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Health Imaging

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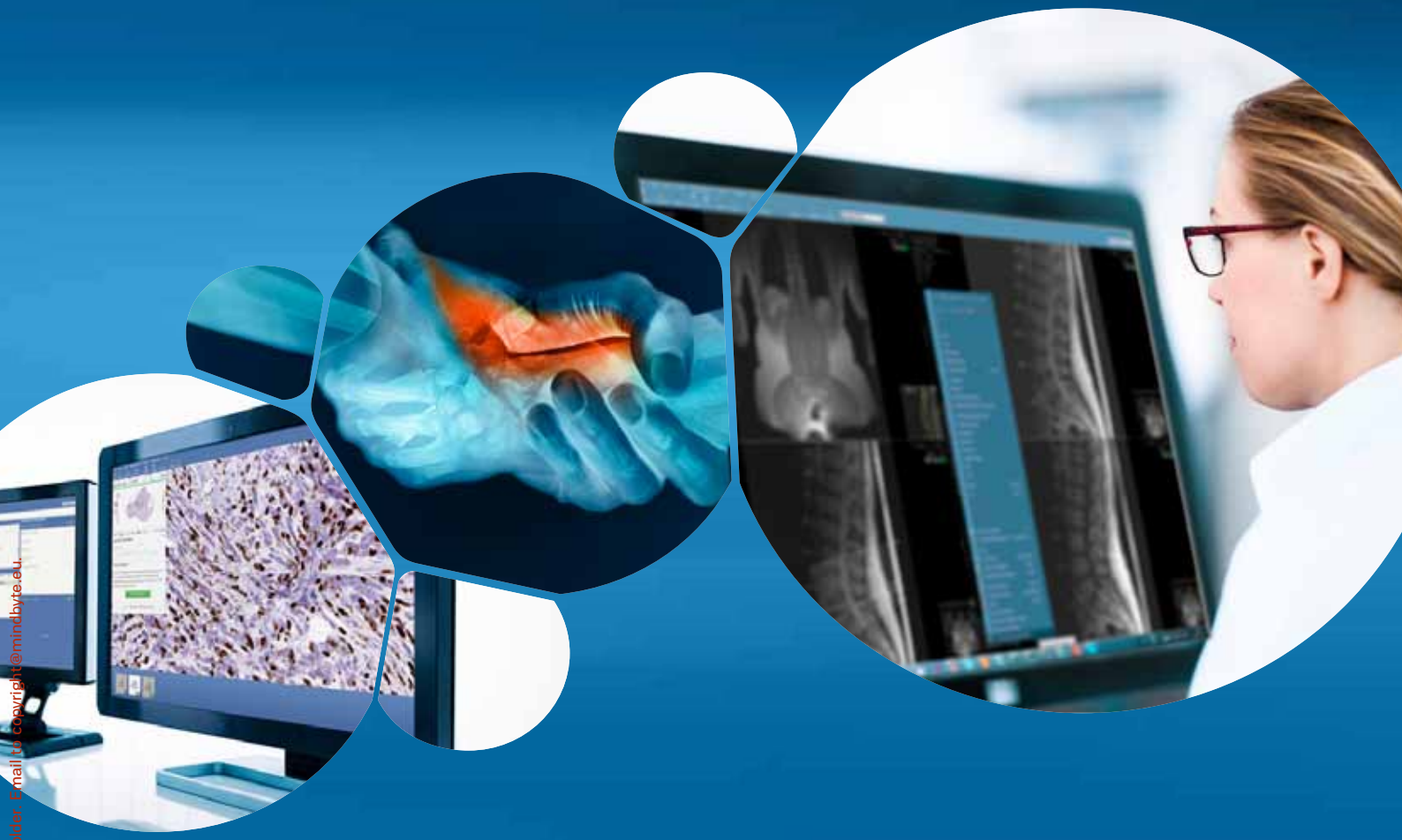
REPORT: WHERE RADIOLOGISTS SEE THE ADDED VALUE OF MACHINE LEARNING

Using a prostate cancer case example, a survey of radiologists reveals more opportunities than threats. Find it at sectra.com/ml_report



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"There are many modern machine learning algorithms that could bring great benefits to diagnostic work, but very few solutions have yet reached clinical routine," says Fredrik Häll, VP Product Management at Sectra Imaging IT Solutions. "A main limitation has been the lack of an effective multi-vendor ecosystem for radiologists to use through a single, unified workplace. The Sectra platform is the missing piece, a solid vendor-neutral foundation."

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SECTRA

Knowledge and passion

2084

In his groundbreaking novel '1984', British writer George Orwell portrayed a futuristic world that could only be imagined at the time of its 1948 publication. With incisive foresight, even without its dystopian character, 1984 showed a society watched by an all-seeing eye that is evident in today's data-driven digital world.

Technology is not good, or bad by nature; it is the way we use it. With technology rapidly revolutionising healthcare, what can sector leaders expect in management, clinical practice, the patient position and training and will the sector succeed in taking advantage of the potential of technology for the ultimate good of all?

In our '2084' issue, HealthManagement.org hopes to touch on these concerns. We present a snapshot of healthcare that is, perhaps, not decades away as our cover story suggests, but, if not already manifest in the sector, just around the corner.

In its new book, The Future of Healthcare, medical device innovation centre, Jacobs Institute, shows what survival tactics healthcare leaders need to make with EHRs, virtual medicine and robotics in the spotlight. Simon Janin of chainSolutions takes a look at the fascinating world of Smart Contracts and the role they could play in healthcare while Virtual Reality authority, Brenda Wiederhold, examines the present and future position of the technology in the sector. Morten Petersen of sundhed.dk examines the growing central position of patient portals while eHealth advisor and hospital CIO Miguel Cabrer offers his view on what healthcare could learn from other industries in tech implementation. How smart technologies are impacting the healthcare business place is highlighted by human resources consultant, Dean Madison.

As well as our look at future healthcare, latest winning practices in 3D printing, deep interoperability, artificial intelligence in cardiology and innovation in acute hospital staffing solutions are featured in addition to an overview on the unique role of women in the imaging workplace and much more.

And back to our cover story, by 2084, which other Orwellian projections will have come to fruition in society in general and healthcare in particular? Making sure that the cure is not worse than the disease is part of the challenge.

We hope you enjoy reading our first issue of 2018 and that it gives you food for thought and inspiration for your practice. ■

Christian Lovis
Professor and Chairman, Medical Information Sciences, University Hospitals of Geneva, Switzerland
Editor-in-Chief Healthcare IT, HealthManagement.org

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"Point of View" articles are part of the HealthManagement.org Corporate Engagement Programme

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1. Data on file and from public sources, 2017. **2.** Results from Friedewald, SM, et al. "Breast cancer screening using tomosynthesis in combination with digital mammography." JAMA 311.24 (2014): 2499-2507; a multi-site (13), non-randomized, historical control study of 454,000 screening mammograms investigating the initial impact of the introduction of the Hologic Selenia® Dimensions® on screening outcomes. Individual results may vary. The study found an average 41% increase and that 1.2 (95% CI: 0.8-1.6) additional invasive breast cancers per 1000 screening exams were found in women receiving combined 2D FFDM and 3D™ mammograms acquired with the Hologic 3D™ Mammography System versus women receiving 2D FFDM mammograms only. **3.** In an internal study comparing Hologic's standard compression technology to the SmartCurve™ system (18 x 24cm).

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Angela Maas
Radboud UMC, Nijmegen, Netherlands. Gynecardiologist & cardiofeminist, The Netherlands

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ARAB HEALTH

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Top healthcare trends 2018

What do healthcare leaders see ahead?

HealthManagement.org spoke to healthcare leaders on the future of the sector. The consensus is Artificial Intelligence (AI), leadership training, population health, cross-collaboration and development of value-based healthcare will lead progress in healthcare.

"There are a number of trends I see becoming more important for imaging in 2018. Future radiologists will become imaging information experts and there will be an increase in opportunities and challenges of machine learning in our profession. It will also be interesting to watch the radiology workforce in the era of artificial intelligence and image-guided therapy. The role of quantitative imaging in treatment planning and the role of imaging in value-based healthcare systems are also worth watching in addition to radiology's impact on population health."

