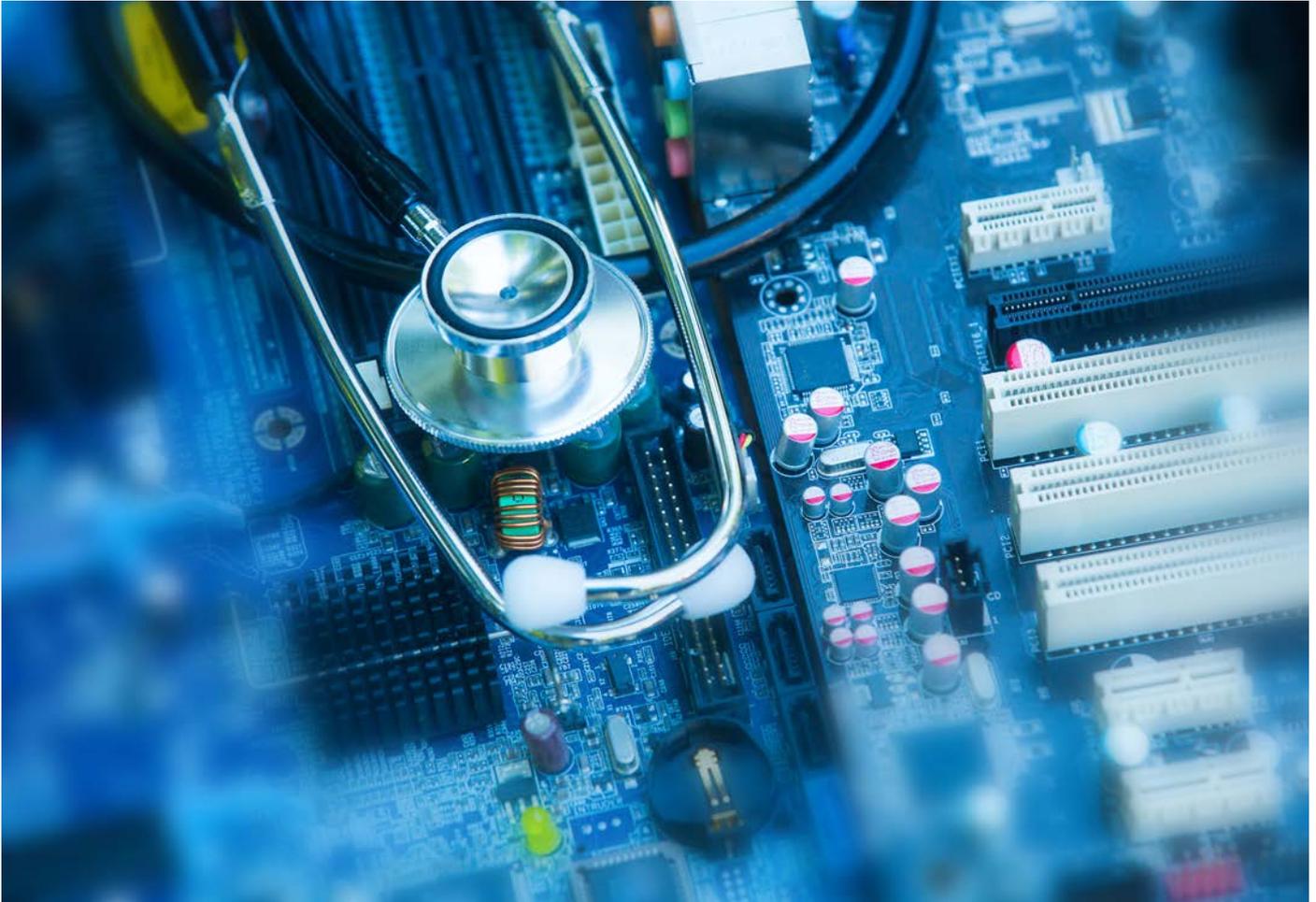


Technology: accelerating innovation across healthcare.

The road towards personalised
medicine and connected care

Prepared by:



The pace of digital innovation in healthcare has accelerated exponentially over the past decade. For anyone keenly observing technology-based innovation from afar, with a wider view on the industry, they will have seen that particularly during tougher economic times, entrepreneurs, researchers and scientists work harder than ever to provide innovative solutions for more efficient healthcare delivery. Economic strain equals cost savings, and cost savings often require solutions that come from thinking out of the box.

