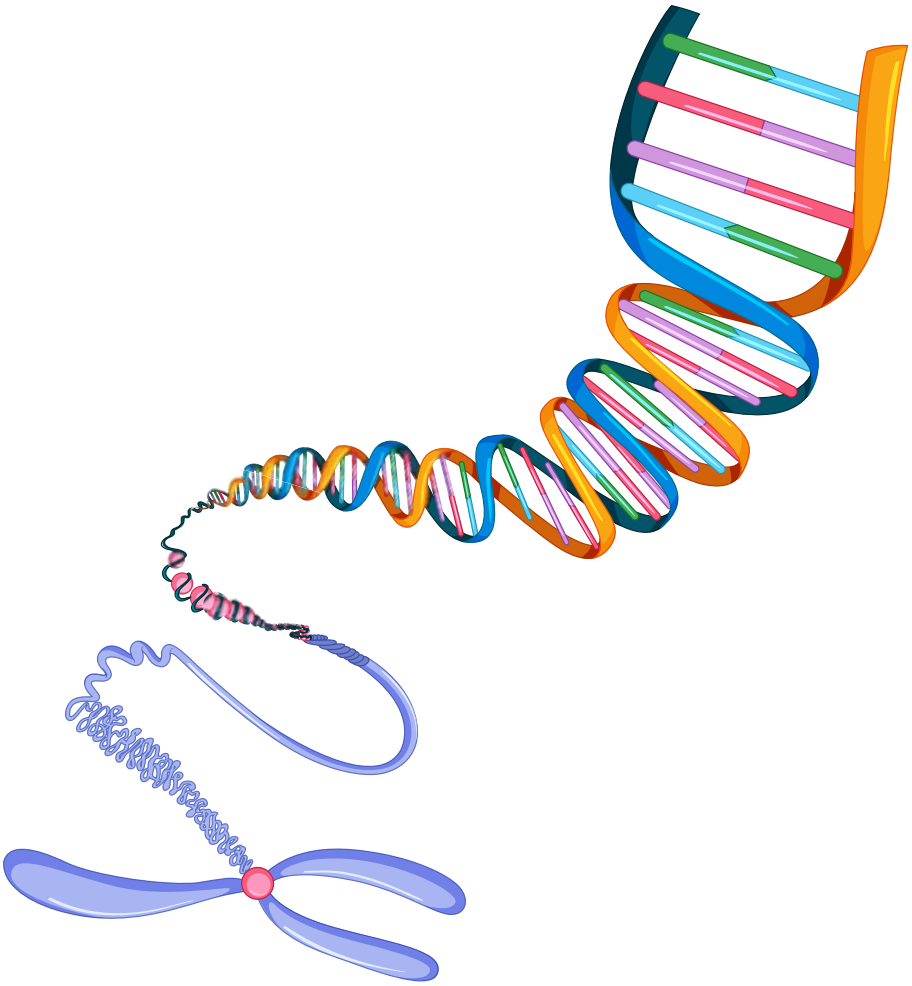
Short Medium Long

Treating and preventing disease with gene therapy

Gene therapy is an experimental technique that uses genes to treat or prevent disease. In the future, this technique may allow doctors to treat a disorder by inserting a gene into a patient's cells instead of using drugs or surgery.



CRISPR: new precision genome editing tool

CRISPR allows scientists to edit genomes with unprecedented precision, efficiency, and flexibility. In April 2017, Chinese scientists announced they applied the technique to nonviable human embryos, hinting at CRISPR's potential to cure any genetic disease.[9]

Making ageing a treatable condition

Human Longevity Inc. and Google Calico all work towards the same goal: to make ageing a chronic condition we can treat. There is a shared passion of changing healthcare, tackling the diseases of ageing, and extending the healthy human lifespan through harnessing technology.

