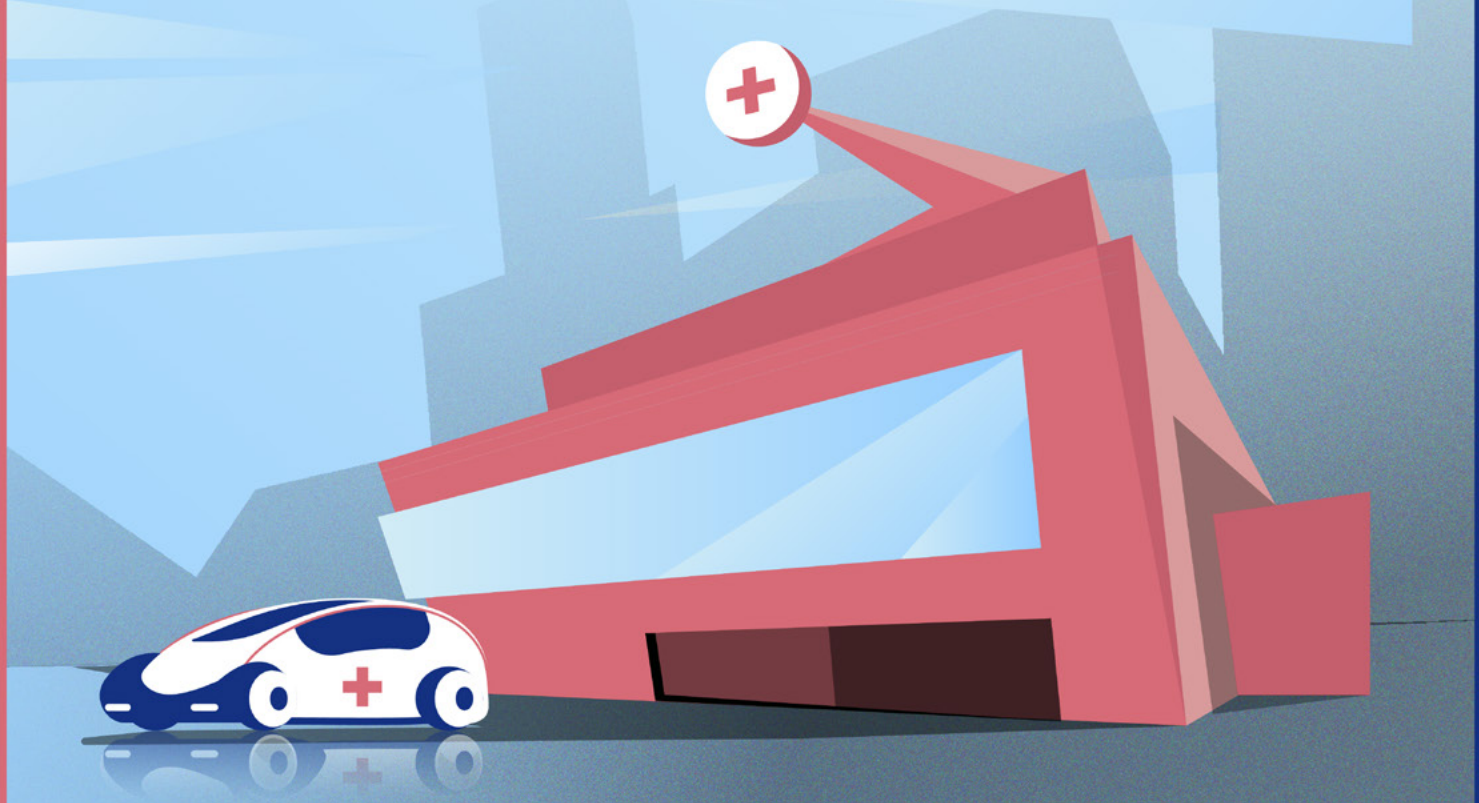
A GUIDE TO THE FUTURE OF HOSPITALS



THE MEDICAL FUTURIST

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A Guide To The Future Of Hospitals

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THE MEDICAL FUTURIST

Welcome message

Dear Reader,

Whenever I talk about the near future of medicine and healthcare, one of the first questions is about what we can expect from hospitals. Will there be hospitals at all by 2035? If so, what will be their role and how will we care for patients in the same buildings we have today?

No matter where you live on this planet, how wealthy you are or how rich your network is, you still have to go to a physical location we call the point-of-care to receive medical help with a huge range of issues. If you ask a medical professional working in one or a patient who has ever been to one, they will doubt if that place would be significantly different a decade from now.

We wrote this e-book to describe what we know today about the practical future of the point-of-care and what we, at The Medical Futurist, envision about their future role, state and promise of that place.

We think there will be hospitals even 30 years from now; however, their role will be different and they will cover a specific group of treatments and healthcare processes.

We hope this comprehensive review will arm policymakers, healthcare professionals and people on the business side of care to better see what is coming and what the hospital of the future will be like.

Dr. Bertalan Meskó

The Medical Futurist

Director of The Medical Futurist Institute

INTRODUCTION

In 1932, Dr. Holbrook described his vision for the future of hospitals in a paper aptly titled 'The Ideal Hospital Of The Future'. In it, the author argued that hospitals will not need any radical changes in their diagnostic service nor in how they manage patients.

Indeed, nowadays, the average hospital and the healthcare experience it delivers share a similar template anywhere in the world. Those institutions currently represent the central point of healthcare where healthcare professionals, medical equipment and diagnostic tools can be found. Patients need to head there in order to get diagnosed, receive treatment, take blood tests and radiological scans, or retrieve medical data.

Most readers will find such an experience familiar; but they might also be familiar with recent changes in the delivery of healthcare, particularly precipitated by the COVID-19 pandemic. Such changes mostly revolve around the integration of technologies with remote components such as telemedicine and at-home lab tests that bring healthcare outside of the confines of hospitals. Such new approaches to diagnostic service and the way patients are managed are becoming more prevalent.

Indeed, much has changed over the 90 years that have elapsed since the publication of Dr. Holbrook's vision; and at The Medical Futurist, we would argue that in the digital health era, hospitals are in dire need of changes. Changes in plural as these range from the design perspective to the roles of healthcare practitioners.

Make no mistake, we do not claim that with the adoption of digital health technologies, hospitals will become obsolete and that they will somehow operate solely on the cloud. Far from that, medical institutions will still be needed decades from today. People will still require acute care and they will turn to hospitals for these needs as well as for invasive procedures and for in-depth analyses that require bulky, specialised equipment stored in hospitals.

However, the roles of hospitals will be different in the future. Much of routine checkups and unnecessary in-person visits will be shifted online via telemedicine

consultations and A.I. algorithms. This will free up time and resources for the medical staff to focus on cases that require more prompt medical attention or invasive manoeuvres. In order to properly adopt these new functions, hospitals will require radical changes, as opposed to what Dr. Holbrook envisioned in 1932.

As such, we are publishing this e-book to guide anyone interested in building, designing, or simply understanding the future of hospitals or healthcare institutions in general. Across 7 chapters, we will explore the central point-of-care concept which will dictate the focus of those institutions, contemplate elements of hospital design through those lenses and analyse the technological trends that will determine hospitals' future.

Throughout these chapters, we also share the insights of design experts as well as medical staff who have adopted novel approaches to enhance the healthcare experience. To synthesise the content of this e-book, it will conclude with the depiction of a hospital from the future that adopts the approaches highlighted within.

1 THE CONCEPT OF THE POINT-OF-CARE

One of the key features of digital health technologies is that they democratise access to care, and with that they also bring a shift to the traditional concept of point of care. Conventionally, this meant delivering care by clinicians at the patient's bedside in a hospital. What digital health approaches now enable is taking a component of care delivery outside of the confines of healthcare institutions. This enables patients to become more proactive in the management of their health.

In fact, the new point-of-care concept in the digital health era will consist of two components, one outside of hospitals and hospitals themselves will retain the other component. While much of routine care will be offloaded outside of healthcare institutions, the latter will still have a crucial role to play. As mentioned earlier, they will adopt new roles focusing on disease prevention, acute care and surgical needs.

Point-of-care (POC) is defined as "a site where medical care is received". Throughout the centuries it has shifted significantly, from the bedside of the ill to doctors' surgeries and hospitals. The past few decades and especially the past few years extended the POC concept outside the walls of healthcare establishments, and thanks to remote and telehealth services, it now includes patients themselves - wherever they are.

"The emerging sophistication of wearable devices that goes beyond vital signs will likely reduce visits to hospital clinics and save time spent travelling," Dr. Diana Anderson, the 'Dochitect', told The Medical Futurist. "This high-tech transition is challenging designers and architects to think about the future design of ambulatory centres and clinic space."

Designing healthcare facilities to function with the two components of the point-of-care in mind will be crucial for hospitals of the future. This will require the incorporation of novel design principles such as patient design. The latter involves factoring in patient input in designing hospital areas to enhance the patient experience as "end users" of healthcare institutions. The need to improve the work environment of healthcare professionals through hospital design will also be as important as patient design. These will help foster creativity as well as enable flexibility within the workspace.

