

BUILDING THE HOSPITAL OF 2030

How mobile technology and IoT is shaping
the future healthcare experience for patients and caregivers.

EXECUTIVE SUMMARY

The hospital that you walk into in 2030 may look very different from the one you know today. With mobile technology now at the centre of how we obtain information, and the rise of connected devices that can detect vital medical information with no more than a touch, our ability to achieve a quick and precise diagnosis will be increased drastically. With the added ability to store, share and review patient information in the cloud, caregivers too will find that the ability to do their job becomes easier.

However the barriers to achieving a digitised health service are significant, and many. Regulations must be adhered to, patients consulted with, and with the addition of every connected device comes the risk of data security breach. These concerns must not be ignored, but neither can they be allowed to stand in the way of progress.

This report examines how technology is likely to transform healthcare over the next decade, looking at the changing nature of the patient experience, opportunities for clinicians and what the hospital of the future might be like. It is based on interviews with senior healthcare leaders, commissioned by Aruba, and in-depth views from two renowned experts, UCL Professor of Intensive Care Medicine Dr. Hugh Montgomery, and digital health futurist Maneesh Juneja.

These conclusions of these interviews delivered five key trends that Aruba believes will shape how the healthcare industry transforms between now and 2030. They are as follows:

- 1. Patient self-diagnosis:** Using app-based and wearable tools to monitor your health and even carry out your own scans, patients will finally have the ability to self-diagnose a wide number of conditions at home, without needing to visit a surgery or hospital.
- 2. The automated hospital:** Hospital check-in will feature imaging technology that can assess your heart rate, temperature and respiratory rate from the moment you walk in, followed by sensors that can perform a blood pressure and ECG test within 10 seconds, and lead to an automatic triage or even diagnosis right there and then.
- 3. Caregivers double their free time:** Doctors and nurses, who are currently spending up to 70% of their time on administrative work, will be able to quickly analyse scans or patient records via their mobile device, freeing up huge amounts of their day to focus on patient care.
- 4. Digital data repositories:** Devices will automatically integrate with your digital patient records, automatically updating on your condition and treatment, giving caregivers a richer, real-time, readily-accessible data to make more better decisions.

- 5. Acceptance of AI:** As artificial intelligence (AI) starts to play an increasing role in diagnosis and treatments, public support will grow to the extent that you will be willing to be diagnosed by machine – provided that services are designed and implemented around patients, the benefits are explained, and permission is sought.

INTRODUCTION

Across the world, healthcare systems face rising pressures on all sides, as costs grow, populations age and demands on their services increase.

Few disagree that changes are needed in the way healthcare is provided to ensure it remains affordable and accessible. “Healthcare costs are rising so fast in advanced economies that they will become unaffordable by mid-century without reforms,” a 2015 OECD report stated. It found that, among its member countries, the increase in healthcare costs had outpaced economic growth without exception over the previous two decades. Now healthcare expenditure within the OECD is set to rise as a proportion of GDP from an average of 6% in 2015 to 9% in 2030 and 14% in 2060.

Rising healthcare costs are the product of a range of factors, from drug prices to the reality of an ageing population and the prevalence of unhealthy habits. According to the UN, the global population of over-60s will grow by 56% between 2015 and 2030, and more than double in size by 2050. This has a direct impact on the cost of healthcare. In the UK, according to researchers at University College London and the University of Liverpool, the population of over-65s requiring nursing and social care will increase by 25% in the next seven years. An older population becomes rapidly more expensive for healthcare systems. According to a 2015 Institute for Fiscal Studies paper, “Average hospital spending for an 89 year old man is around three times higher than the average spending for a 70 year old, and almost nine times more than a 50 year old.”

For healthcare providers this is a perfect storm: as rising costs stretch their budgets, an ageing demographic increases their workload and a less healthy population requires greater, often more complex, intervention. The UK National Health Service’s own figures show that the number of hospital admissions “with procedures and interventions” increased by 56% between 2005/6 and 2015/6. Put simply more people are coming through hospital doors, requiring more of healthcare systems that are already stretched by budgetary limitations.

To remain sustainable amid these pressures, the way healthcare is provided must change. The existing systems are not set up to cope with the rising demand that is fast coming their way. The question is, what will that change look like, how can it be brought about and at what pace?

The single greatest factor in this change is likely to be technology; powered by the millions of connected devices that collectively make up the Internet of Things (IoT). By 2019, healthcare organisations expect 52% of the devices on networks will be IoT devices such as patient monitors and remote sensors on machinery. Such advances hold many of the answers to the challenges of cost, scale and delivery that are threatening to make today’s healthcare model unsustainable.