Lluís Donoso Bach
Editor-in-Chief Imaging, HealthManagement.org

Christian Lovis
Editor-in-Chief IT,
HealthManagement.org

"For 2018 I would say that we will see an explosion of AI in the field of image recognition, embedded in current tools as decision support. New business models, such as Zebra which uses data from millions of scans to catch misdiagnosed diseases and early-stage cancers will also become more prominent. I also see consolidation of large groups as new players, such as Telecom/Mobile/Fitness in Germany or Food Supply/Insurance/Fitness/Mobile Doctors in Switzerland. We can see this with Amazon, Apple and Google too of course but these other examples will put increasing pressure on traditional players. Precision medicine will become a huge driver for data-driven science in life sciences and medicine. Data will increasingly become the new currency in health, and citizen, patients and care providers will further challenge open data movements that will slowly fail because of the profit-driven models behind data-driven technologies (such as AI). I am certain that embedded systems will increase and robotics for surgery will slow down despite increasing precision in telemanipulation because of failing to show real benefit in outcomes/costs in many cases. Initial Coin Offerings (ICO) and blockchains will have a remarkable peak these few next years, but I fear that it will take way longer to really provide usage in health. Finally, of course, patient/citizen communities will grow."

Michael E. Porter
Professor, Harvard Business School

Robert S. Kaplan
Senior Fellow, Professor, Harvard Business School

"Value-based healthcare is penetrating rapidly across many countries, and in peer-reviewed medical literature. National health systems are embracing value-based healthcare as their strategic framework. More providers are moving to integrated practice units to care for conditions and at-risk populations such as poor-elderly, frail-elderly, and opiate-addicted patients. The International Consortium for Health Outcomes Measurement (ICHOM) and the Organisation for Economic Co-operation and Development (OECD) are collaborating to expand adoption of standardised outcome measurement for selected conditions across the developed world. Corporations and regional governments, such as Washington State in the U.S., are increasing their use of value-based bundled payments to contract directly with provider "centres of excellence" for comprehensive care of patients with acute and chronic conditions."

"There is a global consensus about the need for collaboration between healthcare and social services. If we are talking about integrated care this development is absolutely imperative. But if digitalisation in healthcare has evolved slowly, in the social services this technology is just at the beginning. The hope is necessity will push advances hard. It is not going to be easy, but we can see some interesting and hopeful signs: preventive modelling on vulnerability, fragility and skilled nursing facilities readmissions are some examples amongst others."

Josep Picas
President, European Association of Healthcare IT Managers

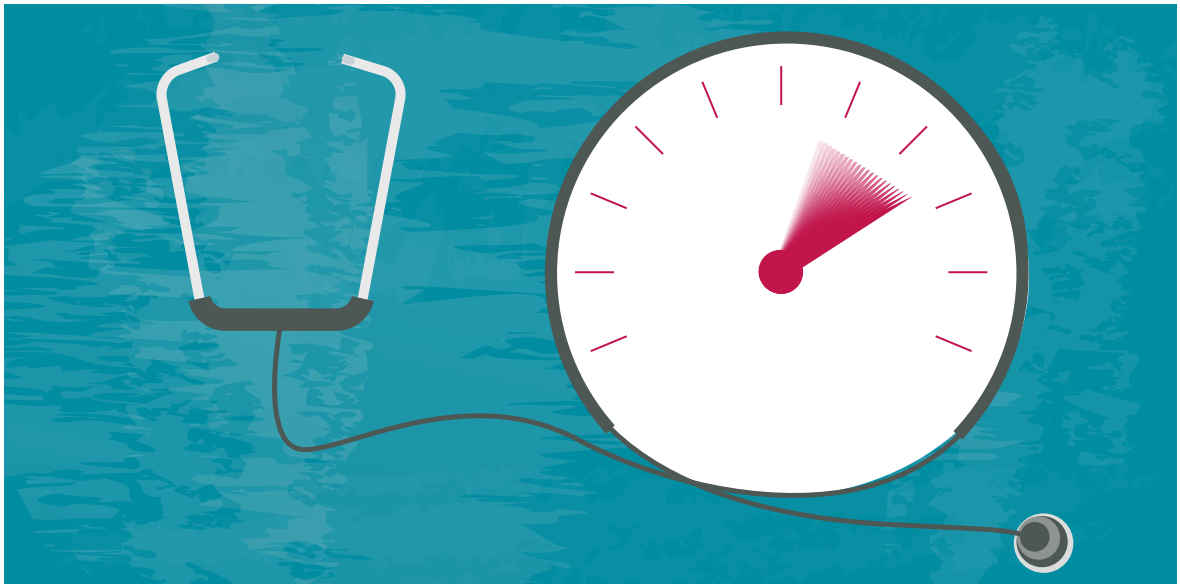
Sherry Polhill
Associate VP, Hospital Labs and Respiratory Care, UAB Medicine

"There will be more emphasis on developing leadership in healthcare. I have seen this in my day-to-day work. In 2015, I started a Leadership School for employees interested in getting into management. There was a need to develop leaders so I took on the responsibility to teach talented people in the lab environment. The curriculum provides introductory sessions on lab finance and quality and information systems followed by leadership skills development covering topics such as communication, emotional intelligence and how to manage stress for example. Another exciting aspect is for current supervisors and above. It was evident that current leaders need to remain flexible and effectively manage all sorts of complex changes for the future. The vision includes preventing burnout, sharpening leadership skills, and helping people develop their potential. "

Committing to the future of medicine

The future is not so far off as a new book on future healthcare shows

A new book released by Jacobs Institute has its finger on the pulse of the lightning-speed changes happening in healthcare and how stakeholders will need to adapt to stay ahead.



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Peering into the future of healthcare is less about predictions and more about implementing systemic change to unlock our potential. A commitment from the healthcare community would lead to dramatically improved patient care and cost savings for everyone in the healthcare pipeline. But we have to remove barriers and think outside the box.

The Future of Medicine book released by medical device innovation centre, Jacobs Institute (JI), based in Buffalo, NY, tackles a myriad of trends of which healthcare executives should be aware.

"We've built the JI on the premise that fostering innovation is the most important thing we can do to ensure improved quality of care for current and future generations," said L. Nelson Hopkins, MD, and Adnan H. Siddiqui, MD, PhD, clinical leaders at the JI.

Virtual medicine

Disruption of traditional healthcare delivery, as we know it, is already underway. Leaders such as Johns Hopkins Hospital, Montefiore Health System, Kaiser, and even the Centres for Disease Control (CDC) have virtual patient monitoring or physician consultation. Montefiore opened a 12-story ambulatory surgical centre—with no hospital beds. Patients do not want to wait for tests, diagnoses, and follow-up appointments. They want accurate answers now. Online chats and telemedicine are the solution. This represents a cost savings to hospitals that aren't paying for traditional overhead. One of the key benefits to being virtual is the scalability. If a digital system works for your current patient volume, you can increase that exponentially with ease. Hospitals that are not moving toward virtual medicine will lag behind early adopters and will not reap the benefits of cost savings.

Universal health records

Electronic health record (EHR) systems can cost more than a new hospital building. Add to that the cost of

cybersecurity, and you have a significant portion of a hospital budget devoted to a big problem. Open electronic medical records (EMR) would help, but no current open standard for EMR exists, despite the $30 billion the U.S. government has paid in incentives for such a transfer. There are presently 245 different EHR systems in use. They are often over-customised for each speciality or hospital, leaving the information in useless silos with HIPAA laws and anti-kickback statutes exacerbating the information-sharing conundrum. With all this info in disparate locations, physicians cannot utilise artificial intelligence (AI) to mine patient data for information and trends that could lead to research breakthroughs or accelerate drug development. The solution to the dilemma lies, in this case, not with hospitals but with the EHR companies. Whichever one can deliver a platform—that can be utilised with AI that can access and translate the data into useful information while also integrating with various smartphone application monitoring systems - and creating it with global scalability in mind—will be the victor in these data wars.