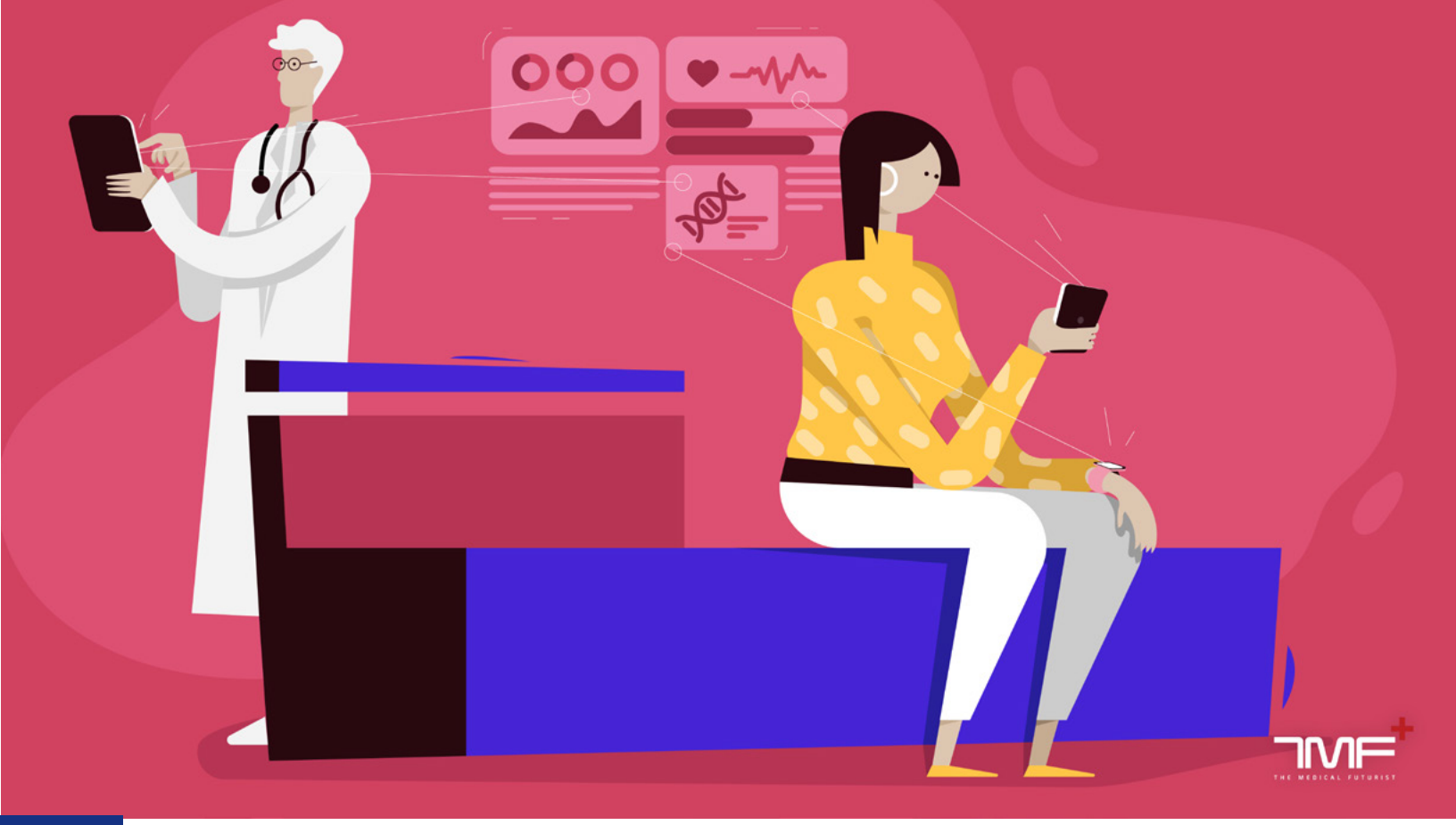
Regarding the shift of the point-of-care out of the boundaries of hospitals, this approach was initiated through emergency medicine, especially via ambulance services where first responders perform life-saving procedures where patients are. Now, these services are equipped with new technologies that further assist first responders such as telemedicine services and portable diagnostic devices.

Handheld ultrasounds like the Clarius and Philips Lumify enable fast assessment of critically ill patients. Abbott's i-STAT blood analyser allows caregivers to evaluate the patient's blood sample on the spot and wirelessly transmit the results to colleagues. Another handheld device is the FDA-approved Viatom CheckMe Pro. It measures a number of vital signs from ECG through blood oxygen level to body temperature.

Beyond ambulatory services, patients themselves can adopt wearables and personal health sensors to make more informed decisions about their health. With a device like the Apple Watch, they can monitor their cardiac activity and even be notified of suspicious signs. The inconspicuous FDA-cleared BioSticker smartpatch can continuously keep track of one's vitals from respiratory rate through sleep status to gait. With the metrics collected, patients can analyse them and share them with their physicians remotely for further evaluation. A number of such personal health sensors are now on the market that can measure one's health parameters from head to toe.

Fuelling the adoption of such personal health sensors are Big Tech companies that are staking a claim in the healthcare industry. Amazon, IBM and Microsoft are some of the many tech companies that are having a rising interest in the multi-billion digital health market. Many will target customers with tailored offerings as a means to gain their trust, but alongside these moves comes security and privacy concerns. Tech Giants have earned a notorious reputation when handling private data and these concerns are heightened when it comes to healthcare.

As such, new roles need to be adopted in the digital health era by each stakeholder in healthcare. Patients and their physicians need to communicate about effective devices and software that are recommended for the patients' condition and how to make sense of the data collected. For their part, policymakers should ensure the setup of regulatory frameworks for secure storage and transparent handling of sensitive data. Such a new paradigm will be required for an effective shift of the new point-of-care concept.



2 ELEMENTS OF HOSPITAL DESIGN

Monochrome, narrow corridors; windowless spaces devoid of plants; sterile patient rooms reminiscent of places of confinement; closed doors of the inaccessible doctor's office: these familiar scenes in hospital design around the world mirror the traditional, hierarchical aspect of healthcare.

In addition, they blatantly lack elements that could facilitate the adoption of digital health approaches. Conversely, adopting these new elements would truly benefit hospitals as a few early adopters exemplify and nothing is stopping them from doing so now. This chapter will cover the design elements that will become essential for future-ready hospitals.

An increasingly important approach to designing future hospitals is that of patient design. This element integrates patients' input in the early stages of designing these facilities. Given that patients are the recipient of healthcare services, it only makes sense to heed to their insights regarding areas that are in need of improvements.

The Oral and Maxillofacial Surgery Department of Radboud University Medical Centre Nijmegen in the Netherlands demonstrates a brilliant example of the importance of patient design. Based on patients' suggestions, the rooms of an entire department of the institution were redesigned.

The head of the department, Prof. Stefaan Bergé, told The Medical Futurist that patients asked for the simplest things: to have more privacy, more information and more games for children in the waiting rooms. This involved simple yet important changes that enabled a more balanced patient-doctor relationship and a friendlier atmosphere.

For example, patients suggested brightly lit rooms with friendly colours. They also favoured round tables over square ones as these enable more friendly conversations, while discussing their ailment with the doctor and viewing documents together through a projector. Also aiding towards a more balanced patient-doctor relationship is the inclusion of a "blue-line" on the floor. The latter subtly indicates the "boundaries of the clinic" that patients cross whenever an examination is necessary.

The healthcare design consultancy fuelfor also advocates for better healthcare experiences through improved hospital designs. They share insights and design concepts for a range of healthcare areas from family-centric chemotherapy care spaces to patient-centric dialysis seating systems offering better personal space. Their concepts from the Ambient Experience have also been adapted in practice in three children's hospitals in Stockholm, Adelaide, and Orlando. By integrating special lights, decorations and playful tools like the GloBuddys that assist in distraction and dissipating fear, paediatric patients are calmer and physicians can work in a more effective manner.

In addition to designing around patients' needs, hospitals should also cater to the medical staff's wellbeing. As Dr. Bergé put it: the most brilliant ideas are usually not born in research meetings, but in coffee corners. To that end, he mentioned that during the design phase, leaders of his medical department should not spare money and effort to build a great social room for the department. The social space enables colleagues to play billiards, drink coffee and casually chat so as to relax after or during a stressful workday.

Dr. Anderson also told us that she hopes to see "more end-user input" in healthcare design practices as they incorporate a more interdisciplinary approach. She also encourages the integration of the element of 'flexible design', which she calls as "one of the main innovations to perpetuate".

Designing flexible spaces allows for conversion to 'pandemic mode', or any emergency scenario experiencing high influx of patients, so as to rethink patient flows within treatment facilities. Such spaces can include the likes of external entry foyers that double as external triage areas when needed or dual hospital entry points and waiting rooms to separate infectious and non-infectious patients.

An example of flexible design in practice is the emergency department of Rush University Medical Center in Chicago, which opened in 2012 and could adapt to the COVID-19 pandemic nearly a decade later. Ventilation in patient rooms is isolated thanks to glass doors. These also enable medical staff to observe patients while reducing the risk of cross-contamination. Moreover, the building's lobby itself can accommodate extra beds as it is already equipped with electrical and medical gas outlets. Virtually any room in hospitals could incorporate such flexible spaces, whether it's a conference room or office to support the extra load of patients when needed.

Beyond designing spaces within hospitals, future hospitals should also take into account the other component of the point-of-care. Healthcare will still be accessed outside of the confines of the hospital. One way this is already enabled is through telemedicine, which saw a surge in adoption during the pandemic. A McKinsey report further estimates that 25% of outpatient services could be conducted through such modalities in the future. This practice can reduce the number of unnecessary visits and enhance the patient experience through convenient remote consultations at home.