Previously, innovation in healthcare has centered on the development of new diagnostic procedures, therapies, drugs, or medical devices; however, today, innovation is playing a more vital role in areas such as personalised medicine and more efficient technology-enabled care models.

There is no doubt that healthcare will experience significant disruptive innovation over the next few years, creating new possibilities and opportunities for traditional healthcare companies and medical device manufacturers to thrive, as well as for new startups and entrepreneurs looking to make their mark on the industry. In fact, according to StartUp Health Insight's year-end report, digital health startups raised US\$ 11.5 billion in 2017, up 27% from 2016.

With many startup companies launching solutions for messaging, artificial intelligence, and organisational structure, investors will be keeping a close eye on the developments in this space over the next few years.

“digital health startups raised US\$ 11.5 billion in 2017, up 27% from 2016.”

Last decade	Current decade	Next decade
Medical Products Equipment, Hardware, Consumables	Medical Platforms Wearable, Big Data, Health Analytics	Medical Solutions Robotics, AI, Augmented Reality
		
Differentiation is solely through product innovation. Focused on historic and evidence based-care.	Differentiation by providing services to key stakeholders. Focused on real time outcome based-care.	Differentiation via intelligent solutions for evidence/outcome based health. Focused on preventive care.

Source: Frost & Sullivan, 'Transforming healthcare through artificial intelligence systems', 2016

Enhancing healthcare through innovation.

According to Stephen Bonner, who was the former CEO and President and is now a strategic advisor at Cancer Treatment Centres of America, healthcare innovations can be analysed in three dominant categories.

1. Science and Technology Innovation

The first, according to Bonner, is that science and technology innovation are moving at a faster pace than ever before, and at very transformational levels.

“The genetic and genomic understanding is providing a much deeper and individualised understanding of the human condition. Adding to that, big data management, Artificial Intelligence (AI), and Machine Learning, and we now have the ability to make much more sophisticated diagnoses, and to connect those diagnoses with swift, efficient, personalised care plans,” he explains. “These care plans will not only enhance quality, cost and access for sick care, but they also will transform how we manage our health, before ever becoming ill. And, through these developments, we are seeing innovation to predict which drugs have the highest likelihood of cures for each individual patient.”

Bonner describes one company that has created a database that includes all of the FDA-approved drugs. It is also developing a system to receive individual patient genomic data, and use predictive modelling to identify the best potential drugs for that patient, and whether the drugs have ever been tested for the patient’s condition. The high-potential drugs can then be tested with patient cells in the lab, before deciding which ones should be considered for off-label use, and be delivered to the patient.

Another company has developed a specially bred, immune-suppressed mouse to allow small tissue samples from individual patients to be implanted very precisely in the mouse. Here, the patient cells grow rapidly, providing ample cells to test a variety of drugs, in the cells of each patient in the laboratory, seeking to identify the one drug, or combination of drugs that are most likely to work for that patient, before any drugs are administered.

“Both of these companies are of course tracking and analysing success and failure rates to build a highly predictive database that can be used for future patients without having to put in the hard work in the labs, with tissue samples and drug alternatives. Also, imagine how that kind of data might be used for developing new drugs faster, and cheaper,” Bonner notes.

Bonner mentions another company that has developed a natural substance that can be injected to create space between healthy tissue and malignant tissue to dramatically increase the delivery of higher doses of radiation therapy for cancer patients, with less risk to nearby healthy tissue. This natural substance is then absorbed into the body and eliminated after approximately three months time.

“All three of these innovations seek better care, better outcomes, better cost and improved patient experiences,” he explains.

2. Delivery Innovation

According to Bonner, the second dominant category in healthcare innovation is the changing delivery of healthcare, in which the key innovation theme is to offer care as quickly, closely and efficiently to each consumer; and, also to allow each medical professional to operate at the top of their licenses.

“This pushes lots of care and information acquisition out of hospitals; the most expensive delivery model,” Bonner says. “We now have stand-alone emergency centres; surgery centres; infusion clinics; dialysis units; primary care minute clinics; and computer apps to bring professionals to the patient virtually. We also have skilled nursing facilities and rehab facilities independent of hospitals.”

“And, the largest pharmacy retail chains are integrating more and more healthcare into their stores allowing these stores capture more information about the lifestyle and health status of individuals than anyone else. The potential to use that data to guide a patient to healthier choices and better therapy, supported by AI and machine learning, is truly transformational.”