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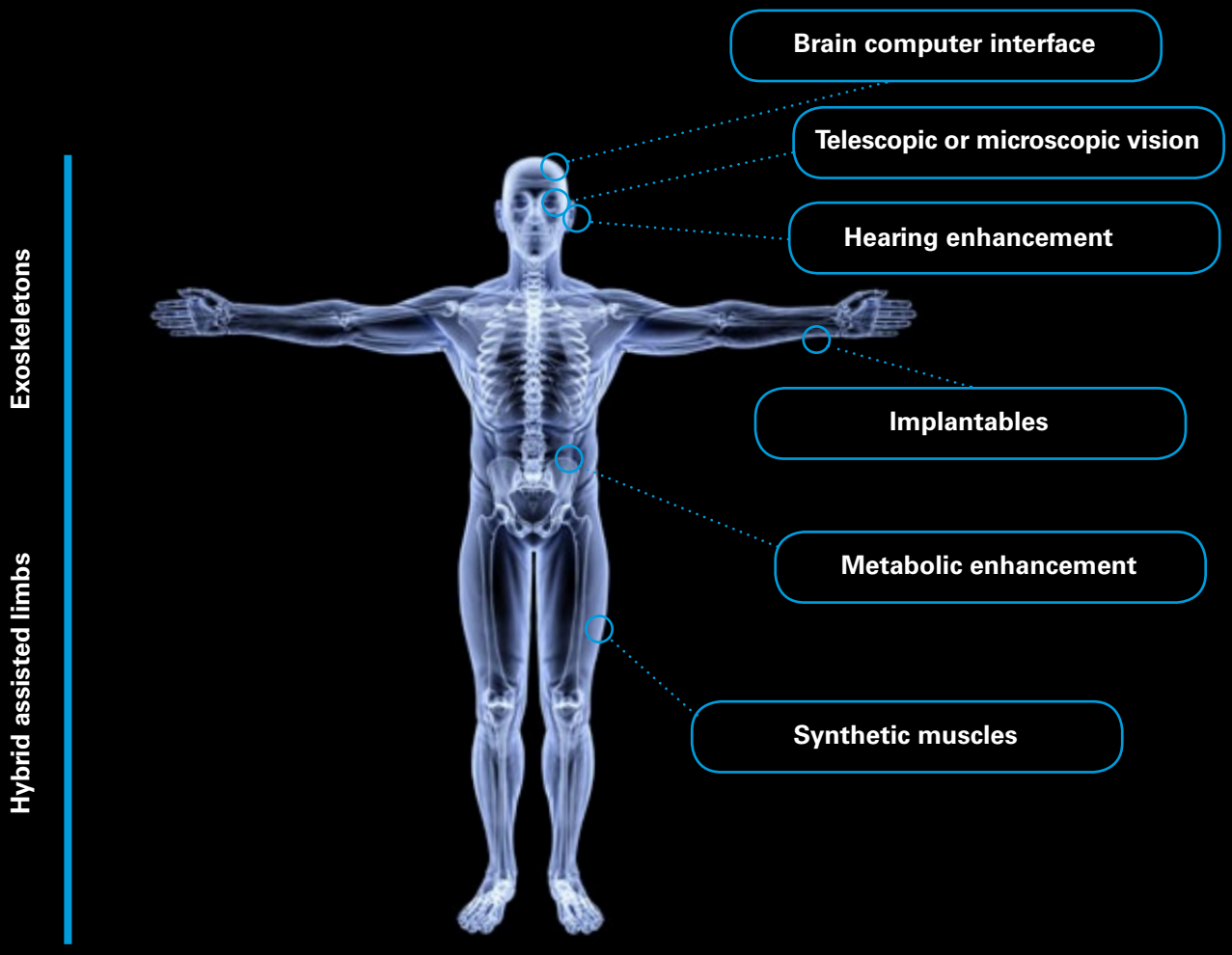
Short Medium Long

Human augmentation: Rise of the cyborg

In recent years there has been significant advancement in sensory and mobility aids to help people with disabilities live fuller lives. We are seeing a shift towards enhancing human abilities including using optical aids to gain 'hawk eye' vision and exoskeletons to unlock superhuman strength. We expect these fields to gain traction and expand beyond sensory and mobility aids – for example, combating cognitive impairment, enhancing metabolic rates or enabling prosthetics to feel touch.

Aesthetically aids are designed to be discrete or even camouflage with the human body, although particularly in prosthetics there is growing interest in high tech design. This sets foundations for a potential future where we could see cybernetic features worn as an aesthetic accessory and an increase in using human augmentation without underlying medical problems.



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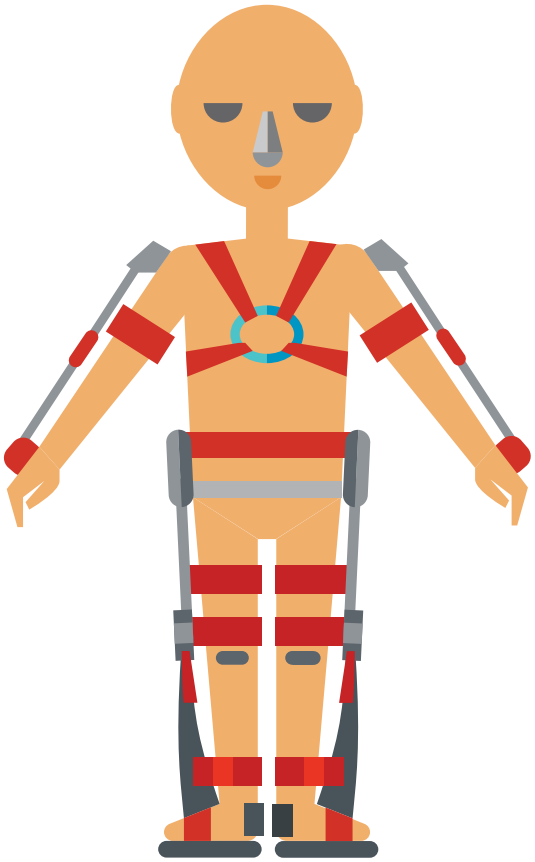

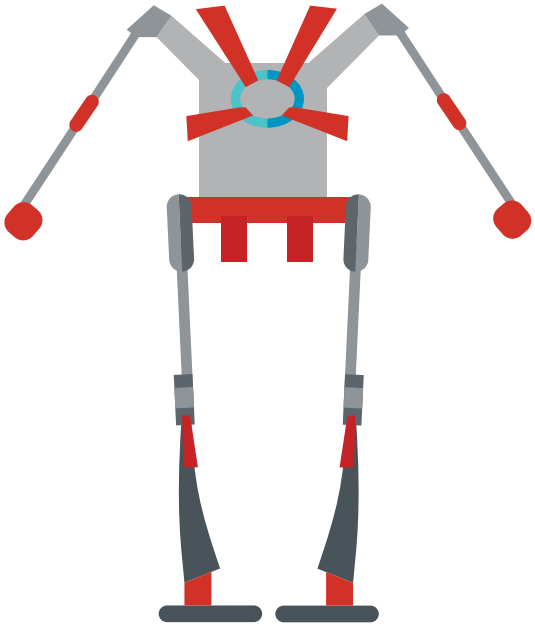

Phoenix exoskeleton

This lightweight exoskeleton helps paralysed people to walk. The secret of the Phoenix's lightweight structure and affordable cost lies in its ability to mimic humans. We see that affordable exoskeletons may well have the ability to replace some wheelchairs.