> “ONE OF THE KEY BENEFITS TO BEING VIRTUAL IS THE SCALABILITY”

Robotic surgery

In reality, robots are already in the operating room—for autonomously suturing soft tissue, guiding visualisation and assisting orthopaedic surgeons, helping neurosurgeons place electrodes in the brain, and more. The current cost of robotic surgical technology is high and requires a minimum patient volume in order to see return on investment.

However, economics will prevail, when a value-based approach is embraced by hospitals. Efficacy and efficiency of surgery improve with robots. New financial models to make robots more affordable—such as pay-per-procedure—will mean even small-town hospitals could offer the latest and greatest technology. When aligned with artificial intelligence, robots will be the preferred surgical method, with physician oversight. Eventually, nanotechnology could mean the end of invasive surgeries altogether.

Ambulatory surgical centres

Big box hospitals will begin to feel the effects of ambulatory surgical centres (ASCs), where low acuity surgeries and procedures can be performed, such as endoscopy, joint replacement, and cataract surgery. There will be tremendous cost savings in having a procedure at an ASC versus at a hospital. Hospitals will not be left behind, however. Enterprising health systems will open ASCs independently or partner with physicians to do so.

Here—as with so many other catalysts of change in healthcare—patient satisfaction drives this migration to ASCs. First, they represent a greater cost savings to patients. For instance, in 2014, a cataract surgery cost $5,672 at a hospital, compared to $2,932 at an ASC. Additionally, patients appreciate the fact that ASCs are smaller and easier to navigate than an overwhelming hospital, and the team is specialised by procedure-type. The efficiency and quality of the care is superior, with equal or better outcomes. This smaller, specialised approach to surgery will complement the advances in robotic surgery, machine learning, imaging, and electronic medical records, creating a more streamlined healthcare experience.

Impact of tech

As healthcare leaders, we are on the cusp of significant changes that will impact the way we deliver care. Technology will empower patients in a way previously unseen, goading us to innovate and invest in everyone’s future.

To learn more about the opportunities and roadblocks on the path to the future of medicine in surgery, staffing, innovation and data amongst other hot future healthcare topics, go to: **www.futureof.org/medicine-1-0.** ■

KEY POINTS

- ✓ Disruption of traditional healthcare delivery, as we know it, is already underway
- ✓ Ambulatory surgical centres are already being used and will lead to cost savings
- ✓ A key benefit to being virtual is the scalability
- ✓ EHRs and related cybersecurity can take up significant parts of healthcare budgets
- ✓ Hospitals lagging behind early adopters will lose out on savings
- ✓ EHR companies that can deliver smart platforms will be victors in data wars
- ✓ Budget-friendly robotics will lead to wide implementation of the technology
- ✓ Patient satisfaction will be one of the biggest catalysts in healthcare change

Visionary leadership

The way forward for US healthcare

Experts draw their conclusions on the American health system and what needs to be done to eradicate the many problems that continue to manifest.

Denis Cortese
Foundation professor at Arizona State University, and CEO of the Mayo Clinic, USA

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Antony Bell
CEO of Leader Development Inc. USA

abell@leaderdevelopmentinc.com

In a recently published book, health leaders Dr. Denis Cortese and Antony Bell offer a radical overview of the dissatisfaction of the American healthcare quagmire and enlist ways which would dissolve the many problems that exist.

According to the leaders, the American healthcare delivery system is breaking and beyond fixing. In their book they explain that the only way out of this quandary is leadership itself. The book titled "*Rescuing healthcare: A leadership prescription to make healthcare what we all want it to be*," was released in 2017 and explains the main ways the healthcare system is so flawed; so much so that it is commonly fought over by politicians, debated endlessly by people all over the country and yet no real changes are enacted.

Cortese, a Foundation professor at Arizona State University and former president and CEO of the Mayo Clinic, and Bell, CEO of Leader Development Inc., a firm that helps leaders in several sectors transform their organisation, believe that the only way for the healthcare system to get back on track and provide quality care at a reasonable cost, is for medical practitioners to be empowered. This will allow them to create meaningful change for both the system and what matters the most: patients.

In a recent interview, Dr. Denis Cortese and Antony Bell speak to HealthManagement.org about their book and what visionary leadership means to them.

What else is needed from senior politicians in order to improve the healthcare system within the US?

A clear vision for what they want out of healthcare. 100% coverage is needed; high-value healthcare delivery; a learning organisation for healthcare in the USA (so that everyone in the healthcare system knows what the system knows); and if they want high-value care they should have systems of

payments that are related to high-value – not fee for service.

For example: "Insurance for all" should mean that all US citizens are in the same programme. This could mean a single government payer such as Medicare or it can mean that the US citizens get the same insurance programme that all our Federal employees and politicians have – The Federal Employees Benefit Plan. This is a government-regulated programme; with financial assistance from the government for those who need it; and freedom of multiple insurance private plans. Leadership means leading – and this means that EVERYONE is in the same insurance programme together.

> "BEST OUTCOMES, HIGHEST SAFETY, BEST SERVICE AND AT LOWEST COSTS IS THE VISION FOR HEALTHCARE IN THE WORLD"

What does it mean to be a successful leader today?

Let us summarise key points from our book (*Rescuing healthcare: A leadership prescription to make healthcare what we all want it to be*) as follows:

a. Personal traits – high moral and ethical character; leadership competence. One without the other will fail. Unfortunately, we have little of both today in the leaders we hear most about

b. Skills in at least three domains of leadership: Organisational leadership skills – create visions and direction; sell and communicate the vision; align the organisation; select people and delegate responsibilities. Operational leadership skills – planning, organising, measuring, setting goals, setting incentives People skills: selecting and matching the right people; explaining and clarifying; motivating and developing people

c. Dealing with several elements of leadership simultaneously and over time. Shared vision; shared reality; strategy; tactics; culture and alignment; skills of the staff; technology; implementation.

How is this "shared vision" to be implemented?

In the field of healthcare, the "organisational" leader will need to work with a small group of key leaders to successfully develop a vision that they will all support. Of course the organisational leader will play a major role in the vision but has to be prepared to modify preconceived ideas as the team develops ideas that are even better and more appropriate. Once the vision is clarified the hard work begins – relentless communication to all the staff and all the employees. The communication needs to be repeated as often as needed and in as many settings as possible until the employees and professional staff begin to think that the vision was all their idea.

How do you think this vision differs from other healthcare systems around the world, aside from it being a pay-for-service system?

The vision of high value healthcare – best outcomes, highest safety, best service and at lowest costs is the vision for healthcare in the world. And it has to be accompanied by a payment system that keeps the best providers in business. It is very unlikely that a traditional fee for service system will ever accomplish that goal. New models of payment in the USA might, such as: bundled payments, capitation, or providers owing their own health insurance plans.

Do you think there is a serious issue of burnout amongst US healthcare staff?

Yes, indeed. All the so called stakeholders in the USA have found ways to reduce their administrative work loads, and sell more of their products by shifting all responsibility and accountability to providers. Who, over time, have become overburdened with required or regulated activities that have nothing to do with direct patient care. Who wouldn't experience burnout?

In order for healthcare to be financially sustainable, what are the most important factors that come into play?

To relentlessly seek out the highest value care and reimburse those providers in such a way that they can remain in business. For instance: use reality pricing based on the very highest quality providers who are able to keep their costs down. Then pay in such a way that they can cover their costs and accomplish a 2-4% profit. Even non-profits must make some money to remain in business, innovate, replenish/replace their facilities. A new regulatory mindset has to come into being, such as we see in regulated utilities that provide a critical societal need (electricity, water, etc.).

"Rescuing healthcare: A leadership prescription to make healthcare what we all want it to be" is published by Morgan James Publishing. ■

Reinventing breast tomosynthesis

Expanding leadership based on clinical evidence

Lori Fontaine
Global Vice President of Clinical Affairs, Hologic , USA

In early September, Hologic launched the new 3Dimensions™ mammography system, a breast tomosynthesis system with the fastest and highest resolution, in EMEA. I recently had the pleasure of showcasing this cutting-edge device at the European Society of Breast Imaging (EUSOBI) Annual Scientific Meeting, where a number of radiologists from a variety of regions congregated.