3. Consumer Innovation

Thirdly, Bonner describes the role of the consumer in demand acceleration across the healthcare ecosystem as the third dominant category in healthcare innovation. “After several decades of deprivation, the healthcare consumer is back in the game and prepared to discipline the industry like never before,” he says.

There are at least three driving forces behind the consumer. First is the shift of financial obligation to the front end of healthcare consumption. “The increasing deductibles and copays have the consumer’s attention. If it’s their grocery money, rent and entertainment funds that now have to be spent on healthcare, they are going to ask a lot more and penetrating questions about quality, cost, and access than ever before. And, if the provider does not have compelling answers, the consumer will simply take their business to someone who can justify the consumer’s business and loyalty” Bonner explains.

A second force driving the consumer, according to Bonner, is their life’s experience in making complex and simple decisions about all of their life’s activities. They are used to having easy and immediate access to the information they need to make decisions and as they now accelerate their role as a healthcare and wellness consumer, they are bewildered and are asking questions such as “Where is my healthcare information? Where is my satisfaction guarantee, including easy access to information and care?”

The third driving force is that healthcare is simply about their lives, their families’ lives and their communities. “Good health is not a nice to have; it is a core value. And with all this foment and drive for change, the consumer is too vitally affected to stand by and passively hope for the best,” Bonner adds.

Technology as an agent for transformation.

Technology is transforming all areas of healthcare as systems all over the world move towards value over volume. As Synapse Medical Business Development, Director Thom Soutter, explains, “Technology is at the forefront of any lean innovation that is required to disrupt outdated models that are costing healthcare spend, and innovation and telehealth advancements cannot come soon enough.”

As a provider of medical administration services, Synapse is at the forefront of providing cutting-edge technology that is transforming the healthcare administration sector today. “We’ve launched a first-of-its-kind billing app that allows billing and payments to be instantly transmitted between medical specialists, payers and health funds,” Soutter says. “We have a similar solution for clinical coding that will allow medical diagnosis, written or system driven, to instantly be made into key health data for hospitals or governments looking to control and maximise their health spend.”

Soutter also identifies specific areas that are a priority for digital transformation. “Healthcare systems, particularly in region’s such as the Middle East, are creaking under the strain of expanding populations and expensive gateways to health. A shift towards preventative methods is needed more than ever as an alternative to curative medicine where appropriate. Healthy lifestyle apps, telehealth and patient engagement through technology will be key.”

According to Cleveland Clinic’s Associate Chief Information Officer, Dr William Morris, who shared his thoughts in a blog post titled “Cleveland Clinic: A glimpse into how technology can drive quality healthcare” published in the Future Health Index, for technology to truly transform care, we need to know why we are using it, create a process and have people in place to carry out that process.

“Consider today’s “wearable” technology,” he wrote. “While it provides considerable information, it isn’t necessarily useful for healthcare providers or patients. To make it valuable and actionable, we need to focus on the right group of people, using the right type of measurements.”

For example, he says that tracking steps in a healthy group may not tell us much. However, tracking steps in a group of patients who just had knee surgery could be compelling. We could identify patients who haven’t taken many steps and intervene to find out why. “Do they still have pain? Swelling? Possible complications?” he asked.

According to Morris, used properly, technology and data can improve our lives – from day-to-day healthy living to

prevention, diagnosis, treatment, and home care.

For Professor Bertalan Mesko, who is the director at The Medical Futurist Institute in Budapest, Hungary, the quest is finding a balance between using new technologies and maintaining the human touch in care.

In an article titled “Digital Health: Scaling Healthcare to the World” published in Health Informatics, Mesko writes that getting in touch with peers through social media, accessing medical information anywhere using smartphones; or receiving care via telemedicine have become common elements of healthcare. However, he says that the challenge is not whether such technologies will become a major part of care, but how the traditional structures will be able to change when everything else changes around us.

Mesko believes that the quest for society today is to be prepared. This way we would be able to implement digital health solutions in a meaningful way and prove that the use of technologies makes care more affordable enabling patients and their caregivers to work as a team.

“The far future of medicine, when the most progressive technologies are part of our everyday lives, should be even more humanistic than it is today. The extensive use of algorithms, robots and sensors should lead to a utopia where everyone receives personalised, accessible, preventive and efficient care,” Mekso writes. “While solving the ethical challenges on the way might become a bigger puzzle than developing the required technologies, this utopia will not arise by itself. All stakeholders of healthcare today are supposed to change along the way. As their roles have changed over the last centuries, it will keep on changing.”