Brain computer interfaces

Neuralink, a human-computer brain interface company developed by Elon Musk, has the aim of creating better, higher-bandwidth connections between our brains and computers. These connections would facilitate rapid 'lossless' knowledge transfer by avoiding the need to compress concepts in your mind, by converting it to spoken or written words or diagrams. It would also be able to help humans keep pace with the rapid advances in AI.

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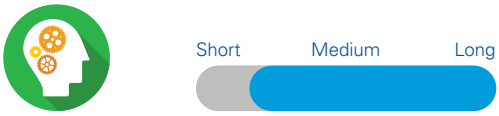
Hybrid workforce

AI expedites breast cancer risk prediction

Researchers at Houston Methodist Cancer Centre have developed AI software that interprets mammograms, assisting doctors with a quick and accurate prediction of breast cancer risk. The program was reported to translate patient charts into diagnostic information at 30 times the average human speed with 99 percent accuracy.



Building a closer relationship between humans and AI

The future of medicine will rely on an even closer relationship between humans and advances in AI – covering machine learning, cognitive computing and deep learning domains.

AI already has a footprint in the healthcare industry, from assisting clinicians with diagnoses to the design of treatment plans. AI is being used in:

- **Clinician decision support:** for electronic medication management systems to alert doctors to potential drug interactions
- **Drug discovery:** mining patient biological data and scientific literature to determine why some people survive diseases to gather insights to improve current therapies and create new ones. Also used to look for patterns in scientific literature to dramatically expedite drug discovery and research
- **Oncology:** help detect abnormalities in X-rays and MRI's
- **Precision medicine:** to perform complex genomics processing to provide assistance in creating highly customised treatments for individual patients
- **Revenue assurance:** mining unstructured clinical notes to identify conditions or complications that weren't coded and improving the quality and timeliness of complex coding.

Other studies have shown that patient outcomes are improved and costs reduced when AI is combined with the work of clinicians.[10] As AI evolves, we anticipate it complementing the effort of doctors – not entirely replacing them.

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Short Medium Long

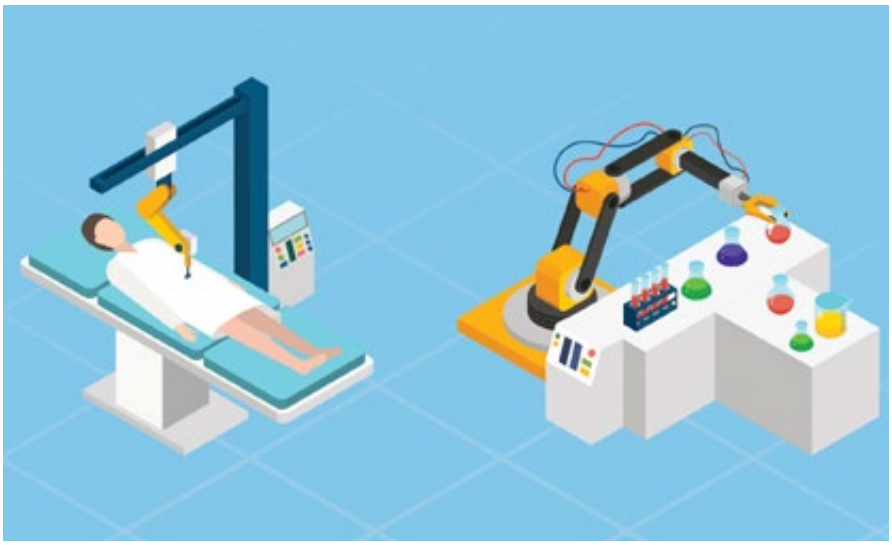
Automation: Rise of medical robots

There are a huge range of medical robotics with varying applications, and outcomes are often similar or marginally better than human counterparts. Over the next few years we expect medical robotics to evolve and transform medicine for the better. They are already being used to provide companionship for patients in hospitals, assist in surgical operations and to clean and disinfect operating rooms and equipment. As AI evolves, we foresee medical robots complementing, and in some cases extending, the efforts of clinicians.

Whilst some applications have the potential to automate human jobs in healthcare, we do not seeing them replacing doctors in the near-to-mid-term future.

Nanotechnology

Nanotechnology has been hailed as the next big thing for decades, but is only now becoming a reality in the medical device space. The applications of nanotechnology include precision drug delivery, cancer treatment, or being used as part of an army of tiny surgeons.



Robotic brain surgeon

Researchers from the University of Utah have created a medical robot that reduces the surgery time from 2 hours to two-and-a-half minutes. The drill produces fast, clean and safe cuts, reducing the time the wound is open and the patient is under anaesthesia. According to the researchers, led by neurosurgeon William Couldwell, this decreases infection, surgical costs and human error.

Teaching your immune system to destroy tumour cells

Researchers from the University of Michigan have developed a new nanotechnology application that has the potential to eliminate tumours. "We are basically educating the immune system with these nanodiscs so that immune cells can attack cancer cells in a personalised manner," said James Moon from the University of Michigan. So far, the nanodiscs have been successfully tested on mice and are shown to be promising, eliminating tumours in 10 days. This suggests that the immune system 'remembered' the cancer cells for long-term immunity agents.

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Medical drones and autonomous vehicles

Drones and Unmanned Aerial Vehicles (UAVs)

The age of drones is upon us – both autonomous flying and driving have become a reality. Drones are already delivering medicine, blood and even organs to rural communities and remote areas around the world.