The Hologic team conducted robust research that revealed clinicians across Europe continue to emphasise the importance of accuracy, clarity, dose and workflow when it comes to breast imaging devices. Fortunately, the 3Dimensions system features are designed to specifically address those areas of interest. The system's Clarity HD high-resolution 3D™ imaging, which reduces recalls by up to 40 percent compared to 2D alone, provides the industry's fastest, highest resolution 3D images to accelerate screening and analysis. In addition, the 3Dimensions system offers Intelligent 2D™ imaging technology, which works with Clarity HD technology to deliver unprecedented clarity, contrast and detail at a lower dose. Intelligent 2D imaging technology features smart mapping, which enables radiologists to instantly move from suspicious areas detected on the 2D image to the point of interest on the 3D slice, saving time and optimising workflow. Finally, with the help of its Intelligent 2D imaging technology, the 3Dimensions system results in a 45 percent dose reduction with a generated 2D image compared to 2D FFDM alone.

Hologic's 3D Mammography™ exam, which detects up to 65 percent more invasive breast cancers and is the only mammogram approved by the U.S. Food and Drug Administration as superior for women with dense breasts compared to 2D alone, is available on the 3Dimensions system. The 3Dimensions system is already installed in several sites in Europe, and it is a truly exciting step forward in Hologic's ongoing efforts to innovate breast screening technology that meets both clinicians' and patients' needs across the globe.

As a woman who participates in breast cancer screening and is passionate about ensuring women have access to the best technology available, I know first-hand how important it is to develop equipment that factors in insights from both radiologists and patients to improve the experience. These insight-driven advancements in technology must be supported by strong clinical evidence, and I look forward to continuing the work on the next innovations that aim to do just that from Hologic. ■

The 3Dimensions™ system from Hologic.

Women in radiology

The American experience and perspective

Professor Stephen Bakers gives an overview of women's place in radiology and how times are changing.

When I write this and no doubt months later if and when you read it, the matter of women's place in society will remain centre stage. In the west, at least, there has been an insistent awareness of their collective lack of opportunity, lack of respect and also a lack of protection in a hitherto male-dominated society. In some regard the pertinent issues to be mediated if not resolved are obvious, in other contexts the impingements are less obvious and need to be better appreciated before they can be effectively corrected.

Medicine is not immune from justifiable presumptions by women that the performance space is not level. True enough, the percentage of female medical students continues to rise and in many places, ranging from Canada to Kazakhstan, they encompass more than 60 percent of trainees.

Yet in each country, particularities of history, culture and policy engender variations in the characteristics of the nature of inequality. Thus, although it may be useful to generalise I focus my comments on what I know best ie. American medicine and, to the point, American Radiology.

> "THE PERCENTAGE OF FEMALE MEDICAL STUDENTS CONTINUES TO RISE AND IN MANY PLACES, RANGING FROM CANADA TO KAZAKHSTAN, THEY ENCOMPASS MORE THAN 60 PERCENT OF TRAINEES"

A first place to look is residency education. As the percentage of women medical students has risen to nearly 50 percent so too has female representation increased proportionally in nearly all specialty programmes, surgical as well as medical. In fact, in a recent study of ours, urology was most rapidly expanding its cadre of women trainees. But one specialty is not increasing its complement of women. For the past 15 years its female presence as trainees has stabilised between 25 and 27 percent per annum. The non-intuitive, in fact, perplexing outlier is radiology.

Why is this so? Many explanations have been proffered for this apparent anomaly. To wit: women are not good at physics, they don't want to be subject to radiation, the lead aprons they have to wear are too heavy. In a survey of women radiologists, we conducted several years ago, none of these choices were regarded as explanations for the limitation. But one factor did emerge in queries of both current radiology residents and those who considered radiology but chose to do something else. Among them the predominant negative factor was the perception by family and friends that young female doctors should choose to pursue as their life's work a patient-centred discipline. Many lay people do not think that description pertains to radiology. Also, today, the spectre of AI inroads in diagnosis will bear directly on the ownership of opportunity in imaging, which is a worrisome consideration for perspective residents, men and women alike.

One would expect that pathology, too, would be less highly regarded because of its further remoteness from patient/doctor interaction. Yet the percentage of trainees in this specialty continues to enlarge, but in the USA, many of these trainees are not native born or are foreigners who have come to our programmes to gain skills and then are mandated to return home. A large percentage of them are from South and East Asia, where they have told us, the biases for direct patient care is not part of the compelling narrative families present to guide career choice.

Once board certified and out of practice, women radiologists in the aggregate tend to self-select or

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be channelled to certain sub-specialties, particularly breast and paediatric radiology which tend to limit work locations to mammography offices and hospitals, particularly children's hospitals. Yet all subspecialties now have, I presume, adequate female representation or, at least overt restrictions are not prominent. In academic practice, however, a disproportionate number of women become supervisors of medical student teaching or residency programme directors. Both are important tasks but their time commitment retards research productivity. And the size of one's C.V. is still a good indicator of advancement up the academic ladder.

> "TODAY, THE SPECTRE OF AI INROADS IN DIAGNOSIS WILL BEAR DIRECTLY ON THE OWNERSHIP OF OPPORTUNITY IN IMAGING, WHICH IS A WORRISOME CONSIDERATION FOR PERSPECTIVE RESIDENTS, MEN AND WOMEN ALIKE"

Women compromise only 15 percent of full time radiologists in private practice in the US Part of the difference between percentage in residency and percentage in practice is that female radiologists over 50 are less common than those who are younger. Also, women radiologists are more likely to work part-time than men.

Among the officers of the national leadership of our specialty, women are no longer rare but they are lower in percentage than their numbers in academic and private practice. Until they extensively populate the upper echelons of governance in our specialty, the inequalities of practice and prospect will remain.

In the hierarchy of American academic radiology, the participation of women as leaders has increased with their expanding representation as members and faculty. In major societies such as the Radiological Society of North America and the Society of Chairman of Academic Radiology Departments they occupy top positions. They continue to play a major role in the policies of the specialty organisation in which they comprise a large percentage of dues payers such as the ultrasound and breast imaging societies.

But they have not ascended to the leadership of the American College of Radiology (ACR). Moreover, in committees of that organisation they are underrepresented which limits their voice in the articulation of their specific needs, perceptions and challenges. The American College of Radiology is compromised predominately by radiologists in private practice. For the most part in the state branch chapters of the organisation women tend to play a limited role. Indeed, the lack of attention to the persisting issue of the relative unattractiveness of female medical students for a career in radiology has not been a major matter for discussion in the ACR. Yet it should be if the specialty is to thrive at a time when its stewardship of the technology it deploys is under increasing threat.

Hence, if American radiology can be likened to a house, the front door is open but many women are reluctant to enter. Once inside there is no glass ceiling but female occupants are still accustomed by choice and by subtle cues to remain in a few rooms none of which are on the top floor. ■

KEY POINTS

- ✓ The percentage of American medical students who are women is increasing but not their percentage in radiology residency programmes.
- ✓ The reasons for the lack of increasing interest are multiple but parental and family member perception of women doctors to be immediate caregivers seems to be a major hindrance to the choice of our specialty.
- ✓ Women are well represented in academic societies in our specialty.
- ✓ Women have a lesser voice in state radiological societies and the American College of Radiology.

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A transformation in mammography

More comfort and increased confidence from 3Dimensions™

Following robust research from Hologic regarding its newly launched 3Dimensions™ mammography system, I was thrilled that our radiology department at Fatebenefratelli and Ophthalmic Hospital in Milan had the opportunity to implement the new system, and what a positive response we got from both our technologists and our patients.

The new tomosynthesis system, which was launched in early September this year, has already gained notable attention across the industry, having been installed in several sites in Europe. Given the improvements observed from its application in our radiology department, I foresee that it will continue to provide incredible benefits into the future.

With the new technology, Hologic aimed to respond to findings from its robust research that revealed that clinicians across Europe continue to emphasise the importance of accuracy, clarity, dose and workflow when it comes to breast imaging devices. I have found that it has responded to these concerns in a number of ways, as I shall detail here.