The role of artificial intelligence (AI).

Improving clinical outcomes with the use of Artificial Intelligence (AI) is captivating the healthcare industry worldwide, both from the perspective of diagnosis and disease management, as well as for governments, tech companies and healthcare providers who are willing to invest and test AI-powered solutions. There appears to be a paradigm shift to healthcare that is led by the increasing availability of healthcare data and rapid progress of analytics techniques, and AI is at the centre of this.

From AI-assisted robotic surgery and virtual nursing assistants, to AI algorithms that can aid in clinical judgements and diagnosis, and the potential to automate administrative tasks with AI, the possibilities are endless when it comes to the integration of AI-powered tools into every day health management.

Some of the most innovative AI-powered health and wellness tools on the market include IBM's Watson supercomputer that helps doctors gauge the impact of certain symptoms, come to a diagnosis and make decisions, as well as Google's recently introduced algorithm that can be used for clinical predictions. Similarly, Apple's ResearchKit focuses on pooling data from various mobile devices in order to aggregate and make sense of more live health data in the treatment of Parkinson's disease and Asperger's syndrome. Meanwhile, Microsoft's InnerEye research project uses state-of-the-art machine learning technology to build innovative tools for the automatic, quantitative analysis of three-dimensional radiological images turning radiological images into measuring devices.



8 ways that AI and Robotics is transforming healthcare:

1. Keeping Well
2. Early Detection
3. Diagnosis
4. Decision Making
5. Treatment
6. End of Life Care
7. Research
8. Training

Source: PWC, *What doctor? Why AI and robotics will define New Health*, June 2017

Forging ahead with 3D printing.

According to Michael Gelinsky from the University Hospital and Medical Faculty at the Technische Universität Dresden in Germany, probably the fastest growing field in 3D printing applications in medicine is currently that of 3D models for medical education and surgical planning.

Gelinsky explains that the logical next step after printing anatomical and surgical models is to fabricate patient-specific implants and devices, i.e., parts that are inserted in the living human body such as prostheses, orthoses, or individual polymer casts for fracture stabilisation. Similarly, 3D bioprinting, or the development of vascularised and fully functional tissue/organ models, is currently under intensive investigation.

For Gelinsky, the future of 3D printing involves intensive investigation by researchers from all over the world as well as rapid progress in hardware and software development by companies and the commercialisation of numerous applications. "As the development of more personalised therapies continues to trend globally, 3D printing will definitely play a stronger role; however, the velocity and degree of translation will be restricted by financial as well as regulatory issues." (Gelinsky, 2018, p.158)



Five top ways that 3D printing is changing the medical field:

1. 3D printing labs in hospitals

A few years ago, very few hospitals were doing 3D printing directly in the hospital. Today, hospitals around the globe are setting up 3D printing labs within their complexes so that healthcare professionals can incorporate the process into a normal day's work.

2. Low-cost prosthetics

3D printed patient-specific prosthetics, often produced on low-cost, MakerBot-style printers, are having a major impact, especially in developing countries. The prosthetics come with the latest technology and are changing the lives of people who in the past had no hope of ever receiving these devices.

3. Customised medical implants

Thousands of 3D printed replacements for body parts such as knees, hips, ankles, parts of the spine, and skull, are implanted every year, and the future holds more promise with 3D printed patient-specific parts. Although not generally approved by the Food & Drug Administration, some have taken place under FDA's emergency clearance process.

4. Customised protective devices and aids

3D printing is enabling high-quality, rapid, low-cost production of everything from dental implants to hearing aids, from prescription eyeglasses to headgear that fits better, work better, and offer better protection.

5. Biomaterials for organ structures and complex organs

With the development of 3D printing, the prospect of being able to reproduce human organs out of biomaterial has suddenly become more than a pipe dream. Taking a step at a time, researchers started with simpler structures such as skin, blood vessels, cartilage, bone, and the bladder, along with parts of more complex organs, such as heart valves, and have made considerable progress.

Source: The American Society of Mechanical Engineers

New opportunities with wearable technologies.

Touted as the future of healthcare, innovation in the wearable technology sphere is immeasurable. With the invention of new devices every day and the increasing adoption of wearable technologies in the world of regulated medical devices, wearables are becoming more and more specific, tailored to specific needs.