Blood Transport using UAVs – ZipLine

ZipLine, a San Francisco based unmanned aerial vehicle (UAV) start-up has signed a contract with the government in Rwanda to trial transporting blood for transfusion across the country. The drones drop blood parcels on parachutes outside remote health centres. Health workers can request a blood drop via text message, and it arrives around 30 minutes later.[11]

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Autonomous ambulances

Through reducing the time it takes for an ambulance to get to a patient, and a patient to get to the care of doctors, we can improve outcomes during medical emergencies. Autonomous emergency response vehicles can help to solve both sides of this equation.

Self-driving ambulances will improve care by allowing both paramedics to help a patient rather than having one required to drive. Alternatively the second paramedic could be redeployed to absorb growing demand, improve performance, or to new models of care.

Ambulances already have the ability to change traffic signals in many countries, and using this in combination with route optimisation and the reduction of human error can significantly decrease the time for patients to reach Emergency Rooms.

Automating back-office healthcare operations

Automated Transport Systems are designed for the hospital and broader healthcare industry to provide safe, and efficient transportation of goods. The core component of this integrated system is the use of autonomous delivery vehicles which typically transport goods including food, medical supplies, linens and waste. While there are many Autonomous Guided Vehicles used at Australian hospitals, the key challenge is in re-engineering the human workflows and workforce.

Saving lives with a system of self-driving ambulances and virtual reality: Frog

Frog has designed a concept for a new Emergency Response system that would leverage a fleet of self-driving ambulances that employ data analytics to continuously optimise the position of the fleet throughout a city. The logic is that if the fleet of ambulances were systematically peppered around a city, ambulances would be closer to the random points where emergencies occur.

It would also virtually place an emergency physician on board with the paramedics, so would allow time-sensitive assessments of the patient and advanced life-support intervention to be carried out immediately on location.

In time-critical scenarios, drones would supplement the ambulance and deliver medical tools, treatments, and crucial instructions ahead of the ambulance and paramedics.[12] Most importantly, AER would result in fewer avoidable deaths by reducing the amount of time from emergency situation to physician intervention.

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Physical environment

Hospital design evolution

We now have a deeper understanding of how the environment can contribute to healing and improved recovery time. We predict a much greater adoption of multidisciplinary design when designing healthcare facilities. Currently, this understanding is culminating in many forms – with hospitals experimenting with:

- **Human-centric change:** Changes derived from empathising with patients, for example widening the bathroom door in patient rooms, or creating family and friend pods in waiting rooms instead of rows of chairs.
- **Interior and spatial design:** This could involve incorporating art, indoor gardens, landscapes and water features to reduce the stress of patients and their families. Also considers the flow of people between spaces, and embedding intuitive way-finding.
- **Acoustics:** Reducing noise sources and to improve sound proofing with sound-absorbing ceilings and carpeting, coupled with music selection and verbal cues from the environment.
- **Lighting:** Exploring how light can be used to benefit patients. There are interesting developments in the circadian rhythm lighting space which utilised our natural alignment to the daily rotational cycle of the Earth. Light is used to control our rest-activity cycle, while also influencing our immune system and potential for healing. Research has shown this may help promote tissue recovery and enhance patient ability to handle microbial threats.
- **Microbial transmission:** Applying outside-the-box thinking on ways to prevent pathogen transmission – for example the largely ignored area of handle design, and how push plates instead of pull handles can significantly reduce contamination. Also, using antimicrobial coating on high frequency areas such as handles, switches and taps.

In a healthcare environment, these benefits have the potential improve overall patient wellbeing, reduce microbial threats and reduce the length of hospital stays.[13] The environment can play a crucial role in helping to normalise rest-activity cycles, sleep patterns, mood and pain, in addition to enhancing the overall patient experience.

Lee Memorial Health System: Cape Coral Hospital, Florida

Cape Coral Hospital is a 291-bed, 442,000-square-foot facility in Southwest Florida and part of Lee Memorial Health System. To become more patient-centred, the hospital created 'Pathway to Discovery' – a circuit of footpaths around Cape Coral's 43-acre campus that encourages more outdoor activity. The 1.1-mile pathway includes a teaching garden with butterfly friendly plants used for clinical rehabilitation sessions, and an auxiliary-funded healing garden near the women's care and birthing suites. The incorporation of water features, a natural pond and an exercise stations is designed to promote relaxation.