However, clinical spaces have consistently been built for inpatient treatment while the inherent design choices might not always translate favourably for remote care purposes. As such, these spaces need rethinking to integrate virtual consultations and remote care as these are becoming more commonplace. Hospitals can even accommodate dedicated rooms designed specifically for such ends. "These will include user-friendly sound and lighting control, with dual screens to simultaneously converse with the patient and access to their medical records," Dr. Diana Anderson told The Medical Futurist.

The consultancy firm Stantec even forecasts a near future where, just like first aid kits are ubiquitous in homes today, a technology kit for remote diagnosis and monitoring will be present in every house. The design of future hospitals should take such concepts into account and having hospital spaces dedicated for remote care is a promising way forward.

With the advent of the Internet of Medical Things, which involves a connected infrastructure of medical devices, software applications, health systems, and services, care can be effectively taken beyond the hospital walls; because some patients simply don't need hospitalisation but rather monitoring. From these stems the concept of 'virtual wards'. The latter are solutions that support patients with remote monitoring and treatment in their own homes through digital, remote monitoring health tools that relay real-time data to the hospital.

Through real-time monitoring and two-way communication, patients can contact medical professionals and the latter can intervene promptly in case of signs of deterioration. In this model, a visiting nurse will perform procedures that require trained professionals such as wound dressings and intravenous therapies.

This concept has already been piloted in countries like the U.K, U.S, Singapore and Australia. The University Hospitals of Leicester NHS Trust is already working on a 120 virtual-bed monitoring ward for patients with atrial fibrillation. The latter will be equipped with personal cardiac monitors and the corresponding data is collected via a dedicated app which allows doctors to assess their condition remotely.

As such approaches become more commonplace, hospitals must be equipped and designed to adequately support and handle them. And this can be achieved by integrating the design elements highlighted here. Also, driving those elements are certain technological trends which we will look at in the next chapter and these should also be accounted for while designing future hospitals.

3 TECHNOLOGICAL TRENDS THAT WILL HEAVILY IMPACT HOSPITALS' FUTURE

In most contemporary hospitals, the technological trends that are prevalent within the institutions tend to consolidate the traditional healthcare model of having an ivory tower of knowledge and skills accessible only to medical professionals. Taking vital sign readings with standard tools from blood pressure cuffs to thermometers is performed within these institutions by healthcare practitioners and it requires patients to be physically present.

For more in-depth analyses, clinical grade equipment, often bulky in design, is found in specialised departments that patients need to get referred to. This equipment collects patient data, which is stored on the hospital's electronic medical record system. Such personal health information is all too often inaccessible by patients themselves once they leave the facility, which would otherwise be helpful for self-monitoring purposes or to seek a second opinion.

In the digital health age however, novel and emerging technological trends will re-shape how hospitals operate. From artificial intelligence (A.I.) systems assisting in clinical decision-making to robot deliveries of medical supplies, the digital health field is bustling with such disruptive technologies.

However, some technologies will be more pertinent in the future of hospitals as they will require adequate infrastructure around which hospitals can be designed and built. This chapter will contemplate those relevant technologies with the greatest potentials to positively upend hospitals of the future.

VOICE-TO-TEXT TECHNOLOGY

Currently, hospitals rely heavily on electronic health record (EHR) systems. But conversely, the tool might be impeding physicians from working more efficiently. A survey found that half of the physicians' average workdays are spent entering data into EHRs and conducting clerical work, while just 27% is spent with actual patients. In another survey, 37% of American physicians identified EHRs as their number one challenge.

A promising technology that can improve EHRs is voice-to-text technology. The principle is akin to a Google Assistant or Siri vocal search where the system can listen in on patient-doctor visits and transcribes the conversation without the need for physical input.

Some companies are already leveraging the technology in combination with A.I. approaches. Augmedix's Notebuilder software uses speech recognition and natural language processing to extract clinical data from doctor-patient conversations. This is used to generate comprehensive medical notes, which are transferred to the patient's electronic health record.

Other companies like Nuance and 3M also offer voice recognition services that create clinical notes that integrate into EHRs.

With such tools, physicians can spend less time typing in EHRs and spend more time providing medical attention to their patients.

RIDE-HAILING SERVICES

While it might not sound obvious at first, ride-hailing services like Uber and Lyft have their role to play in healthcare. Such services, especially through non-emergency medical transportation (NEMT), can address the transportation barriers which represent a leading cause of gaps in access to healthcare.

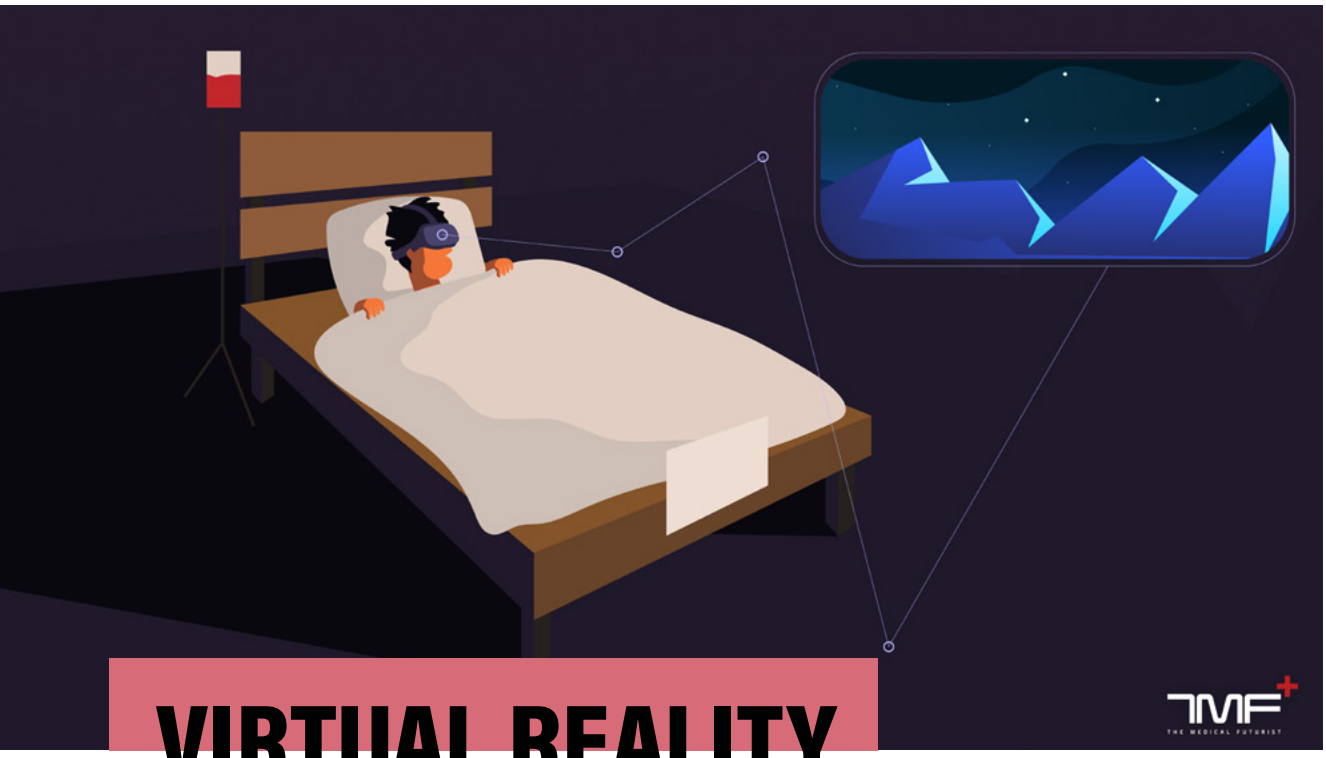
"Each year, around 3.6 million patients miss at least one medical appointment due to lack of access to transportation," John Lewis, former CRO of the NEMT service Circulation (now part of Modivcare), told The Medical Futurist. This can lead to no-shows or missed appointments, and potentially worsen one's ailment. Ride-hailing services can bridge this gap by making transportation to and from

healthcare centres accessible to patients.

“We have had an extremely positive response. Patients appreciate the dramatic improvement in patient access, and respond favourably to the fact that we are bringing the modern conveniences they expect in everyday life to healthcare,” added John Lewis.

Major ride-hailing companies like Uber and Lyft have expanded to provide NEMT rides, and healthcare organisations are quick to adopt them. In the U.S., more than 100 such institutions ranging from physical therapy centres to clinics are using Uber Health services.

With such big players as well as startups like Modivcare and Ride Health addressing the transportation issue in healthcare with a disruptive approach, managers of healthcare institutions have to accommodate for these services or even integrate them in the healthcare experience.



VIRTUAL REALITY

New realities will be part of hospitals in the future; in particular, virtual reality (VR). Traditionally accessed through a headset with an embedded screen that blocks the external environment, VR immerses the user in a virtual environment with which they can interact. While VR has been associated with gaming, the applications of VR in healthcare range from training surgeons to offering a drug-free pain-relief solution.

Companies like Osso VR and ImmersiveTouch offer virtual reality solutions to train surgeons and/or to hone their skills; and these have been proven to be better than traditional training methods. Studies have shown that VR-trained surgeons can experience up to 230% boost in their overall performance compared to their traditionally-trained counterparts. They can also perform surgical procedures faster and more accurately.