From heart rate biosensors and sensors placed under the skin to monitor glucose levels, to electronic smart hearing aids and activity trackers, all relevant patient information can be made easily available on the wearable platform eliminating the need for bulky files for each patient.

According to Boillat *et al.* (2018), the first step in disease management requires radical lifestyle changes moving away from the unhealthy ones. The authors envision the importance of the role of personalised, miniaturised Information Technologies (IT), specifically smart watches, in supporting patient's self-management efforts in any daily life context, acting as a reminder for specific activities and documenting

the patient's progress via a checklist-based approach.

"Wearable technologies, such as smart watches, offer new opportunities to support chronic care and enables patients' self-management. Compared to traditional chronic care management that requires patients to regularly travel to a clinic, wearables provide more flexibility and actively include patients in the process." (Boillat *et al.*, 2018, p.78)

Indeed, this trend is supported by a recent report from Research & Markets that predicts that the global wearable medical devices market will reach US\$ 14.41 billion by 2022, up from US\$ 6.22 billion in 2017, at a CAGR of 18.3% during the forecast period.

According to the report, the growth of this market is driven by factors such as technological advances in medical devices, increasing penetration of smartphones and growing number of smartphone-based healthcare apps compatible with wearable devices, growing preference for wireless connectivity among healthcare providers, and increasing awareness about physical fitness.



Taking to the skies with drones.

Currently, health services and medical resources in underserved communities are limited to motor transportation and face-to-face interactions; however, drones are being explored as a feasible option in providing these services in a more efficient manner (Wulfovich et al., 2018). Current research has explored the use of drones for natural disaster relief, search and rescue missions, and transfer units. However, there is limited research on how drones could be used as telemedicine and transfer units.

According to Sharon Wulfovich et al. (2018), technology is reaching a point of maturity and this opportunity will allow drones to become viable options for a diverse range of services including health services.

“Drones can have a large social impact and can be used for emergency services and response, and, if our hypothesis is correct, drones can also serve as telemedicine units. Drones have the ability to change access to health all over the world and can make medical services readily available and take road infrastructure out of the equation.” (S. Wulfovich et al., 2018)

Benefits of using drone in healthcare delivery:

- Increased ability to reach victims who require immediate medical attention
- Autonomously transport medicine within hospital walls and courier blood between hospital buildings
- Increased ability to care for the elderly as the age in place
- Potentially decrease the cost associated with providing medical care
- Increases the efficiency of providing care to patients in remote locations

Challenges with using drone in healthcare delivery:

- Maintaining the integrity of specimens during delivery:
 - Temperature control
 - The need for special equipment (packaging)
- Payload capacity
- Battery life
- Security for controlled substances
- Regulations; Federal, state and local
- Consumer demand

Source: *The Healthcare Information and Management Systems Society (HIMSS)*



Getting creative with telemedicine.

According to data from GSMA, by Q2 2017, two-thirds of the world's population (or five billion unique subscribers) were connected by mobile. By 2020, this figure is expected to increase to almost 75% of the global population. It is also estimated that developing markets will account for the largest share of new mobile subscription growth over the forecast period with 40% of new subscribers stemming from five markets: India, China, Nigeria, Indonesia, and Pakistan.

According to EY Global Health Sector Leader, David Roberts, who explored technologies that could revolutionise healthcare in an article titled "10 Ways Digital Could Transform Healthcare", mobile technology is increasingly being used to reduce pressure on healthcare systems by removing the need to travel to see a healthcare professional. He believes that telemedicine is likely to have the most transformative effect on more remote communities, where conducting remote assessments of patients via mobile phones is beginning to provide access to medicine for some of the world's poorest people at a fraction of the cost of providing roving doctor services.