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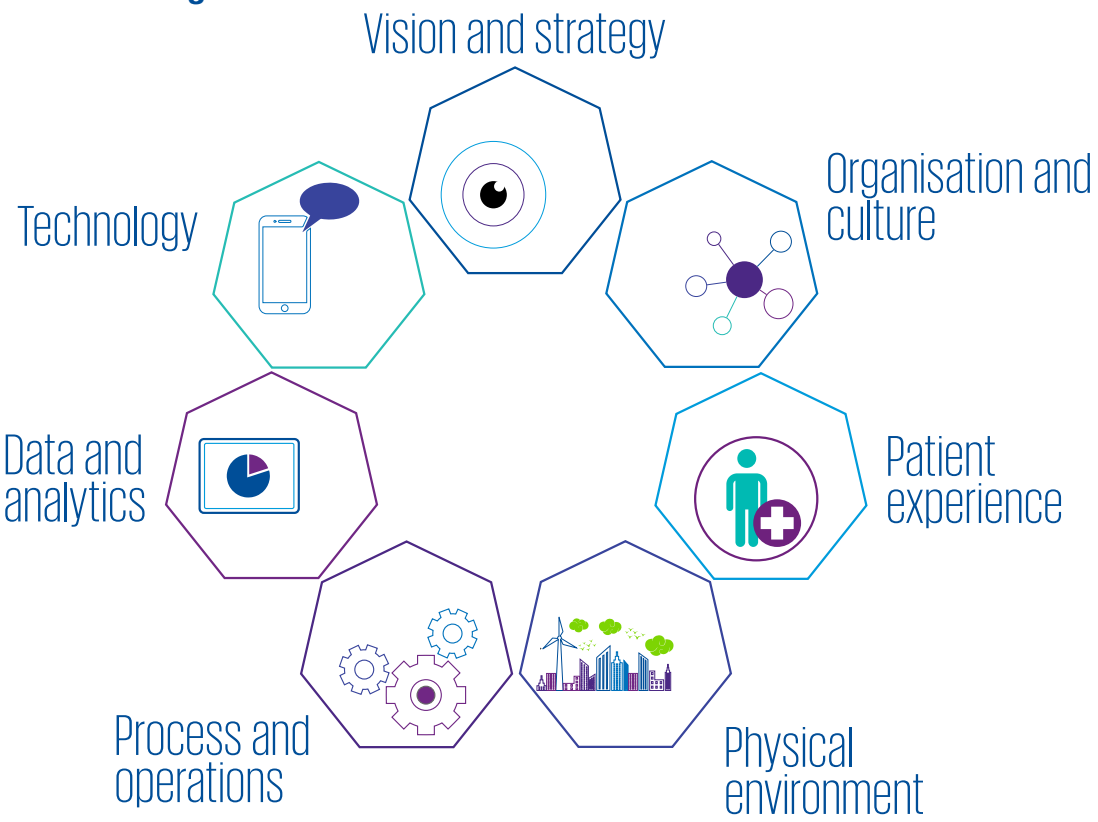
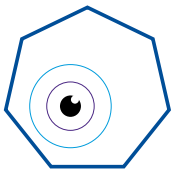
Section 3: What can healthcare organisations do now?

Framework for change





Vision and strategy

Your organisation does not need to predict the future, but rather position itself for multiple outcomes.

Working out how to deliver high quality healthcare to more patients with different and more complex needs and less funding, while responding to broader market disruption and consumer expectations, is a significant challenge for the entire healthcare industry. It requires a vision and actionable strategy that considers the conscious trade-offs that need to be made on relative focus areas, change initiatives and capabilities.

While there is no one path to success, there are a number of common elements in cohesive strategies:

1. A point of view regarding the likely future state healthcare operating model
2. How you intend to operate in the future and rationale (e.g. how and where to provide services to meet demand; new markets and services)
3. Outlining key success factors and capabilities required to be successful in the desired space
4. Investing in innovation and promoting a culture of pragmatic innovation.

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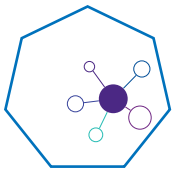

Organisation and culture

Leadership

The role of leadership in embracing the shift and influencing change is critical. As healthcare systems are complex, consisting of intricate and non-linear interactions between a wide array of groups, departments and specialities,[14] it is essential to have an empowered executive team with the influence to affect agreed-upon change and that capitalise on diversity in workforce, embrace collaboration and focus on continuous improvement.

Reference to KPMG Study on Leading in ambiguity and constant change

Future workforce

It is vital to understand the current workforce, and how it may need to evolve to meet future needs, with a particular lens on the impact of digital labour and collaboration between humans and technology (whether it be robotically enhanced surgery, or AI-enhanced diagnosis). New skills will be required and increased collaboration between a diverse range of roles such as consumers, entrepreneurs and clinicians. When designing human roles there needs to be an emphasis on empathy – clinicians should be providing the human element to patient interaction in spite of the increasing prevalence of technology.

Below are examples of new skills that should be considered:

- Alliance, vendor and partner management
- Data science, AI and Quantum experts
- Nano-medical engineers
- AR/VR operation planners
- User experience and Spatial Designers

Reference to KPMG Study on Rise of the humans: The integration of digital and human labour

Defragmenting healthcare research and development (R&D)

Identify opportunities to build relevant and sustainable partnerships for change with incubators, Co-operative Research Centres (CRC), universities, academic research centres, the private sector and global health networks. These partnerships should have a pathway to move viable opportunities into commercial ventures (e.g. future state healthcare product design).

Collaboration with the start-up ecosystem

Understand the value that can be obtained through appropriate collaboration with the start-up ecosystem to help address current business problems, rejuvenate culture or expand into future markets. Developing a framework to effectively engage with the start-up world (including HealthTech start-ups, accelerators, incubators and venture capital firms) can help position your organisation to remain competitive, and be in touch with what is coming over the horizon.