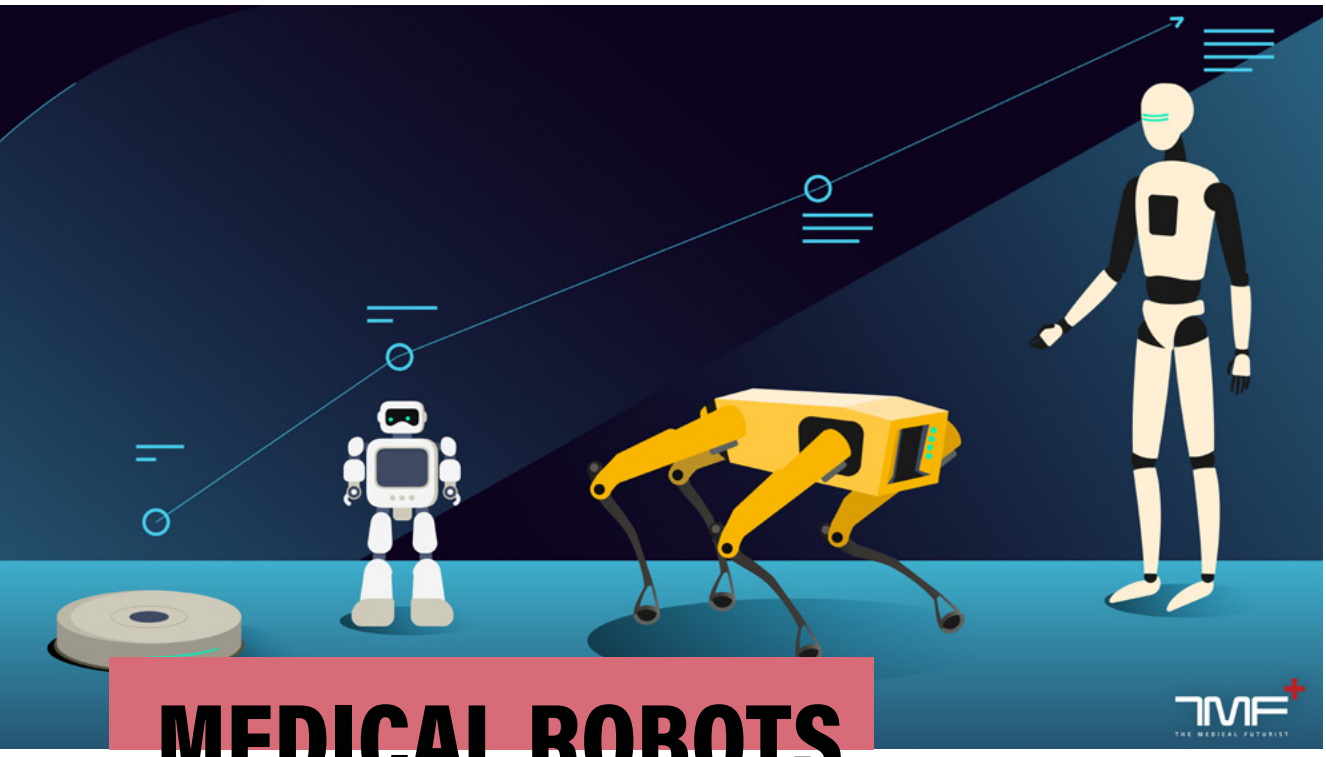
And surgeons are also seemingly prone to adopt such training platforms. "We're consistently training over 3,000 healthcare professionals per month, with many users spending hours on our platform," Dr. Justin Barad, CEO And Co-Founder Of Osso VR told us. Through such practice, some surgeons have also been able to significantly cut down on the time they take to perform procedures like hip replacement.

VR can also be an effective tool to distract patients from painful stimuli and presents as a drug-free alternative. Studies have found statistically significant reduction in pain among women who used VR during labour. Other studies have found VR's potential to reduce pain and anxiety among patients undergoing surgery.

"Imagine allowing a terminally sick patient bound to a hospice bed to swim with dolphins, revisit their favorite spot or tick off on their bucket list a place they have always dreamed to visit," Martin Holecko, from VR start-up Vrgineers, told The Medical Futurist while envisioning the potentials of the technology in healthcare. "The VR experiences bring patients moments of joy, taking their mind away from their condition and even reducing physical pain and give something to look forward to."

A step to integrate the technology in healthcare won't just involve having the required hardware available but also the associated software. For this purpose, so-called "VR therapists" and "VR planners" can become part of the workforce to design effective VR software to incorporate targeted elements for patient groups or help surgeons in upcoming interventions.

Thus, it will be equally important for hospitals of the future to equip themselves with the adequate VR hardware as well as have the ability to develop or at least provide the adequate software for different use cases in healthcare.



MEDICAL ROBOTS

Hospitals of the future will incorporate new members among the medical staff: medical robots. These new recruits can provide support, assistance and even extension to the service that healthcare workers are already offering. In the case of repetitive and monotonous tasks, medical robots might even obtain the capacity to completely replace humans.

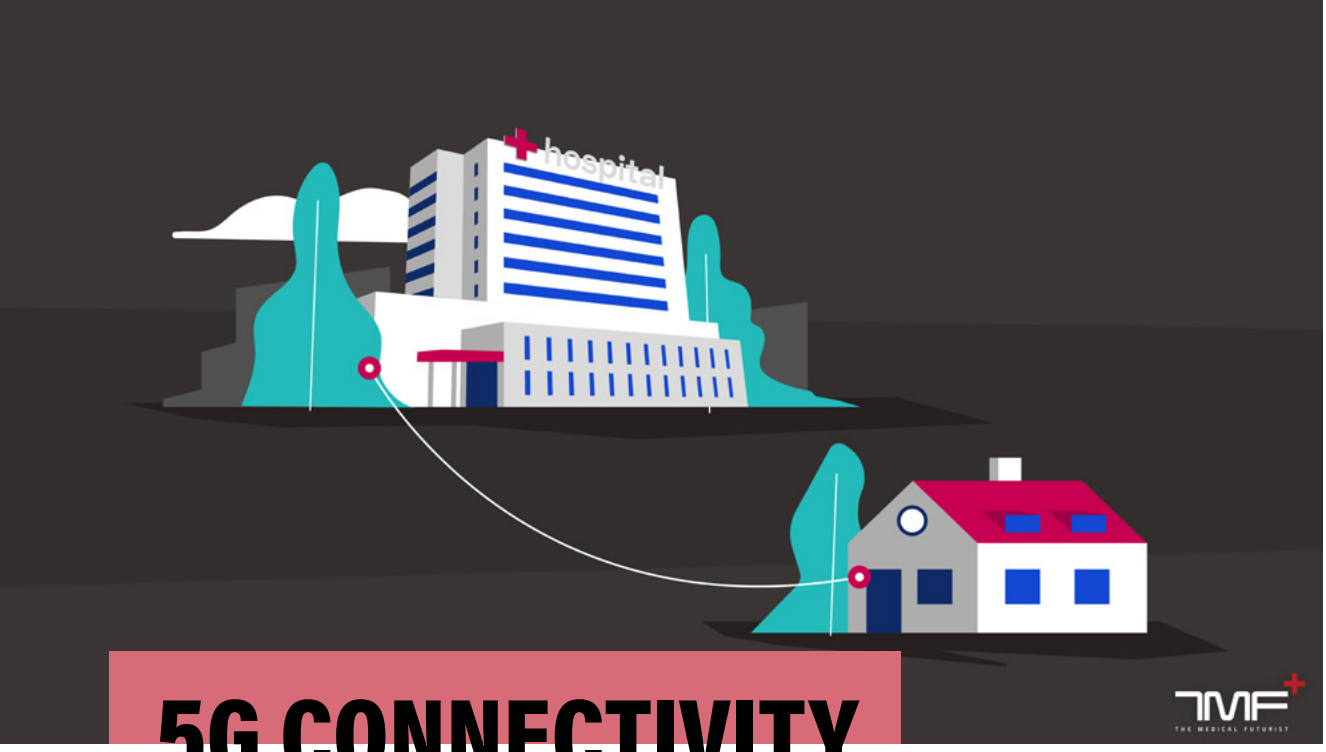
However, there will still be aspects to medicine that medical robots can't replace like creative thinking. Nevertheless, we will have to prepare for their increasing presence in the healthcare setting. The importance of integrating robots in the medical workforce was highlighted during the COVID-19 pandemic, indicating that they are set to stay integrated.

Consider the "social robot" Pepper. It was "employed" in a Czech and Belgian hospital during the pandemic to greet visitors and remind them to adhere to social distancing measures. In the face of such a public health crisis, such robotic assistants can free up the task of welcoming visitors so that the human staff can focus on other creative tasks.

Another repetitive task that robots could handle is that of disinfecting hospital rooms. More specifically, coupling disinfectant robots with UV-C can disinfect hospital spaces more efficiently and quickly than humans can. For example, the disinfectant robot Violet can completely disinfect a CT scanner room in 15 minutes, while this procedure would take a human radiographer up to 60 minutes. Danish company UVD Robots shipped hundreds of its disinfectant robots around the world during the pandemic; and we can expect to see more such assistants roaming the corridors of hospitals to ensure sanitised spaces.

Being impervious to the constraints of human anatomy, robots are also well adapted to handle manual tasks. This can help avoid related injuries and lighten the burden on medical staff so they can spend more time with patients or assist in nursing. One such robot is the TUG from Aethon. It can carry a number of racks, carts or bins up to 453 kilograms in the form of medications, laboratory specimens or other sensitive materials. Six TUG robots are actively delivering linens and medicine across the MedStar Washington Hospital Center in Washington, D.C. Another delivery robot, the Savioke Relay, has been delivering blood samples in Hutchinson Health, Minnesota between the main hospital lab and its onsite clinics since 2018.