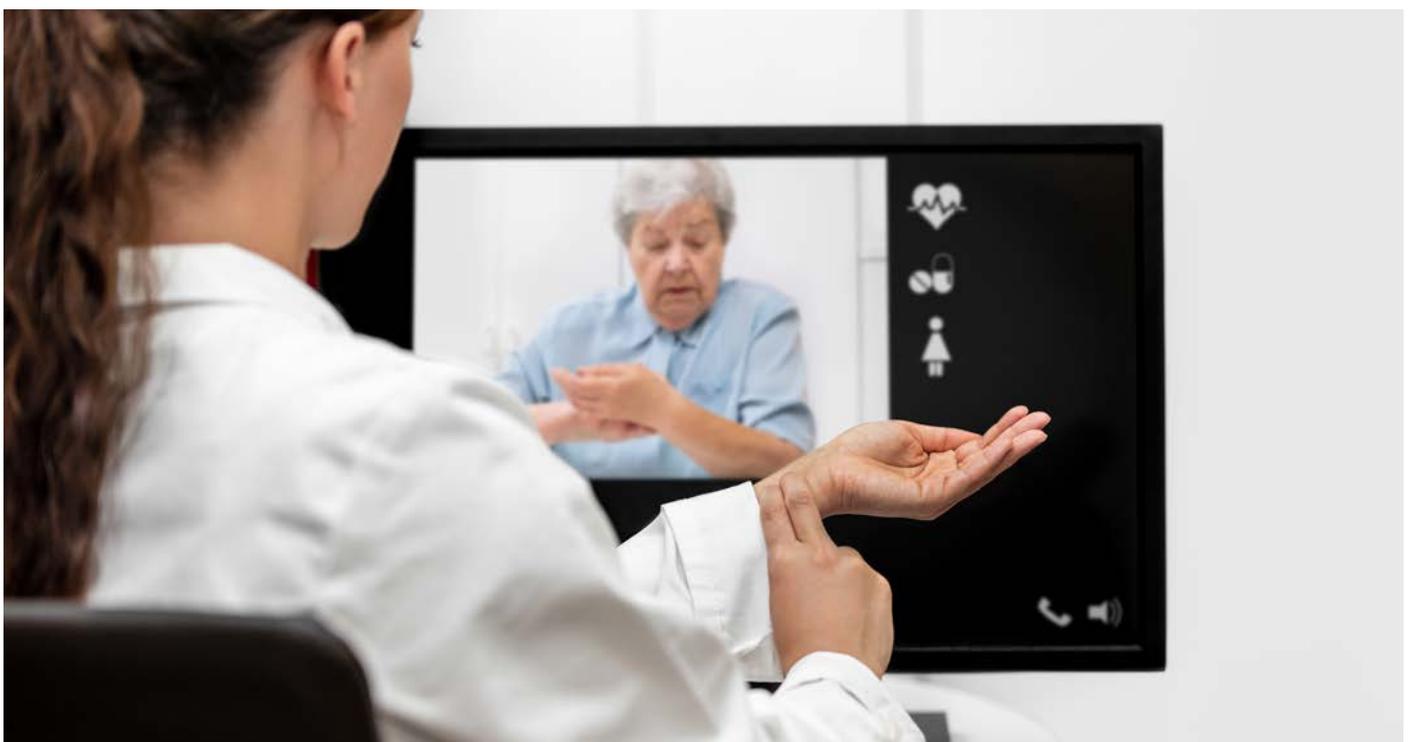
Commenting on the growth of mobile subscriptions in developing countries, Roberts says that this trend has enabled the development of creative solutions that leverage the ability of connected technologies to reach people who would

otherwise find it difficult to access healthcare information.

Meanwhile, the potential for more efficient and cost-effective delivery of healthcare has driven the development of numerous telemedicine services like teleconsultation, telediagnosics, telemonitoring, and telecare, and the use of telemedicine is believed to be a part of the solution in restructuring and redesigning our healthcare systems (Van der Heijden and Witkamp, 2018).

As an example of this, Dutch researchers have developed and successfully applied their Health Management Practice (HMP) model on a large number of telemedicine services using the "start small, think big" approach, leading to a fully integrated telemedicine services. Results show a 70–96% reduction in hospital visits in dermatology and ophthalmology, which translates into an immediate cost reduction of 18% and the response times of 4–5 working hours. The learning effect has had a high impact on the quality of care delivered (Van der Heijden and Witkamp, 2018).

In addition, telemonitoring programmes in mental health have also shown that involving the patient as an active actor can result in more motivation and ownership of their own health and that telemedicine also allows hospitals to remain focused on delivering high-quality specialised care (Van der Heijden and Witkamp, 2018).