Improved efficiency and workflow

My technologists did not have anything negative to say about the machine, contrary to what is common in situations where a new system is introduced. The machine has allowed us to perform each mammography much more quickly, and this has improved our efficiency. In fact, the biggest improvement to my workflow was that all of the technologists in our department wanted to work with the new Hologic machine, enabling improved overall work efficiency.

User friendly and dependable

There are a few elements about the 3Dimensions™ mammography system which have contributed positively to our radiography department, and some key aspects here are simplicity of use and confidence in the technology.

I like the Intelligent 2D™ imaging, as I was not confident with the older software. With time, I have felt more comfortable using this option because I am able to perform well, given that it is more dependable and user friendly. We always fear that we cannot see something with a reconstructed image, however using Intelligent 2D™ gives us the confidence in knowing that the machine has produced a natural image. In the case of Intelligent 2D™, the image is sharp, clear, with a closer resemblance to the natural 2D view, giving a better quality and credible image.

> “IMPLEMENTING THIS SYSTEM IN FUTURE MAMMOGRAPHIES WILL ENSURE PATIENTS UNDERGO LESS COMPRESSION, WHICH OBVIOUSLY MEANS LESS PAIN FOR THE PATIENT”

Less compression and more confidence

In tomosynthesis, the importance of compression is reduced. Previously when the standard 2D image was used, the gland had to be compressed in order for the radiologist to understand whether the mass was glandular or if it was something else. However, using tomosynthesis allows the division of the different layers of the breast, so the process presents less pain for the patient. As the number of patients that become comfortable with the examination increases, a growing number will become confident in the product and the type of system they are trusting in.

Given my department’s positive impressions of the 3Dimensions™ mammography system, I plan to use the machine to perform interventional biopsies in the upcoming future. This new technique will deliver faster and more accurate results. ■

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Prepare your hospital for the future

Healthcare experts around the globe weigh in on the future of the sector

Globally-crowdsourced input has shown that technology will trigger huge transformation in healthcare in the next decade with early adopters reaping long-term rewards.

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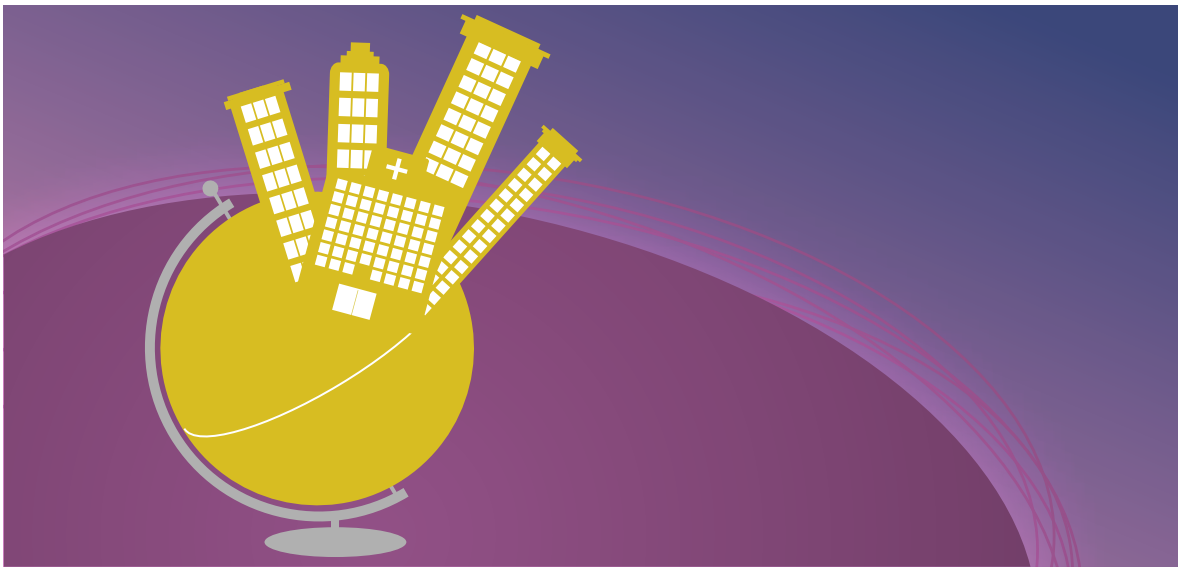

Healthcare is changing rapidly in the face of technological advancements—with groundbreaking innovations such as 3D printing and artificial intelligence (AI) involved in paving the way to the future. Hospital leaders anticipate that the new hospital design on the horizon will lead to higher quality care, improved operational efficiencies, and increased patient satisfaction; however, in order for individual hospitals to achieve these results, a focused strategy should be followed.

Compelled to learn what the hospital of the future might look like, the Deloitte Centre for Health Solutions conducted a crowdsourcing simulation with 33 experts from across the globe, and this has been used to devise a strategy which managers can use as a starting ground to move their hospitals into the future.

Participants in the crowdsourcing simulation included health care CXOs, physician and nurse leaders, public policy leaders, technologists, and futurists. Their charge was to come up with specific use cases for the design of digital hospitals throughout the world in 10 years' time—a period that can offer hospital leaders and boards time to prepare.

It is not only rapidly evolving technologies that are expected to alter hospitals worldwide, but also demographic shifts and economic changes. With ageing infrastructure in some countries and increased demand for more beds in others, hospital executives and governments should consider rethinking how to optimise inpatient and outpatient settings and integrate digital technologies into traditional hospital services to truly create a health system without walls.

A focus on the shifting landscape

The crowdsourcing simulation developed use cases in five categories, which are outlined here:

Redefined care delivery

Emerging features, including the development of centralised digital centres to enable decision-making (think: air traffic control for hospitals), continuous

clinical monitoring, targeted treatments (such as 3D printing for surgeries), and the use of smaller, portable devices will help to characterise acute-care hospitals.

The digital patient experience
Digital and AI technologies can help enable on-demand interaction as well as seamless processes that improve patient experience.

Enhanced talent development
Robotic process automation (RPA) and AI can allow caregivers to spend more time providing care and less time documenting it.

Operational efficiencies through technology
Digital supply chains, automation, robotics, and next-generation interoperability can drive operations management and back-office efficiencies.

Healing and wellbeing designs
The wellbeing of patients and staff members—with an emphasis on the importance of environment and experience in healing—will likely be important in future hospital designs.

Many of these use case concepts are already in play, so hospital executives should be planning how to integrate technology into newly-built facilities and retrofit it into older ones.

Although the crowdsourcing simulation suggests that technology will likely underlie most aspects of future hospital care, it recognises that care delivery—especially for complex patients and procedures—will likely still require hands-on human expertise.

Building your strategy

The crowdsourcing simulation defined some core elements that should be present in an enterprise digital strategy to help hospital leaders get started in the move towards the future. These include:

Create a culture for digital transformation
It is essential that senior management understands the importance of a digital future and drives support for its implementation at all organisational levels.

Consider technology that communicates
Digital implementation is complex. Connecting disparate applications, devices, and technologies—all highly interdependent—and making certain they talk to each other can be critical to a successful digital implementation.

Play the long game
Since digital technologies are ever evolving, flexibility and scalability during implementation can be critical. The planning team should confirm that project scope includes adding, modifying, or replacing technology at lower costs.

> “IT IS NOT ONLY RAPIDLY EVOLVING TECHNOLOGIES THAT ARE EXPECTED TO ALTER HOSPITALS, BUT ALSO DEMOGRAPHIC SHIFTS AND ECONOMIC CHANGES”

Focus on data
While the requirements of data interoperability, scalability, productivity, and flexibility are important, they should be built upon a solid foundation of capturing, storing, securing, and analysing data.

Prepare for Talent 2.0
As hospitals invest in exponential technologies, they should provide employees with ample opportunities to develop corresponding digital strategies.

Hospital leaders may not see immediate returns on investments in people, technology, processes, and premises, but in the longer-term—as digital technologies improve care delivery, create operational efficiencies, and enhance patient and staff experience—the return result can be in higher quality care, improved operational efficiencies, and increased patient satisfaction. ■

KEY POINTS

- ✓ A crowdsourcing simulation with global experts has created a template strategy on future hospitals for managers
- ✓ Technology will be a key driver in transformational change as well as demographic and economic shifts
- ✓ Huge changes are predicted in care delivery, the digital patient experience, enhanced talent development, healthcare design and robotic process automation
- ✓ Core elements present in an enterprise digital strategy should include having a long-term view, focus on data and creation of a digital culture

Future medicine, today's healthcare

Is the "Smart Hospital" a chance for change?