Robotic deliveries aren't just tied to deliveries within hospitals but can also take to the air in the form of medical drones. Such airborne medical goods deliveries have been conducted on a regular basis in countries like Rwanda and Ghana, in partnership with drone firm Zipline. The company expanded its aerial deliveries to the U.S. following COVID-19 needs.



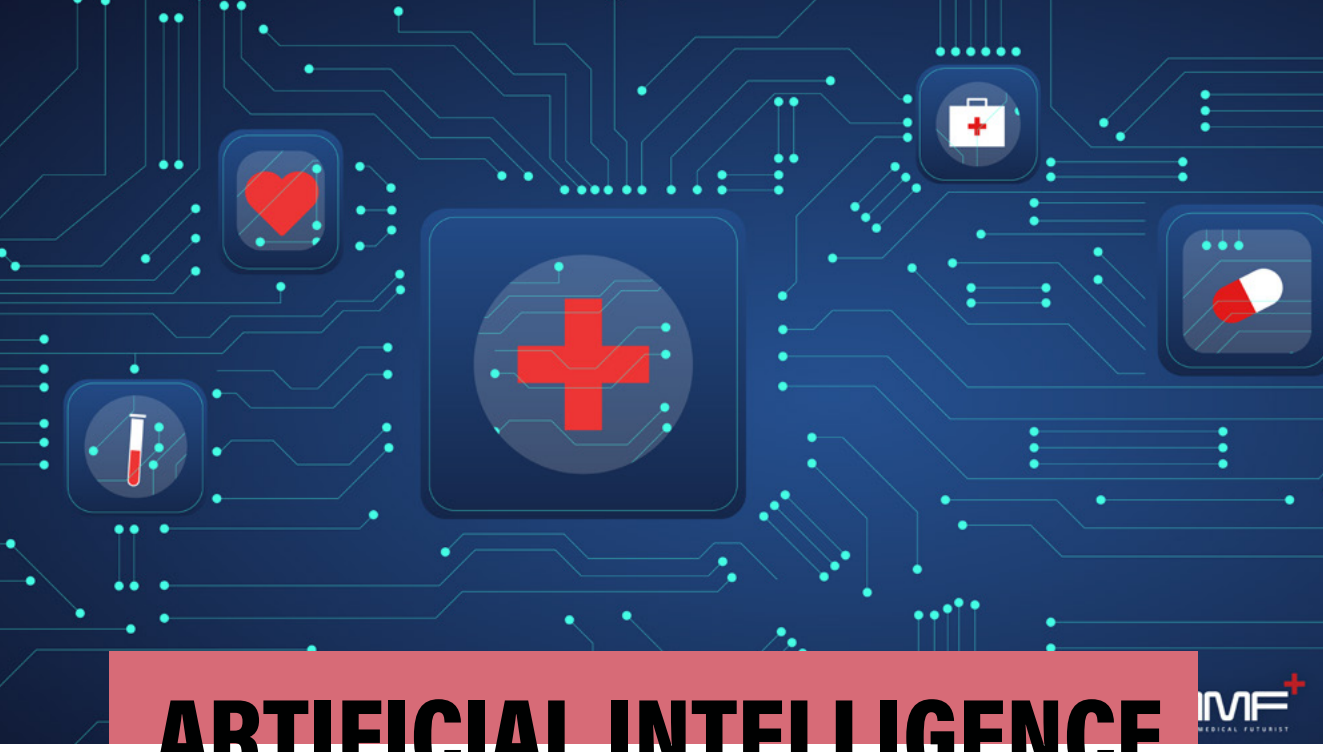
5G CONNECTIVITY

The telecommunication industry's latest darling, 5G networks, will have a crucial role in the future of healthcare. With its high bandwidth and low latency, the 5th generation mobile network allows for reliably fast data download at speeds over 1 gigabit per second (1gb/s); or at least 10 to 100 times faster than 4G connectivity.

As such, 5G will enable reliable infrastructures to be built to support the stable interplay of health sensors and smart software essential to the Internet of Medical Things discussed in the previous chapter. This could enable, for example, the smooth operation of telemedical consultations or even remote surgeries to take place.

The latter use case has even already been shown to work. In late 2021, experts at the Beijing Tiantan Hospital in China performed deep brain stimulation on a Parkinson's disease patient who was some 200 kilometres away. The procedure was performed with the assistance of the 5G-powered Remebot medical robot while human specialists remotely controlled the operation and observed the patient's vitals in real-time. Such an approach could enable experts to be accessible in resource-poor areas as well as locations without access to specialists required for delicate procedures.

As such, healthcare institutions will have to effectively leverage 5G's potential in the digital health age. Already, more than three-quarters of health tech executives are very or somewhat likely to adopt the technology for telemedicine and remote monitoring purposes. Some hospitals like Siriraj Hospital of Mahidol University in Thailand are being built to support 5G-enabled tech. The FDA for its part is also issuing guidelines for 5G healthcare systems to prepare institutions to transition to the technology.



ARTIFICIAL INTELLIGENCE

We've talked - and continue talking - extensively about what A.I can do and cannot do in healthcare at The Medical Futurist; and there's no denying that A.I. will have a significant role in the future of the field whether it's for assisting in clinical decision-making or organising logistics. The potential of A.I. in healthcare is attracting massive investments and increasing life science research; and hospitals have to leverage these potentials as well.

One such potential lies in the technology's ability to drastically reduce alarm fatigue. This phenomenon refers to the point when caregivers become desensitised to alarm signs from the myriad of devices emitting a cacophony of beeps all day in the clinical setting. But being desensitised to this sheer amount of signals, most of which being potentially false, leads to the risk of overlooking alarms that actually require medical attention. An A.I.-based system could address this issue. Researchers developed an A.I. tool to reduce notifications received by caregivers by up to 99.3%. As the authors noted, "nearly all studies assume that a reduction in the number of total alarms and/or false alarms will reduce alarm fatigue".

The technology can also be applied to detect signs of fever in visitors, like Tampa General Hospital in Florida in collaboration with Care.ai did during the pandemic to screen for potential COVID-19 cases. In other screening scenarios, A.I.-based chatbots can be used to triage patients remotely without the need to overload the emergency department with non-acute cases.

In fact, A.I. offers a plethora of assistance in the diagnostic process. It can help in

the identification of conditions like ADHD, sleep disorders and quantify coronary artery calcification. Patients can expect such tools to be prevalent as doctors' assistant in the hospital of the future, where an A.I. tool scans through their medical record and radiological imaging to identify any potential suspicious signs while physicians perform physical examinations. The A.I.'s recommendations can then be interpreted by the physician to determine the proper medical journey tailored for the patient.

Another application of A.I. in healthcare is resource allocation. Qventus developed a software programme aimed to help hospital administrators during the COVID-19 pandemic. Their model takes into consideration the patient influx from COVID-19 and the related deaths, and forecasts its effects on the hospital's capacity like beds, ICU and ventilator capacity.

These are only some of the vast number of potential applications of A.I. in healthcare and we have a whole e-book dedicated to the topic. But it's safe to say that the technology will become integral to healthcare systems and hospitals should accommodate them, whether it's through cloud computing infrastructure or educating staff on its effective use.

4 THE ROLE OF NURSES AND PHYSICIANS IN HOSPITALS OF THE FUTURE

While the technological trends discussed in the previous section will precipitate new ways that hospitals will be designed and function, they will not make the core of hospital staff obsolete. Far from that, technological innovations can lift the burden off nurses and physicians of many monotonous and repetitive tasks. This can prove crucial in public health crises where time is of the essence and medical attention is in need on patients rather than administrative tasks.

Taking over soulless tasks such as in-house deliveries and disinfecting rooms from nurses is what medical robots are for. For instance, Moxie from Diligent Robotics is an autonomous robot that can pick up supplies from closets and deliver them to patients' rooms. The UV disinfection robot Xenex LightStrike Robot can disinfect a patient room as quickly as in 10 minutes and a surgical suit in 20 minutes.

In the future, nurses can even expect the delicate and often stressful task of blood draws to be handled by robots. Vitestro's A.I.-powered blood-drawing robot has already performed 1,500 automated blood draws on over 1,000 patients. The company is undertaking clinical studies for regulatory approval of its device, with the aim to make it market-ready by 2024 in the European Union. As such robots never get overworked, tired and can precisely locate veins, they can perform blood draws more efficiently. However, nurses will still be required to provide empathy and support to the patient throughout the process. This exemplifies how the role of nurses will change.

With the automation of such tasks, nurses will be able to use the valuable time freed up to focus on more important tasks such as attending to patients. In future hospitals, such tasks can take the form of the telehealth nursing care concept. This involves nurses around the world participating in telephone triage set-ups. Through such a service, nurses can monitor a patient's oxygen levels, heart rate, respiration, blood glucose and more. They can also instruct patients as to how to dress a wound or treat a minor burn remotely. We've discussed how hospitals should accommodate telemedicine spaces and this remote nursing care concept represents a perfect use case for these newly designed areas.

With more time on their hands, nurses will also be able to focus on patient education, aided by new technologies. In particular, 3D printed anatomical models can assist nurses in describing medical procedures to patients more clearly. As this approach offers better visualisation, communication around complex procedures is improved. Hospitals can thus consider investing in 3D printers for this purpose. But 3D printing isn't limited to anatomical models as they are useful for providing certain medical equipment such as personal protective equipment or spare parts for clinical devices, which proved crucial during the COVID-19 outbreak.