But what will that technology look like in practice, how much of an impact can it make and how quickly will we start to see its effects? What is more, can these changes be done securely? Through examining in turn the patient experience, the clinical opportunities and what the hospital of the future might look like, this report seeks to shed light on how far and fast technology can transform healthcare provision in the next decade.

I. Enabling and securing the patient experience

A patient becomes ill, is admitted to hospital and sent for tests. That has been, and remains, the norm in modern healthcare. Yet that could be changing, thanks to wearable technology and apps that have the potential to take much of the testing and monitoring burden away from hospitals and into the home.

The AliveCor Kardia, for example, allows a medical-grade ECG (scan of the heart's electrical activity, which can detect abnormalities in rhythm, blood flow and the first signs of a heart attack) to be taken simply through a sensor attached to the back of a phone, or a smartwatch, giving a read-out within 30 seconds that allows users both to track their own heart activity and to share that data with their doctor; potentially surfacing problems before the stage when people would typically have realised there was something wrong.

“Before this technology was invented, the hospital would either have to stick electrodes on your chest and run a test, or they'd ask you to wear a Holter monitor, which is quite big and bulky,” says Maneesh Juneja, a health futurist who describes the product as a “poster child” for digital, patient-directed healthcare.

Aruba's study found that 64% of healthcare organisations have begun to connect patient monitors to their network. Such technologies have the potential not only to improve efficiency of care in the hospital, but to significantly reduce future hospital visits, shifting the burden of diagnosis and monitoring away from healthcare providers, and allowing algorithms to provide the basic interventions and guidance that currently fall to human doctors.

“Let's say you are diagnosed with diabetes or high blood pressure in 10 years time,” says Maneesh Juneja. “Once you've been diagnosed, a lot of the monitoring of how you're taking your medication could be done without the healthcare system seeing you as frequently. They could track your data in real-time and know if you're deviating from your recommended diet or treatment plan, then send you a digital nudge on your smartwatch or augmented reality glasses.”

Above all, he says, the rise of wearable medical tools and self-diagnostic and monitoring apps can empower people around their healthcare. “It's about giving the patient a feeling of more control. The use of this technology and the integration of this technology is enabling that shift in culture from one of systems-centred care to person-centred care.”

Putting people back in the driving seat of their own health is not limited to how they monitor and treat conditions. It also relates to security of data, another area in which experts anticipate significant changes in the next decade. “A big question is who is going to hold your data,” says Dr. Hugh Montgomery, Professor of Intensive Care Medicine at University College London. “At the moment it's me, or at least it's my hospital. That may start changing in in that you might have access to, and even curate, your own data, and grant permissions to other doctors or nurses to see them or not. So it might be that you've decided that because you had a termination of pregnancy at 16, or you broke your wrist at 17, or had a mental health problem at 19, you're going to keep that off your records. There is an increasing move towards patient-curated and patient-owned data.”

As the number of devices and apps that collect medical data, and are potentially integrated with central medical records, increase, the question of who owns and controls this data is likely to become pressing. Maneesh Juneja believes that public attitudes will become more permissive as the benefits become clear. “If it means continuing to have universal healthcare, the shift in consumer attitudes will probably be they won’t mind sharing their data, they won’t mind being tracked all the time, they won’t mind visiting a hospital and having an initial consultation with an AI doctor, or a virtual nurse.”

The increased availability of patient information, shared by a growing number of connected devices, raises the significant risk of data security. According to Aruba’s 2017 global study, of those healthcare organisations that have adopted an Internet of Things strategy, 89% have experienced an IoT-related data breach. As the surface of the network extends from the hospital, to the home, to the patient themselves, so too do the potential sources for data to be lost or stolen, meaning far greater visibility is required into the people, places and things that are being connected, with the ability to create unique security rules for each.

The future of healthcare, from the patient perspective, is undoubtedly one in which people will have digital tools at their disposal to do many things that would once have required a hospital visit or the direct intervention of a doctor. It is also one in which information is likely to flow much more freely between the individual patient, their doctor, and any external providers of apps and devices that collect medically-relevant data. All of which holds significant potential to improve early-recognition of emerging problems, reduce patient errors in the adoption of treatment plans, and to lower the burden of visits on hospitals.