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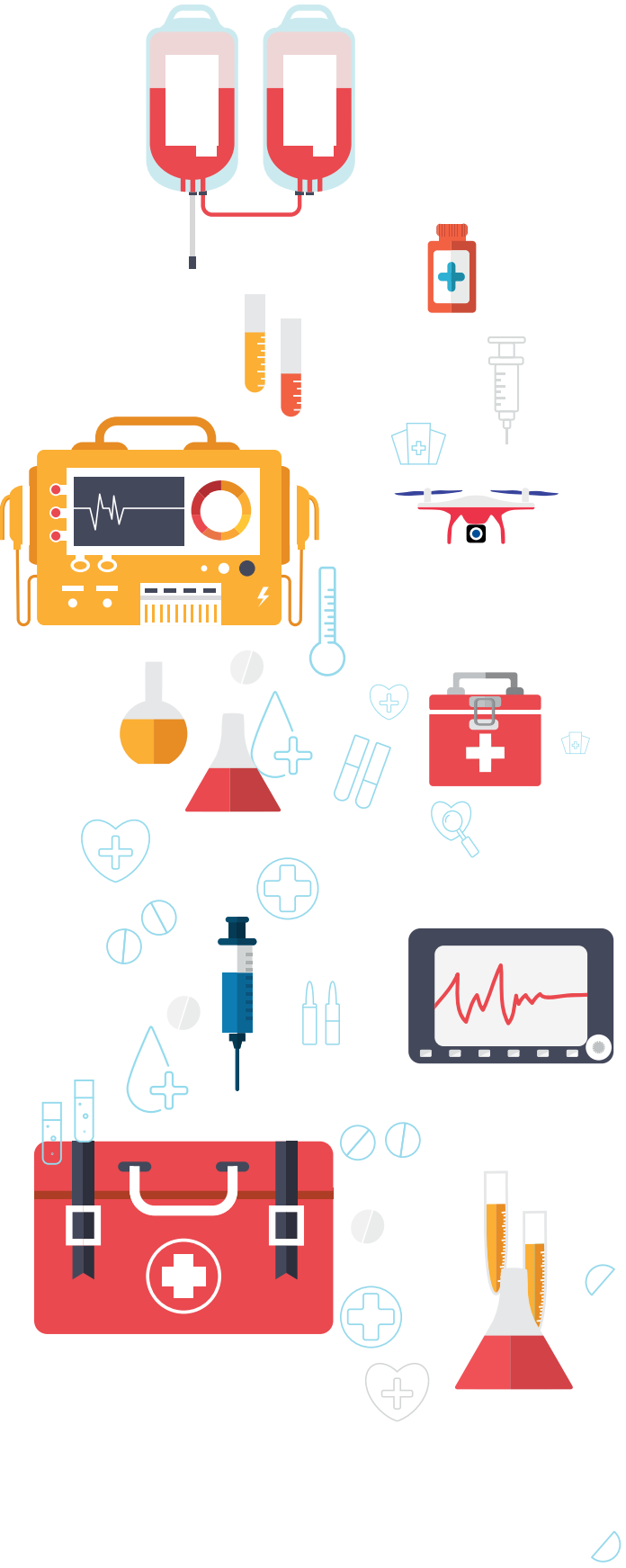

Making innovation work for healthcare

A deliberate and unique framework is required to support innovation in healthcare. Organisations in the health sphere are often wary of traditional innovation approaches (i.e. 'safe to fail') due to the direct impact their actions have on human health and lives. However, understanding the potential opportunity cost (e.g. lives, length of stay, and available beds) can help drive an appreciation of the significant benefits that could be obtained from embracing a pragmatic innovation framework. The framework needs to allow for the exploration and incubation of new ideas, and the ability to experiment with emerging technology to implement innovative solutions; all while appropriately managing risk and overcoming traditional roadblocks.

Establishing an innovation centre

Many different models can be followed when establishing an innovation centre. Often these physical centres are created as a centre of gravity for innovation. Clear goals and objectives must be used to inform the type of environment created.

An on-site innovation centre can drive cultural change and accelerate incremental innovation; while establishing an innovation outpost in places like Silicon Valley can accelerate disruptive change through access to cutting-edge R&D.

Regardless of the model, healthcare providers need clear focus areas within the centre, and a strategy for what happens to successful proof-of-concepts, and how are they funded and transitioned into full-scale implementation.

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Patient experience

Understanding your patient journey

Develop an understanding of your current patient experience along their care pathways with a shift from mitigating 'friction points', towards designing experiences that patients value – feeling safe, informed and consulted etc. From here you can begin to identify initiatives to enhance the experience, particularly focused on 'moments of truth'.

These initiatives can be assessed by ease of implementation (considering cost, difficulty, resourcing, timing and business change) and the relative impact (patient demand levels, cost reduction, patient experience, patient outcomes and employee productivity). From this exercise 'quick wins' can be delivered to build momentum, and strategic choices will need to be made to prioritise projects with similar return profiles.

Further reading: Patient Experience: Recalibrating our ideas of success in healthcare

Integrated patient care pathways

Develop partnerships and alliances that can more effectively integrate patient care pathways through encouraging more co-ordinated delivery of care (e.g. aged care and health, primary care and acute care). Establish partner management capability to enable third parties to form part of the pathway where appropriate (e.g. retailers, technology providers and other adjacent third parties).

Designing patient experiences

Organisations should take a patient-centred approach to the design, delivery and evaluation of healthcare services, with a focus on empowering patients to be more in control of their health and needs. Key design principles to follow include:

Transparency: Empowering the patient with transparent information around conditions, treatment regimes, pricing etc. Imagine a scenario where patients can compare the results of different hospitals or even individual doctors. Of course, common sense needs to prevail here and unintended consequences managed.

Data driven personalisation: Leverage patient data to drive predictive, preventative and personalised health and healthcare delivery – find the right solution for the right patient at the right time.

Game mechanics: Making use of game mechanics to help drive behavioural change – this can be used for preventative or treatment linked reasons.

Digital by default: Using digital and mobile technologies by default instead of physical channels where it improves accessibility, patient experience or outcomes.

Channel preference: Segment your patients and consider how you can make use of their natural channel preferences to drive greater engagement with their health and more streamlined services and communications.

Adoption: Don't make the mistake of focusing all your effort in the design and launch of a new service or product. Pay careful consideration to adoption and active patient migration.

Social connection

Support the creation of health social networks that connect patients, providers, entrepreneurs and research, and provide a place to build support communities where patients can share their experiences. These forums have become a rich source of insights that can be analysed.

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Built environment

Shift the locus of healthcare

When responding to an increased forecast of inpatients, instead of adding new inpatient beds, actively look for opportunities to shift the locus of care toward the home. Embrace remote health solutions where appropriate, such as using connected devices that enable continuous real-time monitoring and response for low risk patients.