As technology handles repetitive tasks, it also enables patients to monitor their health parameters remotely. From food scanners through meditation headbands to ECG monitors, they will be able to constantly gather individual health data. And to help them navigate through this load of personalised health insights, physicians will need to serve as digital health guides for patients. Based on those individual data, physicians can create personalised lifestyle routines, diet and workout routines for their patients.

Already, training in the emerging field of lifestyle medicine is helping physicians, in particular general practitioners, adopt such a role and it can help redesign primary care. Dr. Réka Vernes, who specialised in this new field, described that "lifestyle medicine approaches medical care of chronic non-communicable diseases from a new dimension". She added, "we follow lifestyle health parameters to gain more information and other aspects of the patient; and this is where digital technology comes into the picture."

Dr. Vernes shared an instance where she had a patient who came to her office because his sleep app showed he had several awakenings during the night. This led to further tests that indicated he had sleep apnea. In another case, the alarm of a patient's heart rate monitor went off due to a very low heart rate. This initial sign later helped indicate that he needed a cardiac implantable electronic device. These examples demonstrate how physicians can take on the roles of guides to help make sense of health parameters collected by the personal health sensors of empowered patients who turn up at their office in person or remotely.

Indeed, in the future, doctors will still need to turn up to their hospitals but will increasingly deal with patients remotely and with their data. In fact, they can expect to provide remote care to significantly more patients than they do today as such a consultation modality will be as common as in-person visits. Like today, physicians will handle more data than patients themselves, but a much larger percentage of that data will come from patients themselves from their personal health sensors and wearables, while the data presently mostly comes from medical professionals obtaining data about patients at the POC.

Above all, for these tools to become commonplace, nurses and physicians need to adopt new roles in the hospitals of the future. This will involve understanding the technologies that their patients use and help them decipher the data collected for personalised insights. Technology won't replace their jobs but healthcare professionals will have to start understanding and embracing new technologies as part of their work for the best interest of their patients. With repetitive tasks handled by technology, medical professionals will be able to dedicate more time to patients and will have to deliver on what makes us human: paying attention, being empathetic and caring.

5 TECH GIANT'S IMPACT IN REDESIGNING HOSPITALS

Also adopting new roles in the digital health era are tech giants as they branch out in the healthcare field. Technology companies from Google to Apple are investing heavily in this sphere to reap a share of the profitable digital health industry.

However, financial incentives aren't the only reason for their steady march into healthcare. Recent years were rife with reports of big tech businesses mishandling sensitive data. Facebook's Cambridge Analytica scandal compromised over 87 million users' private information while Google's social media counterpart, Google+, had an undiscovered bug that exposed the personal data of nearly 500,000 users. As they scramble to rebuild their public image, tech giants find in healthcare a way to redeem themselves.

In the digital health age, they are rebuilding their image through healthcare with their unique edge: technology. As we elaborate in our e-book dedicated to the topic, Tech Giants in Healthcare, big tech companies are throwing their nets in

every direction to claim their stake in healthcare. This ranges from investing in partnerships with start-ups to teaming up with research institutions and developers to create new tools for patients and doctors and to developing health-related features on their own platforms.in partnerships with start-ups to teaming up with research institutions and developers to create new tools for patients and doctors and to developing health-related features on their own platforms.

In particular, they are forging into the healthcare market with a disruptive approach. Consider Amazon's moves to disrupt primary care and pharmaceutical services. It launched its telehealth programme, Amazon Care for its own workers in 2019, and expanded it to other employers in 2021. In 2022, the service further expanded to include in-person offerings for urgent and primary care where a provider can head to patients' home for follow-up care.

Despite its Amazon Care efforts, the tech giant planned to close the service by the end of 2022. The telehealth service was "not a complete enough offering for the large enterprise customers we have been targeting, and wasn't going to work long-term", according to Neil Lindsay, senior vice president of Amazon Health Services. But this does not halt Amazon's other digital health endeavours, as exemplified by its acquisition of hybrid primary care organisation One Medical.

In the pharmaceutical space, the company first obtained drug licences in 2017, acquired "online pharmacy" PillPack in 2018 and then went on to launch Amazon Pharmacy in 2020. The latter allows clients to order a "mix of generic and brand-name drugs", connect to a pharmacist online and it even integrates in most insurance plans in the U.S.

By covering both remote primary care and pharmaceutical services, Amazon's healthcare branch essentially operates as a virtual hospital; albeit relatively limited. But it might be a matter of time before the services available expand. And with its patients-first approach and hybrid offerings, Amazon might have an edge over traditional healthcare institutions.

As such, the latter could take insights into such an approach to also offer reliable healthcare services in a hybrid manner that enhances the patient experience with more options and better convenience. This is especially the case given that it's not only Amazon aggressively going after healthcare.

In 2021, the Wall Street Journal reported that Apple has been working on offering medical services that would be fully run by Apple with Apple-employed doctors working at Apple-owned clinics. The company has also been rolling out several healthcare-related services that leverage the Apple Watch as a point-of-care device. It received FDA clearance for the ECG function of the smartwatch and has been working steadily on validating its efficacy in a number of studies.

With its Health app, Apple is also aiming to bridge patients and doctors. It makes health data collected from a user's iPhone, Apple Watch and other apps easily accessible and allows patients to select specific data, such as sleep activity and heart rate, to share with their doctor for related insights. In addition, the Health app supports integration with some electronic medical record (EMR) systems in the U.S. Such developments indicate that Apple wants to be taken seriously in the healthcare field; more so given that the CEO, Tim Cook, even expects that Apple's greatest contribution to the world will be healthcare.

In the near future, physicians will have to be able to handle such data gathered to monitor patients and identify any potential warning signs; while further down the line, they should expect automated systems to crunch through such information to indicate whether their patients are on track with their health goals.

Such disruptive approaches can radically redesign hospitals of the future, which might increasingly adopt a hybrid approach to healthcare delivery. As patients will have this convenience offered by big tech companies, they will come to expect such options across the board and hospitals have to be up to the task.

Hospitals should present compelling offerings as Big Tech companies will likely focus on routine care rather than complex and expensive procedures, such as cancer treatment, in a bid to maximise their profits. This would leave such costly procedures up to traditional players in healthcare, which will be "robbed" of the financial base flowing through routine care.

While some companies are moving to disrupt the traditional delivery of healthcare, others are focusing on specific technologies that can overhaul healthcare practice from within. For instance, NVIDIA, the graphics processing unit (GPU) manufacturer, has a dedicated healthcare team that focuses its efforts on A.I. as it envisions a major role for the technology in the future of healthcare.

Kimberly Powell, VP of NVIDIA, shared the company's vision for that future with The Medical Futurist in a Patreon interview. "Hospitals will use A.I. cameras to automatically screen for elevated body temperature, use genomics sequencing to predict how lethal a virus or suspected condition could be for each patient, use A.I. in medical imaging for detection and predicting clinical outcomes, incorporate A.I. into everyday cameras and microphones to monitor and interact with patients," Powell said.

To back this vision, the company has been steadily working on developing relevant A.I. tools. For over a decade, NVIDIA has partnered with the medical devices ecosystem to bring innovative diagnostic imaging, robotic surgery and patient monitoring devices to the market. They previously launched the Clara A.I. platform to support medical imaging and genomics as well as the Clara AI toolkit to assist radiologists in image classification.

They've also partnered with institutions to further fuel research in the medical A.I. sector. In 2020, NVIDIA announced its plans to create an A.I. centre of excellence in Cambridge, which will house the U.K's most powerful supercomputer. They plan to turn the area into a hub where researchers and startups can collaborate in the long-run.

Another tech giant that has its focus on medical A.I. is IBM. With its Watson Health arm, the company has been deploying A.I. solutions in healthcare whether it's to assist providers in decision-making or aid in the efficient delivery of evidence-based care. The company has also been supporting further development in the medical A.I. field through research. In 2021, the company's researchers trained an algorithm that could predict with 75% accuracy who among elderly patients could develop Alzheimer's based on writing patterns.

However, reports have suggested that IBM has been refocusing its efforts away from A.I. - going as far as selling assets from its Watson Health branch - and towards quantum computing in healthcare. The Cleveland Clinic and IBM announced a decade-long partnership in 2021 to harness the technology with the aim to discover new strategies to cope with public health crises like COVID-19.

Even through such partnerships, tech companies can leave their imprint on the designof hospitals of the future, with A.I. and quantum computing for the case of NVIDIA and IBM. With their resources, user base and disruptive moves, tech giants can bring ample novelties - as well as take away established processes - from healthcare institutions. As such, when contemplating the future of hospitals, it also becomes crucial to factor in their moves or even consider potential partnerships that could enhance the healthcare service.

6 FACTORING IN CYBERSECURITY AND PRIVACY

Given healthcare's inevitable shift to adopting digital approaches, this signifies that more and more sensitive patient data will be stored digitally. In addition, technologies such as artificial intelligence will constantly manipulate patient data in order to determine the best outcome for treatments or resource allocation. Elsewhere, partnerships between healthcare institutions and Big Tech companies will also raise eyebrows among the public and regulators. Combined, these will fuel privacy concerns; and rightfully so. And to address these concerns, proper safeguarding protocols and approaches have to be put in place.

We've discussed how the COVID-19 pandemic precipitated the adoption of remote care technologies and virtual care programs. However, not all of these virtual services have been optimised for care delivery, the Emergency Care Research Institute (ECRI) said in a report; making them prone to attacks by malicious third parties. The non-profit, which focuses on safe, effective, and efficient care, even listed cyberattacks as the major health technology hazards for 2022.