Prof. Heinemann explains how futuristic and smart technologies that are used in preventive and diagnostic healthcare, are embedded in a new digital professionalism and quality.

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Artificial Intelligence (AI) in diagnostic radiology, robots in nursing and operating theatres, augmented and virtual reality in surgery and medical training, 3D-printed skin, blockchain technology for clinical data exchange, modern and smart buildings, preventive healthcare via apps and wearables, at-home aftercare from a screen using interactive hospital cloud services such as telemedicine and high-performance sensors, simulation techniques, cardiovascular risk prediction with deep learning, security & cyber crime prevention, gamification of patient care, and of course electronic medical records (EMR), automated pharmacy systems, fresh hospital design with real hospitality services, voice-command devices in patient rooms, integrated management systems focussing on patient satisfaction – all these and more in preventive and diagnostic healthcare, therapy and research are embedded in a new digital professionalism and quality. They describe at least some elements of what a smart hospital could look like. It may all sound a little like science fiction, but it is already far more science than fiction. Right here, right now, we have access to a future that really works.

The emergence of a new kind of medicine, and shifting – albeit it slowly – legal conditions at European and national level (in Germany and not only here) have raised many hopes of better health and recovery, but also many concerns, fears even, about the dehumanisation of medicine, about transparent "datients" (data+patients) or even "drive-ins" for the sick, and about skilled medical staff becoming dispensable, not to mention the mainstream top's for today's hospitals, like cost pressure, an ageing population and a shortage of practitioners and caregivers. Central to these developments, the three most important stakeholders in a hospital face the historic challenge of digital transformation, which cannot simply be delegated away to regulation or the market: doctors and nursing staff, patients and hospital managers today must rethink their relationship. Where there is risk, there is also opportunity, so is the smart hospital a chance for change, a new and trusting beginning?

It is certainly time for a new beginning: neither demigoddery nor Google-based self-treatment nor coldly calculated process optimisation is much use to a system that is clearly ailing economically and socially. A new beginning is a good thing anyway, and does not imply that whatever went before it was all bad. To the contrary, in fact: in Germany, measured patient satisfaction is often higher than the apparent reputation of the hospital landscape (a declining number of some 1,900 hospitals, and 33 university clinics) would suggest. And that satisfaction undoubtedly goes further than the patients' delight at an unexpected flatscreen TV with Netflix in their hospital room. At any rate, if a systematic approach is taken to this new beginning, it is precisely smart hospitals – in theory – that offer a chance for – real! – change. As an integrated clinic concept, the smart hospital drives clinical excellence, patient centricity, strategic and operative effectiveness and efficiency with digital disruption in today's and tomorrow's clinics.

Clinical excellence – the best medicine for all

The digital transformation in medicine is primarily a scientific (research), economic (efficiency), legal (E-Health Act, EU-general data protection regulation), and social (data ethics) issue – not a purely technological one (a vast amount is already possible today). And the market is booming, the global hunt is on for the new digital health unicorns, the law and society are, to a degree, "critically positive". And, as mentioned before, not everything is still out of today's reach: within the boundaries of what is legally possible and socially acceptable, hybrid operating theatres, imaging, and ultramodern operating technologies are as relevant as a patient experience that is enhanced by navigation systems, better room facilities, or optimised access to information. Many of the players in

the healthcare industry, like Siemens (D), GE Healthcare (USA), Samsung (South Korea), Qualcomm Life Inc. (USA), athenahealth Inc. (USA), SAP (D) or Philips (NL), are offering increasingly sophisticated features and services around the smart hospital.

Digital disruption changes medicine intrinsically, but with it, not against it. Digital transformation makes medicine clearer, richer and, for medical practitioners in research and healthcare provision, future-proof. Data are not the "new oil" just for many other industries, but also for the health industry. Here too, however, and here of all places, quality counts: pulp data in, pulp results out! The Power of Three - good data, smart use, secure internal access - starts with data. Only clearly validated, annotated and curated data can at best assist evidence-based medicine, they cannot replace it. "AI+top radiologist = positive patient outcome" is the successful formula. Correlation for sure does not imply causation. And just because it says "health app" on the label, it does not mean that what comes out is health – more research is needed here. Precisely for that reason, it takes both types of expertise, medical and digital, to get the best data and, ultimately, the best possible outcomes for patients.

In a smart hospital, comprehensive clinical excellence means that medicine is enriched, not replaced, by responsibly implemented digital possibilities. Doctors and nursing staff are not rendered superfluous, quite the opposite, in fact. With their expertise and skills, they will have more time and more digital resources with which to work, agile, themselves healthy and successful, for patients, research and other meaningful uses. In a smart hospital, the right solutions are available to doctors and nurses in all the different departments and institutes and are designed to increase their work efficiency. The practitioners in a smart hospital will have more time for good consultations, more time to go into individual concerns, strengthening the patient's own competencies and putting more emphasis on a cooperative relationship between doctors and patients. That is medical, not industrial, healthcare. This is where the chance for medical excellence to systematically be made accessible, in principle, to everybody. In essence: best medical performance for all, without compromising the reasonable idea that additional services cost additional money.

Patient centricity – fostering dignity is a duty and a success factor

Making humanity the focal point of everything a medical institution and its stakeholders think and do is the central message. Data security/privacy and the human quality of care are key elements of that. A new digital maturity among patients is more than merely thinkable in this context: more responsibility, more transparency, more security, and above all more quality of care in patient outcomes. It almost sounds too good to ever be true. But the chances are real and tangible. And, equally, it is simply unacceptable that the average consumer in the digital age is so much more competent in selecting best prices, fashion styles, playing complex videogames, or accessing (hopefully real) news than in what really counts most in life: their health. A smart hospital in this sense is also a promotional platform for lifelong patient-learning to prevent disease and, if necessary, to enable patients to cooperate with doctors.

Smart Hospital		
Clinical Excellence	Patient Centricity	Effectiveness and Efficiency
The best medicine for all	Fostering dignity is a duty and a success factor	Agile hospital management is an empowering strategic and operative design feature

Figure 1: Three Core Issues for Building a Smart Hospital

A smart hospital does not produce health; it creates the conditions for recovery with integrity, empathy, medical excellence and great professionalism, and it partners patients in shaping their individual preventive and restorative health regimens. This combination of scalability and personalisation can only succeed through digital transformation: it is difficult to imagine an economically successful clinic with scalable services offering individualised medical excellence any other way. Dignity is not a marketable good, but without digitally transformed management of the scarce resources and innovative medicine, there is constant institutional tension between market and competition (whether the clinics are private or public). The economically motivated goal of discharging patients as quickly as possible meets the ethical goal of treating patients as human beings with dignity, because patients want to recover as quickly as possible. That is why an important university clinic like Essen, for instance, is right to be also thinking about the patient experience and designing its version of the smart hospital around it.

Effectiveness and efficiency – Agile Hospital Management is an empowering strategic and operative design feature

Digital processes and a corresponding culture of

innovation push costs down – above all unnecessary ones – and create opportunities for long-term economic success and good employment conditions (which will include teamwork, development opportunities, optimal duty rosters, and security). Change, agility, innovation and transformation – clinics also operate in an often over-complex and impenetrable "VUCA world" (volatile, uncertain, complex, and ambiguous) and should therefore constantly strive to overcome internal, usually subjective, obstacles. There are undoubtedly objective barriers for them to overcome as well: think of the often very colourful IT systems and their difficult integration and compatibility, for example.