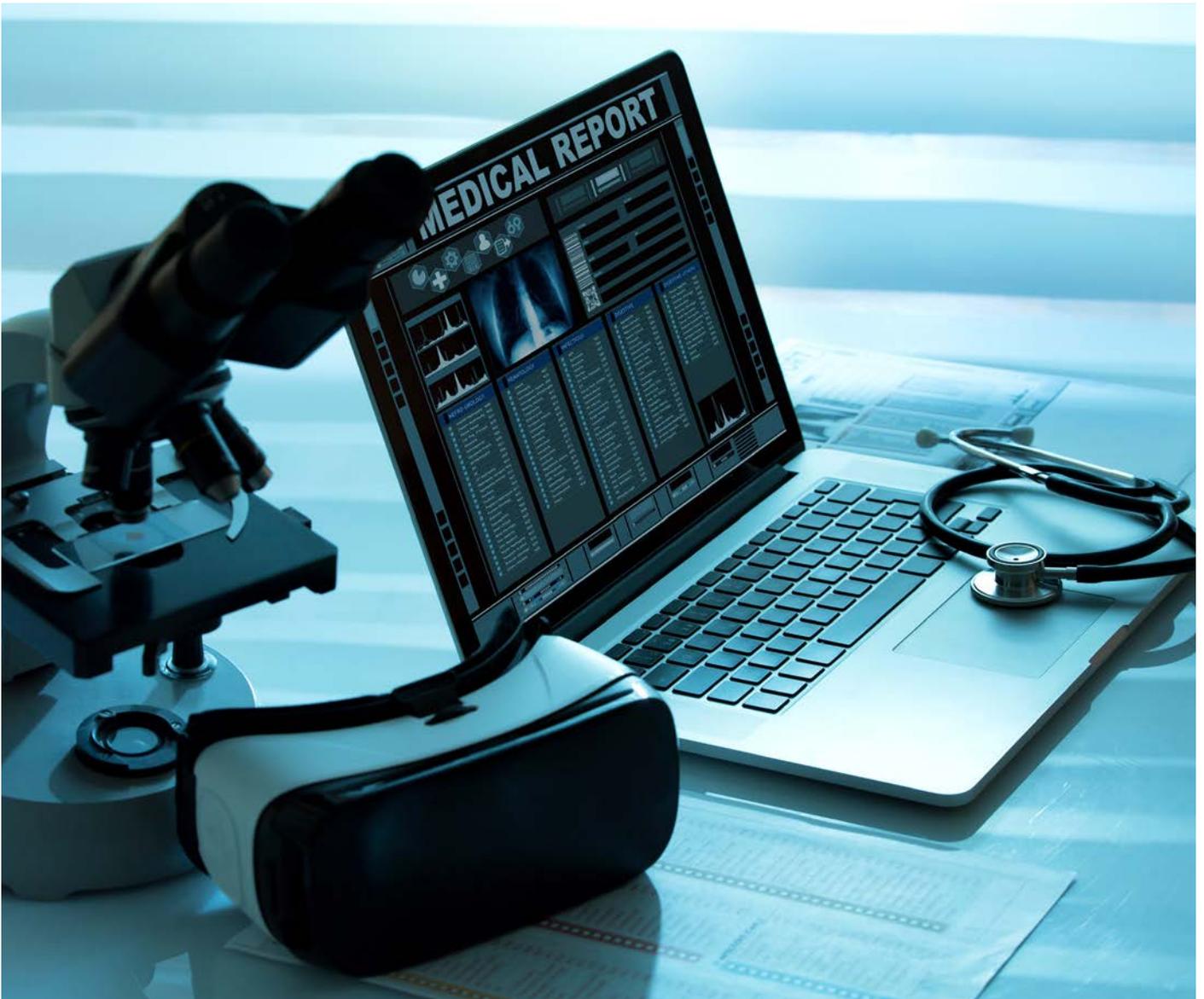
Virtual reality (VR) for healthcare.

A recent report by Grand View Research has predicted that the global Augmented Reality (AR) and Virtual Reality (VR) in healthcare market will reach US\$ 5.1 billion by 2025. The growing adoption of VR in the medical field, increasing investments in such emerging technologies, and constant developments in healthcare IT are some of the key factors responsible for growth of this market.

Also, the mobilisation of healthcare to smartphones and other devices facilitates the migration of services beyond the walls of the traditional doctor's office and into the homes and everyday lives of those who need it most. From the use of VR as a distraction tool for pain management during

medical procedures, to its implementation as wellness-based technology for stress management and rehabilitation, researchers have been able to benefit from rapid advances in computer hardware, software, and image processing (B.K. Wiederhold, 2018).

According to A. Li et al. (2011), by combining a series of different technologies, including head-mounted display (HMD) with head-tracking systems, headphones for sound/music and noise-cancelling headphones, as well as manipulation/navigation devices, VR technology provides a multisensory, and three-dimensional (3D) environments that enable users to become fully immersed in a simulated world.