Considering recent cyberattacks, it is no wonder that these top the list of hazards. Global technology company Acronis noted that there was a rise in ransomware cases at the start of the COVID-19 outbreak. A ransomware attack in mid-2020 on cloud computing vendor Blackbaud compromised sensitive data of over 10 million patients, including health details and social security numbers. In 2021, some healthcare providers in the U.S. were even forced to cancel crucial services such as surgeries and radiology exams due to disabled systems or networks following cyberattacks.

While such attacks often take place with the help of malicious software, cybercriminals also exploit digital systems through 'social engineering' methods. These involve exploiting human psychology rather than focusing solely on digital systems. An example could be to call the IT staff and convince them into thinking that the caller is a clinician who forgot their password and to make them provide new credentials to access the hospital's system. One might not think themselves of being vulnerable to such seemingly simple deceptive tactics, but they can be more common than we might think. In a simulated phishing attack by security company Rapid7, 45 CEOs, or 75% of the total group in attendance, fell for at least one phishing campaign.

The famous hacker Kevin Mitnick, who popularised the term social engineering, even terms humans as "the weakest link in any security system"; and this warrants the need to reinforce these links. While tens of billions are spent on cybersecurity software globally, a fraction of that could be used to educate and train staff to identify and counter social engineering attacks. This could include frequent simulations to increase awareness of such attacks, familiarise staff with one another to identify impersonation attempts and raise red flags about suspicious activities. Hospitals should increasingly adopt such training practices if they want to reinforce the integrity of their digital systems.

The social aspect is one part of the equation, with the other part residing in the technical aspect. The latter requires investing in adequate tools to counter hacks. Istvan Lam, Founder and CEO of Hungarian data privacy company Tresorit, emphasised this when talking to The Medical Futurist. "Two things are key in prevention," Lam explained. "First, healthcare institutions and organisations should use anti-virus software with anti-ransomware protection to protect themselves. Second, it is crucial for everyone to update operating systems and software applications."

The latter advice might sound obvious, but outdated software was behind the leading cause of the infamous WannaCry cyberattack on 61 NHS institutions in 2017. The ransomware led to the digital systems of healthcare institutions being inaccessible until a ransom was paid. This resulted in the cancellation of operations and clinical appointments, loss of internet connection in hospitals and diverted patients from emergency departments even one week after the incident. While it is one of the most high-profile cyber attacks in healthcare in recent years, it raises the need for ensuring secured digital systems.

In addition to ensuring secured systems, other privacy concerns will arise when tech companies and the tools they deploy increasingly handle patient data. This is particularly relevant when A.I. tools come into the picture. These tools are often developed by third-party companies which license their software for clinical use. The developers mostly employ centralised training methods where the A.I.'s developers collect data from patients' health records and sensors and feed them to the algorithm. The way that these companies handle the data might not be transparent.

The collaboration between Google's DeepMind A.I. unit and the Royal Free London NHS Trust illustrates such concerns. In 2017, an agreement between the two entities provided DeepMind access to patient data from the Trust in order to develop Streams, a kidney disease-monitoring app. This included details such as all admissions, discharge and transfer data, accident & emergency, pathology & radiology of some 1.6 million patients.

Following an investigation, the U.K.'s Information Commissioner's Office ruled that the record transfer from London's Royal Free hospital failed to comply with the Data Protection Act. The Trust was found to not properly inform patients that their data was being used for this purpose. It had to set up a legal basis for future data processing, complete a privacy impact assessment and commission an independent audit.

While the collaboration intended to deliver a promising medical product that could help prevent complications of a patient's condition, it came at the cost of the erosion of one's privacy. And even though health datasets are anonymised, researchers previously showed that these can be used to re-identify patients. Forfeiting one's privacy for the adoption of digital health tools is a constant

conundrum that stakeholders in healthcare have to face.

Hospitals will have to acknowledge such concerns and even promote alternative, privacy-first A.I. training methods. One such method that has been gaining attention for digital health use cases is federated learning (FL). In contrast to traditional centralised training techniques, FL involves training algorithms in a decentralised fashion with multiple participating institutions.

Started	Tech Giants	Healthcare Collaborator	What they do //// Status (Ongoing ●, Finished ●)	Country
2022	Amazon	Fred Hutchinson	*Developing cancer vaccines and recruiting patients for clinical trials*	USA
	Amazon (Web Services)	Tufts Medicine	*Digital health ecosystem*	USA
	Google	Northwell Health	*Administrative automation using A.I.*	USA
	Google (Verily)	Lumea	*Providing A.I. to Lumea's end-to end pathology platform*	USA
	Microsoft	Bethesda Health Care	*Cloud services to improve patient care*	Australia
	NVIDIA	SingHealth	*A.I. and software tools to be used in medical research*	Singapore
2021	Amazon (Web Services)	Houston Methodists	*Voice assist in hospitals*	USA
	Google	HCA Healthcare	*Providing tools for data analytics*	USA
	Google	HCA Healthcare	*Google Cloud's healthcare data products*	USA
	Google	Hackensack Meridian Health	*Deploying A.I. and Machine learning technologies in clinical settings*	USA
	Google (Verily)	Mayo Clinic	*Decision support for cardiology*	USA
	Google (Verily)	Highmark Health	*Cloud services*	USA
	IBM	Cleveland Clinic	*Providing computational power for research*	USA
2020	Amazon (Web Services)	Radboud University Medical Center	*Machine learning platform transferred to cloud*	Netherlands
	Google	Amwell	*Providing cloud platform for telehealth services*	USA
	Google	Highmark Health	*Providing cloud, analytics and A.I. technologies*	USA
	Google	Defense Innovation Unit	*A.I.-enabled digital pathology solutions for cancer research*	USA
	IBM	Groupe Santé CHC	*Digital healthcare app run on IBM cloud*	Belgium
	Microsoft	John Hopkins Medicine	*Cloud services*	USA
	Microsoft	Addenbrooke's Hospital in Cambridge	*Providing A.I. tool for cancer research*	USA
	NVIDIA	The University of Florida's academic health center	*Generating synthetic health records with AI..*	USA
	NVIDIA	The University of Florida's academic health center	*Training a neural network to process clinical records*	USA
	Samsung	Centene Corporation	*Virtual care for underserved communities*	USA
2019	Amazon (Web Services)	Pittsburgh Health Data Alliance	*Cancer diagnostics, precision medicine, voice-enabled technologies and medical imaging*	USA
	Google	Mayo Clinic	*Providing cloud, analytics and A.I. technologies*	USA
	Microsoft	UCLA Health	*Cloud services*	USA
	Microsoft	Jackson Laboratory	*Providing A.I. for cancer research*	USA
	Microsoft	Humana	*Cloud services, decision support AI and voice technologies*	USA
	Microsoft	Apollo Hospitals	*A.I.-powered Cardiovascular Disease Risk Score API*	India
2018	Apple	40 different hospitals	*Digital health records*	USA
	IBM	Apollo Hospitals	*Implementing Watson for Oncology and Watson for Genomics*	India
2016	Google (Deepmind)	Moorfields Eye Hospital NHS Foundation Trust	*Get retina scans from the hospital to develop A.I.*	UK

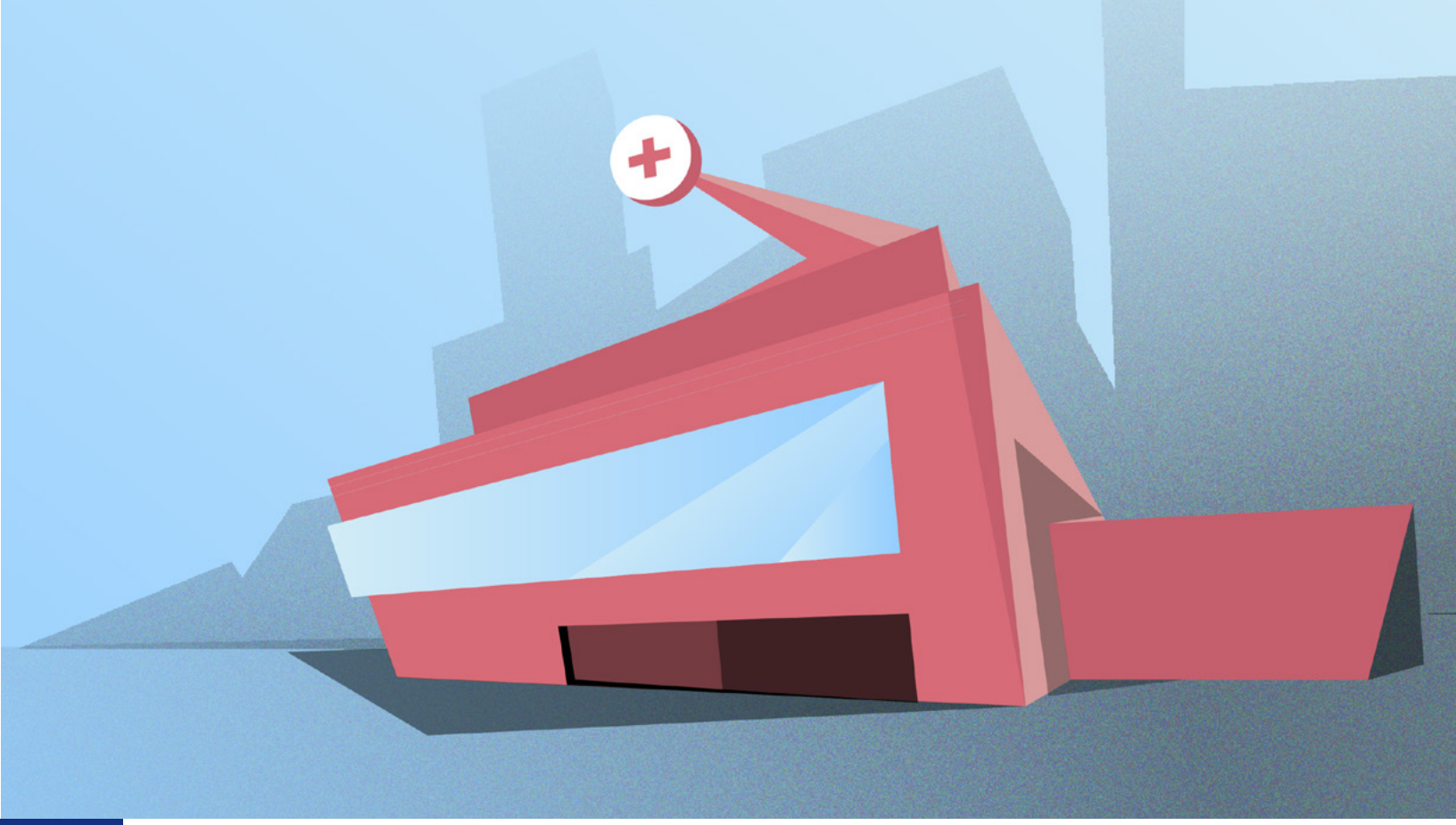
Each institution develops algorithms themselves in-house based on data that they possess locally such as from medical records. Subsequently, they each share these individually-trained algorithms, stripped of personal data, in order to build a single, larger algorithm. This process is repeated to develop high-quality A.I. tools without sharing patients' data outside of the hospital's systems. Studies have