Human-centric design

Patients and clinicians should have a role in evaluating, planning, and testing the layout of healthcare facilities, particularly when it comes to patient units and patient rooms, in order to create a more comfortable environment.

Open design competition

Consider utilising open innovation to gather new and more innovative hospital or clinic designs. This becomes particularly powerful when you provide insights learned from the empathy stages of human-centric design.

Design principles

Changing demographics, technologies and care pathways will require an unprecedented level of flexibility in healthcare facility design. These are the key design principles to consider:

Flexibility – adaptive re-usability of space, sustainable design, the ability to expand and contract units

Future ready – proactive consideration of emerging treatments and technologies and the requirements to support these. For example videoconferencing, remote medical treatment and VR facilities

Focus on recovery – boost healing and recovery time through lighting, acoustics, music and positive distractions (e.g. art, indoor gardens, landscapes and water features)

Connectivity and integration – intuitive way-finding and optimised routes for clinicians and patients. Connection to surrounding areas and public transport systems

Plug and play infrastructure – primary hospital and back -office services should be central, and remain in service while wings and modules are added and removed.

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Process and operations

Process optimisation

A visual management system (e.g. process mapping across people, process and technology) is necessary to establish a baseline to track and measure change. Establishing cross-disciplinary teams that collectively understand clinical implications, technical process improvement and the potential for Robotic Process Automation, coupled with an influential sponsor, is critical to a successful healthcare improvement effort.

Once this is in place, a data-driven approach can be taken to identify, design, implement and monitor the effectiveness of improvements.

Focus on finding opportunities for:

Straight-through processing: Enabling transactions to be conducted electronically without the need for rekeying or manual intervention. Ensure your data standardisation and governance mechanisms are strong (refer to Data and Analytics findings).

Robotic Process Automation: The use of robotics to automate industrial and clerical processes. This can begin with transactional or rules-based tasks; the next horizon is identifying opportunities to draw on machine learning, AI and decision support to automate tasks that are more cognitive.

Task optimisation: We should enable healthcare professionals to work to the top of their qualifications and extend their responsibilities to optimise workflow and efficiency (e.g. pharmacists administering vaccines in addition to GPs) and identify appropriate areas for robots to substitute human tasks.

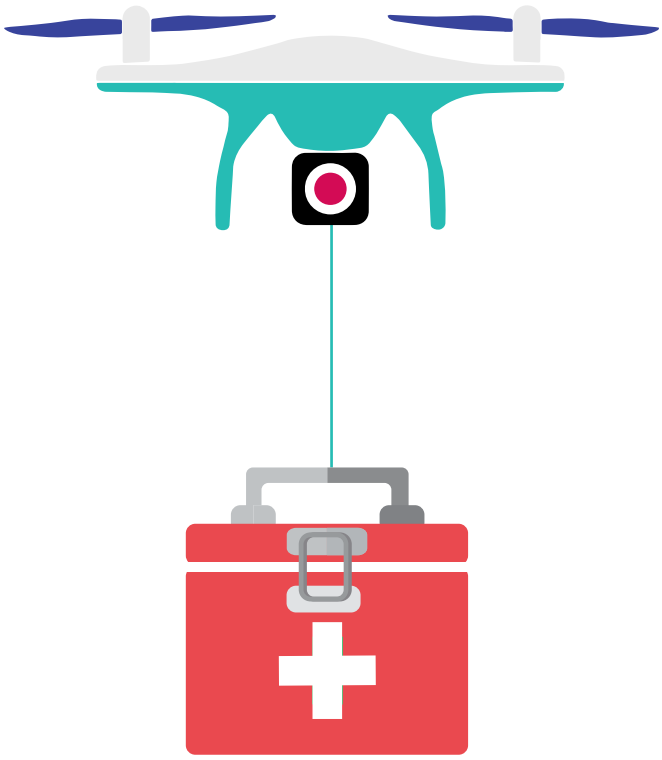
Logistics and transport: Adoption of Automated Transport Systems and Integrated Logistics to optimise routes, reduce human error and reduce time to provide care.

Workforce enablement and mobility

The use of digital processes, tools and people skills to achieve significant improvement in employee productivity and operational efficiencies. Equipping clinicians with the tools to work anywhere can reduce the strain on medical professionals. At a fundamental level this involves considering Bring Your Own Device (BYOD), Wi-Fi, Single-Sign On and Mobile Workbenches; and could extend to more futuristic use cases including virtually assisting during live medical procedures.

Training redesign

Health professionals are expected to work together in multidisciplinary environments however, they are currently trained separately, resulting in a limited understanding of the roles of other members of the team. A transition from a siloed to a more collaborative approach to training would benefit both patients and professionals, leading to cross-pollination of knowledge and enhanced patient results. Organisations should also explore the selective use of emerging technology such as VR into training, providing a safe environment to simulate realistic scenarios with no risk to patients.



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Data and analytics

Open data

SNOMED CT is a comprehensive, multilingual clinical healthcare terminology.[15] It can help your organisation improve the quality of data collected and patient safety – particularly in the area of medications management. This will also provide the foundations for scalable information sharing, supporting better integrated care and enabling greater transparency.

Augmenting the Electronic Medical Record

Explore ways to set up your Electronic Medical Records to capture and connect to the huge amount of personal health data the public is already generating through consumer devices such as wearables, monitors and smartphones and relevant information from external sources.