But to get there, serious questions have to be posed in areas from data security to the efficacy of self-diagnosis. And the healthcare sector must recognise that the challenges are not just around technology, but collective understanding and agreement of what these changes represent. “For any healthcare provider, patient engagement and experience has to be more than a marketing buzzword,” says Maneesh Juneja. “You have to include patients from the beginning and design new products or processes with them on board.”

The greatest power that technology will put into the hands of patients is going to be their permission, both individual and collective, for what healthcare in the future will look like.

ii) The clinical opportunity

While patients may play a more active role in the healthcare systems of a decade's time, that does not mean the importance of clinicians will decrease. Indeed the opportunity exists to harness technology to enhance the role of doctors, focusing it much more on expertise and caregiving, the jobs for which they ultimately train.

That might sound obvious, but studies suggest that many doctors are currently spending much more time on administrative work than medical. "In the surveys done in the UK 18 months ago, about 72% of a junior doctor's time was spent doing administrative tasks, ordering tests and chasing them up," says Hugh Montgomery. A study in the USA, led by the American Medical Association, found that doctors were spending only 27% of time seeing patients, against over 49% on paperwork.

"We need to start creating platforms that improve efficiency of communication between doctors and between departments, that document notes better and allow ordering of tests and visibility of results quicker," says Dr. Montgomery. He points to the administrative workload on doctors as something that not only limits the amount of time that can be spent attending to patients, but which is an active factor in doctors choosing to leave the medical profession.

In theory technology holds significant promise to reduce that workload, from automating processes to connecting up different sources of data and allowing doctors to direct testing and treatment from their smartphones. Aruba's 2017 study found that 41% of healthcare organisations have begun to connect imagine machines like X-rays, and 37% are connecting pumps or valves in an effort to centralise and streamline information that can prove vital to patient care.

But the healthcare systems of today are some way off fully-connected IoT environments. "The vision is where these devices are all connected and data is flowing seamlessly," says Maneesh Juneja, "but when you speak to someone in a European hospital, they will often say that they can't even get the computer systems between one hospital department and another linked, and a patient has to take their own MRI scan on a CD and transport it from one part of the hospital to the other."

More robust networks and more intelligent devices are what can move the vision of healthcare that runs on a seamless flow of data closer to everyday reality. Pumping technology is one area where this could happen in this near future, according to Dr. Montgomery. "Pretty much every company is beginning to talk about bringing out programmable pumps for delivery of drugs that could be controlled from a central computer or a smartphone," he says. "At the moment the electronic patient record can't see those drugs being delivered. You can manually update the computer, but the pump infusion rates aren't being accurately recorded. There's a big drive for pump technologies that can do that."

A significant, but less immediate, opportunity he points to is the development of pumps that cannot just monitor and report their own activity, but help determine it. "There is talk about using artificial intelligence and machine learning to monitor, for example, a patient's cardiovascular parameters, understand what those signals mean and adjust the drug and fluid doses accordingly." As he puts it: "There's the dumb-smart stuff and the smart-smart stuff. The dumb-smart stuff will be around

how do you communicate and access existing data better. And the next phase will be can the machines interrogate those data, and inform and guide treatment plans better as well?"

This greater role of artificial intelligence in frontline healthcare provision could have benefits beyond reducing the administrative workload on doctors. It could also help improve the accuracy of test results and the treatments that are determined as a result. "There's a lot of investment going into imaging analysis, automated analysis of scans and histopathology slide data," Dr. Montgomery says. "Humans aren't good at doing it, they make mistakes; they'll miss about a third of cancers on mammograms for instance, and there are also just far too many for them to do."

Accuracy of diagnosis and efficiency of delivery are two areas in which IoT, machine learning and AI can start to change how doctors work, lightening their workload and supporting their decisions with better, more immediate information and evidence. Machine learning also has a role to play in accelerating drug discovery and bringing new treatments to market in a radically reduced timeline. There are also experiments in how virtual reality can enhance areas from pain management to physical therapy and the training of doctors and nurses.

In the short-term the focus may be on how technology can create efficiencies that liberate clinicians from the administrative burden, but over the next decade the possibility for much more far-reaching change is clear. Surgical robots, for instance, are expected to play a rapidly increasing role in the operating theatres of the 2020s, with the market doubling in size from \$3bn in 2014 to \$6bn by 2020.

As more medical data is collected, and artificial intelligence (AI) plays an increasing role in diagnosis and treatments, public suspicions around autonomous care will be put to the test. A 2017 survey from PwC showed that 55% of consumers across EMEA are happy to engage with AI and robots in place of human doctors, revealing a significant gap in support between countries such as the UK and Germany (where only 39% and 41% respectively said they would be happy to do so) and regions like Turkey and South Africa, where 85% and 82% respectively said they would be.