I see no convincing arguments that modern agile management methods and digital transformation issues are necessarily diametrically opposed to a more humanistic kind of medicine. On the contrary, it is also and especially down to hospital management as a facilitator to make a meaningful and successful future for patients, caregivers and the other stakeholders, a task that is hard to achieve with an aversion to innovation and neofeudalistic management of shortages and shortcomings. These aspects alone far exceed what is already necessary for the digital management of hospital processes. Digitally inspired medical excellence and value-based patient centricity will require long-term heavy investment, which falls both to the state and the hospitals themselves. A smart hospital also systematically uses the economic opportunities that arise from skills and experience – the assets – of its operation to generate strategic advantages (eg through cooperation), stimulate innovation (eg through start-ups), and create new sources of income (new business models). Cooperation with other health industry stakeholders like pharmaceuticals companies will also succeed better on an equal footing.

Market Research Future (2018) is forecasting for 2023 a 62-billion US dollar global market for smart hospitals, with a substantial growth rate of some 25 percentbetween 2017 and 2023 – it is a market of global quality, and many countries are much further than Germany (in the USA, 80 percent of around 5,000 clinics already have electronic health records; in the UK, in South Korea and Australia, examples of more advanced smart hospital approaches exist). Not least, however, smart business elements can also bring significant benefits to the funding structure of the (smart) hospital.

Naturally, legal certainty remains a major concern, not only in Germany. WhatsApp diagnoses may suit many patients' lifestyle, but the infrastructure is unregulated – there are no (agile!) standards. That said, the impetus is essentially on national and local government to take swift and consistent action when it comes to regulations – the clinics can only stand by and support them with the arguments.

In this sense, it is perhaps – a little too – daring to see in the much discussed and indeed controversial – ambitious – version of the smart hospital a chance for a new and trusting beginning in the sense outlined above. And yet there still seems to me to be good reason to do so. Neither an aversion to innovation nor recklessness will help, so perhaps the "smart hospital" is an ambitious idea on sensible middle-ground. At the same time, the term itself does not reflect the full agenda. Ultimately, a smart hospital is one that no longer has the shortcomings of clinics today. And all the stakeholders stand to benefit from that, which is why it is a good thing that at least some clinics are on their way transforming to smart hospitals. ■

KEY POINTS

- ✓ The "Smart Hospital" is a chance for change: As an integrated clinic concept, the smart hospital drives clinical excellence, patient centricity, strategic and operative effectiveness and efficiency with digital disruption in today's and tomorrow's clinics
- ✓ Clinical excellence – the best medicine for all
- ✓ Patient Centricity – fostering dignity is a duty and a success factor
- ✓ Effectiveness and efficiency – agile hospital management is an empowering strategic and operative design feature

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Let's change before we have to

The race is on to implement technology effectively for improved liaising and better health outcomes

Health technology can change healthcare but only with implementation of basics such as collaboration, communication and easy exchange, combined with transformation of some traditional workflows.

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AirBNB, TripAdvisor, Uber, OpenTable, WhatsApp and many others have appeared in a disruptive manner and have changed the market and the approach to it. They each have two very important things in common: they are global concepts applied locally and are led by users who are the main beneficiaries of these platforms. The user is not only in the centre but is, in fact, the centre. It is the user who directs, decides and values.

Not only have processes changed but each of the above has also helped improve competition. I remember how difficult it was to get an airport taxi five years ago in New York. But on a recent trip there, I could see how the official taxis had new regulations such as the obligation to take a passenger and prohibition of talking on the phone while driving. I think this is thanks to Uber.

Health Information Systems: the basis that should exist

And what is happening in healthcare? The sector continues to be mysteriously immobile. The system still controls processes and information with paternalistic excuses – but, in spite of this, the trend that supports patient ownership of medical history is already well underway.

Another obstacle is that there is no solid foundation on which to build. Information systems and electronic medical records are moderately implemented within and between healthcare facilities but it is not a robust, solid and interconnected basis on which new models can be built. In other sectors, such as banking, travel and hospitality, there are more solid computer systems that allow other systems to be built upon them. Innovation and competition is promoted.

In healthcare we usually cannot consider making an appointment reservation system with the medical centres of a city (private, insurer or public) without starting from the base. Each entity manages it in a controlled way through its website. Nor can we easily access a specialist. It is the system that will direct us to the specialist that is considered most appropriate.

New online processes, activators of eHealth 2.0

Yes it is true that there have been advances. There are platforms and portals that allow the search of, appointment with and assessment from a doctor. There are clear processes for a second opinion. Patients who want another doctor to review what their assigned doctor has told them can now do so online. I had the opportunity to work four years in a global company, BestDoctors, that offered second opinion medical services. The experience and the learning were formidable. We designed a powerful system that allowed the collection of clinical information, evaluation and analysis to select the expert in the field and all the exchange of information, reports and images so that the specialist could evaluate and give their opinion. This saw exhange of information and services amongst patients and doctors in the UK, Holland and New Zealand, the United States and other countries, making a global and accessible system.

New web platforms have appeared (TopDoctors, Doximity, Grandrounds) where the whole process is online and managed by the user. The patient is central.

Communication, collaboration and coordination

After 20 years working passionately in eHealth projects, I have been able to participate in projects of all kinds: digitalisation of Electronic Health Records (EHRs) in hospitals and health services, corporate Health History projects and citizen clinical protocols, global platforms of collaboration and exchange of clinical cases and global initiatives of second medical opinion, etc. In the

end, there has always been a common element identified as a fundamental problem: lack of communication and coordination.

Users have always demanded an adequate communication system that allows multidisciplinary care teams to communicate easily and efficiently.

The American Institute of Medicine (IOM) in its Improving Diagnosis in Healthcare report published in the autumn of 2015 concluded that improving the diagnostic process required greater levels of collaboration and improvement of communication. The IOM report showed that to address problems such as diagnostic and treatment errors it is also necessary to use new approaches to the problem and tools that are different from the traditional ones. The report concluded that the diagnostic process is a collaborative process and, in the immediate future, will require collaboration tools that integrate and promote the communication of all the people who contribute to the process. This would mean involving family members and the patient, as well as caregivers, doctors, nurses and social agents.

> “WHEN IT COMES TO TECH IMPLEMENTATION, THE HEALTHCARE SECTOR CONTINUES TO BE MYSTERIOUSLY IMMOBILE”

Nobody disputes using Information and Communications Technology (ICT) to improve notification systems. It is no longer about boosting the electronic medical record, but to take a step further: promote exchange, collaboration and communication.

The health system boasts of focusing on the patient as the main axis, but the patient goes beyond the health system and may not need a system as protectionist or paternalistic. The patient moves, travels, changes the system, city or country, seeks a second opinion or the opinion of an expert or friend and has an environment around him that supports him in his care (caregivers at home, residences, rehabilitation centers, etc.) or in their day-to-day life (exercise, food, etc.). There are new services, like Idonia.com, that provide a free-to-use exchange platform where hospitals can deliver the medical images and tests to patients using the Internet and avoiding the painful CD/DVD burning and delivering process. Patients can also manage and share their medical images and information in a secure environment.

Take into account the survey among 955 health professionals conducted by Harris Poll for PerfectServe4 in U.S. (Perfect Serve 2015) where they represent a large majority of actors in the ecosystem: specialised doctors, primary care physicians, nurses, case managers and administrators.

The vast majority (98 percent) considered it necessary to improve communication and assistance to reduce readmissions and improve population management.

Some interesting results included:

Communication

- 69 percent of professionals considered that patient care was delayed while waiting for important information about the patient
- More than half of the professionals admitted that they did not always know the member of the healthcare team to contact in a given situation
- 71 percent of doctors said they had lost time trying to communicate with the healthcare team
- Only 25 percent considered that they could contact colleagues to collaborate or consult in an effective way.

Technology

- Telephone (83 percent) and patient portals (74 percent) were the two most commonly used forms of communication
- Among the clinicians, when it was necessary to contact a specialist doctor about a complex case, the EHR was used only 12 percent of the time.
- Most nurses and managers did not believe that the EHR was adequate for effective communication with doctors

Lack of time, difficulty in finding other doctors, lack of personal relationship with other doctors, lack of information feedback, discrepancy in medical prescription and lack of clarity in pending tests and home care are further problems identified among professionals.

Studies identify different ways in which the coordination of the healthcare team could be improved. Many times those involved were not aware of the problems encountered by their colleagues - for example, that the primary care physician or care team was admitted to emergency. There were also coordination problems in the follow-up of a patient at discharge, pending tests or home care.