shown that such a technique performs comparably to other centralised models to deliver quality and reliable performance.
FL thus offers a promising approach to address privacy and transparency issues when developing such software. With Big Tech also looking to partner with hospitals for their own healthcare endeavours, such a training method could enable patients to share their health data with more peace of mind. FL would ensure patients that their personal data will not leave the healthcare facility while enabling them to contribute to developing tools that can improve healthcare. Indeed, there is no effective A.I. without patient data to train them on, but adopting privacy-focused approaches like FL offers could foster a trusting relationship between patients, hospitals and developers.

On top of the challenges to maintaining privacy while promoting the adoption of digital health tools, healthcare facilities will also need to grapple with new health IT concerns. In June 2022, an investigation by The Markup revealed that the websites of 33 of the top 100 U.S. hospitals use a tracker tool that shares sensitive medical data to Facebook when patients use their online portal to schedule appointments. The tracker monitors the website users' behaviours such as the buttons clicked and the details used to fill forms. In some cases, details such as a patient's doctor's name, their appointment time and potential health condition were shared with Facebook.

Experts believe that the use of this tracking tool may be violating the U.S.'s medical privacy law, the Health Insurance Portability and Accountability Act (HIPAA). And following The Markup's findings, some hospitals removed the tracker from their website.

Thus, hospitals will need to adopt measures to properly safeguard their systems as well as the patients' data they store and manipulate. And if they wish to have their digital health approaches embraced by patients, they will need to ensure that their data are handled responsibly and transparently.



7 WHAT A HOSPITAL FROM THE FUTURE WILL LOOK LIKE?

In the words of acclaimed science fiction author William Gibson: "The future is already here — it's just not very evenly distributed." This same quote can very much be applied to the future of hospitals; as while much of the technologies and approaches that have been discussed at length in this e-book haven't been adopted en masse (yet), there are instances, however few and far apart, where they have been successfully implemented.

This indicates that the future of hospitals that they paint isn't tied to the realm of speculation but is just awaiting adoption. To conclude this e-book and condense everything that has been discussed within, we will describe what an ideal future hospital might - or even should - look like.

The hospital of the future will be purposefully designed, rather than built for purpose. With the shift towards remote care, these institutions will adopt the role of centres for disease prevention to attend to acute care patients and for patients

who need surgical procedures or scans from large radiology machines. Chronic care and cases that do not require immediate medical attention will be handled remotely through telemedicine consultations where vitals will be monitored by patients' wearables and personal health sensors that relay the collected data remotely for clinical insights. As such, major segments of future hospitals will incorporate areas designed to handle remote care.

To further support remote care, virtual wards will be set up, like the University Hospitals of Leicester NHS Trust is piloting, and will be offered as an option for patients. By connecting hospitals directly to patients' homes, healthcare practitioners can monitor how their patients' ailment is progressing. In non-emergency cases where patients require assistance, nurses can be dispatched to attend to their needs. And in cases where patients' health metrics indicate signs of deterioration, healthcare professionals monitoring them can schedule an in-person visit for further analyses or can even order an emergency medical ride, staffed and equipped, from the hospital's own ride-hailing service.

When patients will actually need to be physically present in a hospital, they will do so with less anxiety as they will consider these facilities as areas where they are valued and treated as equal-level partners in their care management. This view of hospitals by patients will be supported by the integration of elements of patient design like Professor Stefaan Bergé included in his department at Radboud University. This will enable healthcare institutions to be optimised for the patient experience and caregiver performance. Physicians will be able to provide compassionate care, listen empathically to their patients while an A.I. assistant handles the paperwork and transcription of the conversation to extract medical information for health records keeping.

The hospital's A.I. system will subsequently be able to organise the optimal patient pathway and the relevant logistics such as appointments and scheduled follow-ups. By adopting a Waze-like approach, it can determine where the queue is shorter and which test will take less time to perform for each patient.

This information will be relayed to the patient through their healthcare app, rather than paper-based reports that can be easily misplaced or peeked into. Indeed, future hospitals will go paperless in a bid to not only cut down on paper use but also to reinforce privacy over patient data. The Bedfordshire Hospital NHS Trust has been working with Xerox to make the paperless hospital a reality. With their

health records accessible remotely online and securely stored, patients can have further insights into their own health and can even use the data for second opinions.

As hospitals will focus on cases requiring prompt medical attention, they will also integrate digital health technologies to assist them in this function. They will be equipped with VR headsets to provide patients a drug-free alternative to pain reduction whether it's in acute cases, for managing post-operative pain or to assist in labour and delivery. Having such devices at hand will also enable hospitals to make use of various VR software that can not only assist patients but can also train surgeons in perfecting their craft.

These healthcare facilities will also integrate a dedicated 3D printing station. With these printers, healthcare professionals can print models for patient education or even 3D printed casts on demand. The latter have been popularised in Latvia through startup CastPrint's work. "You can go in any clinic or hospital in Latvia and ask the traumatologist about CastPrint, and they would've already used it, or at least know there is a viable alternative to the traditional plaster cast," said Janis Olins, one of CastPrint's founders.

A 3D printing station would also integrate 3D printers for medication production that can manufacture medicines based on specific doses or even combine drugs into a single pill for better adherence. In 2020 FabRx released M3DIMAKER, the first pharmaceutical 3D printer to manufacture personalised medication. It can print personalised medicine at a rate of about 28 pills/minute. This can assist in the efficient distribution of medicine to in-patient wards.

The optimal hygiene level of those wards for patients requiring acute medical attention will be maintained by robots. The latter will also be roaming the hospitals' corridors to transport medical supplies. With "staffers" like Moxie and Xenex LightStrike Robot handling manual tasks, nurses can dedicate more time to their patients and deliver an overall enhanced healthcare experience.

On the other hand, it is also important to contemplate aspects that will be obsolete in future hospitals, and these should ideally not be present in the healthcare experience in upcoming years. As EHRs handle patient records and provide access to these data online, the era of paperless hospitals will be ushered in and paper-based medical records will be a relic of the past.

Similarly, lab reports, radiological scans and vital signs will be recorded digitally in sharable formats, and not stored on physical hardware such as CDs. Such information will be analysed by A.I. assistants to determine the optimal patient pathway. This will assist in limiting waiting lists, queues and the related confusion during the healthcare experience.

Also with the assistance of A.I., alarm fatigue will be a thing of the past as will be repetitive, administrative tasks. However, A.I. won't replace the human medical staff altogether as the latter will be required for providing empathy, creative thinking and the general human touch.

The table below summarises what and what not to expect in the future hospital as elaborated in this chapter.

WHAT TO EXPECT IN FUTURE HOSPITALS

- Radiology machines
- In-patient care & beds for patients in serious conditions
- Acute & emergency care
- The ability to receive patients from ambulances
- A network of physicians from a range of specialties
- EMRs and printers
- In-patient care for patients on the prevention side of care
- Dedicated rooms for remote care consultations
- 3D printing stations
- Artificial intelligence supporting decision-making
- 5G connectivity
- Cloud computing

WHAT WILL NOT BE IN FUTURE HOSPITALS

- Medical records on paper
- A.I. directed doctors and nurses
- CDs and DVDs for downloading radiology files
- Confusion about where a patient should go next
- In-person waiting lists and queues
- Alarm fatigue
- Fax machines
- Pagers
- Hand-written notes

As such, hospitals of the future will not only change by the way they look, but also in the way they function and deliver care. This novel outlook on these healthcare institutions is not only fuelled by digital health technologies but also approaches that are pertinent in the digital health age and the empowered patient.

Hospital designers and managers, as well as clinicians and patients, need to get acquainted with the developments which are set to alter the traditional approach to care delivery. It is with this aim that we issued this e-book and we sincerely hope that you found it insightful.

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