Despite the clear need to address public perceptions, the fact is that technology has the potential to radically enhance how doctors diagnose, monitor and treat patients from the moment they enter the hospital door: improving the accuracy, speed and effectiveness of diagnosis and treatment. The hospitals of the future, therefore, may start to look and run very differently from those of today.

iii) The hospital of 2030

As the imprint of mobile, cloud and IoT advances, what will its impact be on how hospitals function? And how can more data-driven, digitally-operated hospitals deliver improved patient outcomes?

In the view of Maneesh Juneja, “we’ll see a shift to smaller hospitals and smaller facilities, because a lot of demand will be reduced in terms of prevention and monitoring. The facilities will be smaller and you’ve got the potential that, in rural areas you might not have a facility but a mobile autonomous surgical unit, or consultant facility.”

While healthcare may become increasingly home-based, and alternative models of centralised care may become possible, hospitals will remain integral for the foreseeable future. Which does not mean they will stay the same as they are today. The hospitals of 2030 are likely to be significantly more technologically-driven in a number of different ways.

“As you walk in we will be able to tell your respiratory rate, your heart rate, your oxygen saturations and your temperature from imaging,” says Hugh Montgomery, “and if you put your hand on a sensor, within 10 seconds your ECG (electrocardiogram) and blood pressure too. We might well be able to integrate those data, automatically triage you and potentially even make a diagnosis.” That contrasts starkly with today’s system of moving at the pace of clinical availability from reception to an initial assessment by a nurse, and if necessary examination by a doctor.

“I think in 10 years we’ll probably have automatic diagnoses from blood tests,” he also predicts. “From a drop of blood, within a few minutes you might be able to assay around 50,000 different proteins. That’s radical and in no way happens at the moment. I might get 30 variables, I certainly wouldn’t get 50,000. And that would require machine learning to be able to interrogate them. But it could potentially mean your diagnosis could be made very much more quickly.”

While imaging technology and radically enhanced diagnostic tools will enable triage and diagnosis to happen more rapidly, genuinely connected hospitals will ensure that this data does not sit in silos but is accessible by doctors when and where they need it to make treatment decisions, says Dr. Montgomery. “I certainly think you’re going to see the doctor using their smartphone in 10 years in a way that they just aren’t now.”

The patient of the future, therefore, if they even need to visit a hospital at all, will enter a place where technology plays a central role from the moment they step through the door, and an initial assessment is made, to diagnosis and treatment, whether that is a drug administered, monitored and adjusted by an intelligent device, or a surgery carried out robotically.

Technology has the ability to join up many of the elements that are too often disjointed today, giving doctors the information they need at their fingertips, and avoiding damaging breakdowns in communication or understanding. Above all, it can make the patient journey from assessment to diagnosis and treatment much quicker, potentially bringing down a cost of care that should already have been reduced due to patients being assessed and treated in the home.

If that is the potential, how quickly should we expect hospitals to move towards it, given the pitfalls inherent in integrating systems and new technologies, and handling greater flows of data? “I think we’re in for a massive transformation and disruption in the next 5-10 years for two reasons,” says Hugh Montgomery. “Firstly the technology’s changing that fast, and secondly, there’s this massive pressure to get it out there. Because if we don’t, health services are going to fall over.”

In the view of Maneesh Juneja the challenge is as much one of culture as technology. “The technology is relatively easy to build, the hard part is getting people, policy and process to move; both in tandem but also just as fast as the technology is evolving.”

He cautions that “culture change in organisations, especially healthcare ones which are risk-averse, takes time. It’s not a one-year thing or a three-year thing, this is going to be a long-term shift. It will change much more once younger people rise up through the ranks, those who are currently growing up with all these new tools, and they become the leaders of these organisations. They will drive that change much harder.”

The combination of cultural and technological change needed to drive digital healthcare means the changes outlined here will emerge neither seamlessly nor rapidly. Yet the imperative for today’s healthcare systems, struggling to adapt to a world of slow-growing budgets, fast-rising patient demands and data security policies, creates a context and a necessity for change. If the question facing the world’s healthcare providers is unambiguous — how the necessary services can be delivered more efficiently, less expensively and more effectively — it is equally clear that many of the answers lie in the adoption of technology that can make a difference on security, experiences and outcomes alike.

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