Prioritised application of predictive analytics and AI

AI has applications across the entire healthcare value chain from diagnostics, through to case management, care delivery and post-care engagement. Investing in big data, predictive analytics and AI capability is a critical enabler to a modern healthcare provider. Consider identifying priority areas by identifying processes or treatments that have high error rates, and exploring whether clinical decision support, insights or predictions on complex data could help to solve the problem.

Experimenting with Quantum Computing

Adopt and experiment early with quantum computing simulators. This is critical to upskilling classical software engineers, and will help healthcare providers understand and identify and explore potential use cases before Quantum Computing becomes mainstream.

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Technology

Open Technology Ecosystem

From a foundational perspective a focus on building out an open technology ecosystem is paramount to benefiting from new collaboration models. There should be investment in the integration platform – with a particular focus on API management and orchestration to enable the plug-and-play of new capabilities.

Internet of Things (IoT) enablement

Ensure that sensors, actuators, gateways and infrastructure to support IoT networks are considered as part of a broader technology strategy. Unlocking valuable insights from these devices lies in the aggregation and integration of data from the network with master data stores. Adopting IoT interoperability standards helps to unlock the value of IoT by ensuring IoT systems can easily exchange data and make use of that information. PAS212:2016 is a lightweight standard which can be extended to a wide range of IoT applications.

Cyber security

Health information, particularly genome data, is amongst the most personal. There are unprecedented levels of information available to healthcare providers. This coupled with the rise of open technology and data, and greater collaboration with third parties means that healthcare providers need to continually assess and evolve their cyber security, identity and access management, and continuous authentication mechanisms. This can be used to manage risk while also providing a more secure and seamless customer experience.

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Virtual Reality experience

We believe the future of healthcare will be centred on people. Take a look at our virtual reality experience to see how emerging technologies could help transform the way we interact in an increasingly connected world.

In our vision of this future, our patient Anna is not feeling well. We explore how she interacts in a connected world with her AI assistant EVA to monitor, understand, and pro-actively manage her health.

Link to 360 degree video

To arrange viewing the experience in true virtual reality at KPMG, please contact innovationlab@kpmg.com.au

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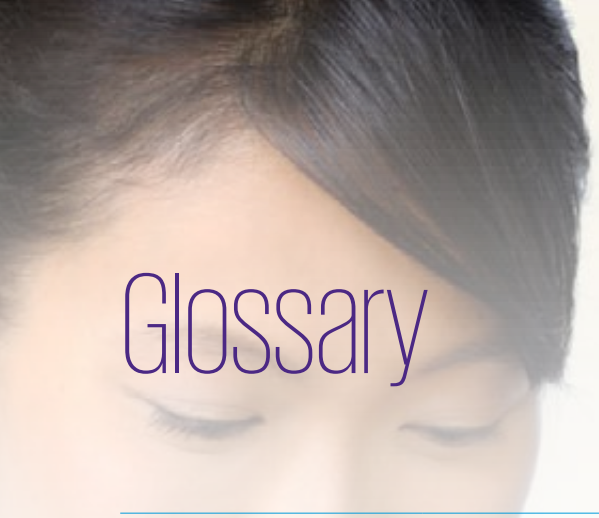

Glossary

3D printing	3-D printing is a manufacturing process that builds layers to create a three-dimensional solid object from a digital model.
Artificial Intelligence (AI)	The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.
Augmented Reality (AR)	AR is a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.
Automated Transport System (ATS)	Automated Transport Systems are systems used in healthcare organisations that are designed to efficiently manage medications and material transport (including autonomous guided vehicles) to improve workflow, streamline costs and enhance the patient experience.
Circadian Rhythm Lighting	Circadian rhythm is the alignment of living organisms to the daily rotational cycle of the Earth. These biorhythms control our rest-activity cycle, while also influencing our immune system and potential for healing.
Cognitive computing	Cognitive computing refers to computing that is focused on reasoning and understanding at a higher level, often in a manner that mimics the way the human brain works.
Digestible	Digestibles are microchip-embedded drugs that can tell doctors whether a patient is taking their medications as prescribed.
Drone	A drone is an unmanned vehicle. The term "drone" however encompasses several vehicle types. For example: – UAV (unmanned aerial vehicle) – AUV (autonomous underwater vehicle) – UGV (unmanned ground vehicle).
Exoskeleton	An exoskeleton is an external skeleton that supports and protects the body of a human or animal.
Gene therapy	Gene therapy is an experimental technique that uses genes to treat or prevent disease.
Genome sequencing	The process of determining the complete DNA sequence of an organism's genome.
Implantable	An implantable is a medical device manufactured to replace a missing biological structure, support a damaged biological structure, or enhance an existing biological structure.
Nanotechnology	Nanotechnology is the branch of technology that deals with dimensions and tolerances of less than 100 nanometres, especially the manipulation of individual atoms and molecules.
Precision medicine	Precision medicine is an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person.
Robotic Process Automation (RPA)	Robotics Process Automation (RPA) is the use of technology that allows software to interpret existing application for processing a transaction, manipulating data, triggering responses and communicating with other digital systems.
Spatial design	Spatial design is a relatively new conceptual design discipline that crosses the boundaries of traditional design disciplines (including architecture, landscaping, interior design, service design and public art). It focuses upon the flow of people between interior and exterior environments.
Straight-through processing (STP)	Straight-through processing (STP) enables the entire trade process for capital market and payment transactions to be conducted electronically without the need for re-keying or manual intervention.
Virtual Reality (VR)	VR is a computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.
Wearable	Wearables are electronic devices that can be worn on the body, either as an accessory or as part of material used in clothing. One of the major features of wearable technology is its ability to connect to the Internet, enabling data to be exchanged between a network and the device.

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January 2018. N15785LOB.