Conclusion.

Healthcare facilities, medical device manufacturers and service providers across the globe are facing increasing pressure to innovate in order to become competitive and to offer new and improved treatments to patients. Indeed, as innovation in healthcare appears to take many forms – from drug discovery, surgical discovery, device and service improvement, to professional training and patient education – measuring its overall impact on quality improvement in healthcare can be challenging.

However, when it comes to the influence of technology in healthcare, the positive impact is clear. Not only have technological innovations facilitated much smoother communication within healthcare organisations and, more importantly, with patients, but embracing digital healthcare services allows for the provision of cutting-edge care, improved operational efficiency, better patient outcomes, and reduced costs, to name a few.

Working alongside government entities such as the UAE Ministry of Health and Prevention, Dubai Health Authority, Department of Health Abu Dhabi and SEHA, Arab Health will host the Innovation Hub - a dedicated area at the show for you to immerse yourself in the latest healthcare innovations.

The Innovation Hub is comprised of two key sections for you to explore:

- Innovation Showcase
- Innov8 Talks

Innovation Showcase.

Growing from the Personal Healthcare Technology Zone in 2018, the Innovation Hub at Arab Health 2019 will have a more prominent focus on healthcare innovation. Working together with key influential stakeholders, the hub will provide you with a dedicated showcase area to meet and discover the start-ups, SMEs, and innovators. Located within the central Plaza Hall, companies will display and demonstrate their new products and innovations that will contribute to shaping the future of healthcare.

Product areas to explore:

- Artificial intelligence
- Disease management devices and technology
- Health monitors and home care devices
- Healthcare start-up companies

For more information visit: www.arabhealthonline.com/innovation

REFERENCE LIST:

- Cleveland Clinic: A glimpse into how technology can drive quality healthcare (2017, 23 June), Retrieved from: <https://www.futurehealthindex.com/2017/06/23/technology-drive-quality-healthcare/>
- M. Gelinsky, 2018, "Digital Health: Scaling Healthcare to the World", Digital Informatics, Springer International Publishing AG, Chapter 11, p.158
- Boillat *et al.*, 2018, "Digital Health: Scaling Healthcare to the World", Digital Informatics, Springer International Publishing AG, Chapter 8, p.109
- 10 Ways Digital Could Transform Healthcare, Retrieved from: <https://betterworkingworld.ey.com/digital/10-ways-digital-could-transform-healthcare>
- J.P. van der Heijden and L. Witkamp, 2018, "Digital Health: Scaling Healthcare to the World", Digital Informatics, Springer International Publishing AG, Chapter 3, p.27
- B.K. Wiederhold, 2018, "Digital Health: Scaling Healthcare to the World", Digital Informatics, Springer International Publishing AG, Chapter 9, p.123
- Li A, Montano Z, Chen VJ, Gold JJ., 2011, Virtual reality and pain management: current trends and future directions. *Pain Manag.* Chapter 1, p.147–157.
- S. Wulfovich *et al.*, 2018, "Digital Health: Scaling Healthcare to the World", Digital Informatics, Springer International Publishing AG, Chapter 11, p.158

- Mobile device accessories
- Smart watches, fitness trackers and applications
- Telemedicine platforms

Innov8 Talks.

A dedicated seminar theatre will be a prominent feature in the Innovation Hub for the inaugural Innov8 Talks. Come listen to start-ups and entrepreneurs present their healthcare innovations to a panel of industry experts and potential investors.

The Innov8 Talks will host 8 pitches, each 8-minute-long, across each day of Arab Health. The judging panel will determine the best innovation.

Further free-to-attend sessions are seeded through the four days of the Innov8 Talks, with discussions led by keynote speakers, setting the theme for each day, as well as afternoon sessions each with a regional focus.

About Arab Health:

For 44 years Arab Health has brought the latest innovations in healthcare to the MENA region. From state-of-the-art imaging equipment to the most cost-effective disposables; developments in surgery to advances in prosthetics, Arab Health continues to be at the heart of healthcare in the Middle East. The 2019 edition of the show will take place from 28-31 January and will welcome 4,150+ exhibiting companies to showcase their latest innovations to 84,500+ healthcare and trade professionals. Running alongside the exhibition are 11 CME accredited conference tracks and a variety of workshops and hands-on training sessions for medical professionals to advance their knowledge and skills. For more information, visit www.arabhealthonline.com.