It seems clear, therefore, that improving the

coordination and communication of the care team could prevent readmissions and loss of tests with the resulting unnecessary repetition.

Communication and clinical collaboration are key to improving the diagnostic process as well as for the efficient monitoring of a patient and are applicable and necessary in different clinical scenarios such as home care, healthcare partner, primary/specialised care coordination, non-physical care and multi-centre collaboration.

Big Data, Artificial Intelligence (AI) and Chatbot are trending topics and, although it may not be possible to obtain the same value as applying them to other more mature sectors technologically, they can help the digital transformation in healthcare.

Artificial Intelligence

In imaging analysis, for example, there are tools of Artificial Intelligence that can be trained in a specific pathology to support a diagnostic process. Google is promoting a project focused on diabetic retinopathy in the UK.

An innovative and totally disruptive initiative in which I have been able to collaborate recently is particularly relevant. It is about combining AI with automated communication mechanisms (chatbots) to improve the monitoring and communication of chronic patients. For this project there has been an interesting alliance between two entities. On the one hand a home care company in the Balearic Islands for the personalised monitoring of chronic patients at home has managed to retain patients through constant communication. On the other hand, a technology company, specialised in eHealth, medical imaging, artificial intelligence and transactional chatbots applied to different health processes and scenarios has also been active.

Through this alliance, they have managed to create the first virtual brain to monitor and control chronic patients at home in the form of a virtual assistant who controls and monitors patients by communicating with them in a simple and direct way. The virtual assistant reminds patient to take medication and records data periodically through an automatic conversational system based on AI concepts. A control system (the brain) helps to prioritise actions, control and classify patients and automates certain tasks that are repetitive. It also distributes tasks to doctors, nurses, caregivers, rehabilitators and, if applicable, family members. This allows the support team to focus on patients who require immediate action as identified by the virtual assistant and the intelligence system.

Technology, in this case, is a differential change. The main effort has been to create a solution as powerful in its action as it is simple in its presentation. The focus has been on giving value to the process. Without the need for a complex and confusing App for the user, a virtual assistant controls everything that happens, coordinates and establishes communication links. Anybody from the healthcare team can be in constant contact and avoid traditional misunderstandings and miscommunication issues.

Promoting communication and collaboration in parallel to improving information systems is essential. Integrating all the care, clinical and social teams that interact with the patient inside and outside the system (residences, hospices, rehabilitation centres, caregivers, nurses, etc.) is a basic step forward for digital transformation.

With different experiences and projects I believe that solving a basic problem such as lack of communication would be a first step. It is a fundamental aspect in the change that has to occur in the healthcare sector. Change is not only digital. I hope that the change occurs before we are forced to make it. ■

KEY POINTS

- ✓ Technological disruption has improved competition in a range of sectors while healthcare is lagging
- ✓ In healthcare there is not a solid and interconnected basis on which robust communication models can be built
- ✓ There are some encouraging examples in healthcare where the patient is central
- ✓ ICT can promote exchange, collaboration and communication as well as boosting EHR use
- ✓ Studies show better coordination amongst healthcare personnel is needed for improved overall efficiency
- ✓ It is essential to promote communication and collaboration in parallel to improving information systems in healthcare

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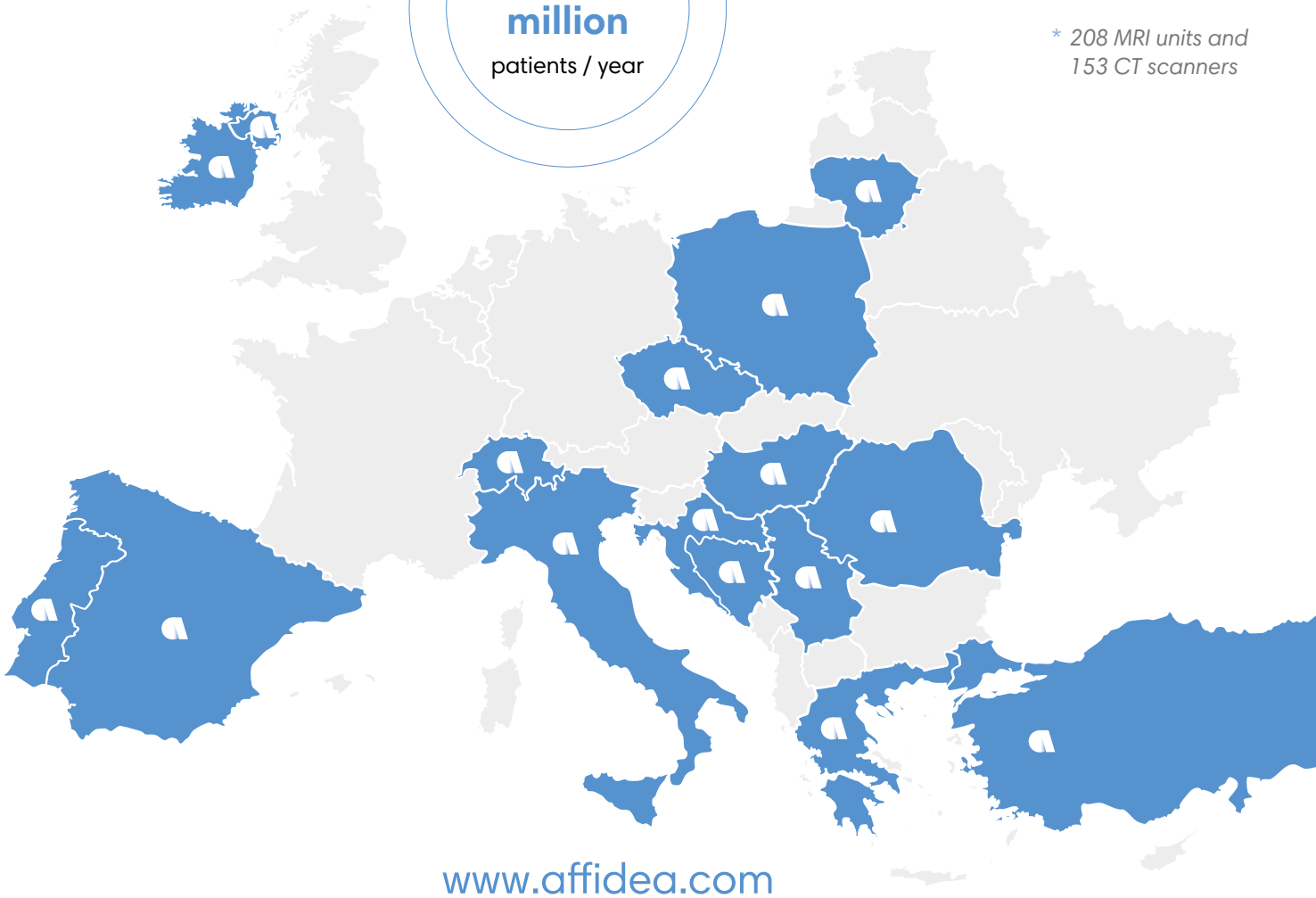

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Smart contracts in healthcare

Looking at the future of Smart Contracts in healthcare

Could Smart Contract-enabled blockchains help protect patient data while also promoting watertight agreements in healthcare?

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How Blockchain and Smart Contracts will impact the funding of research and innovation in healthcare

Definitions

- Blockchain: A digital ledger in which transactions made in bitcoin or another cryptocurrency are recorded chronologically and publicly
- Smart Contracts: A smart contract is a computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract
- Decentralisation: Decentralisation is the process of distributing or dispersing functions, powers, people or things away from a central location or authority

Across different industries, the funding process for research and development can be markedly disparate. In the healthcare industry, many relevant topics do not get sufficient funding because they are not profitable for pharmaceutical laboratories. Blockchain will enable the crowdfunding of health-related research, thereby decoupling funding from business interest and linking it to social needs.

Blockchains, especially Smart Contract-enabled blockchains like Ethereum, make it possible to create "tokens". Tokens can be seen as new digital currencies whose rules can be chosen with great flexibility. Those tokens can be natively sold on the blockchain platform for other tokens - which creates a token economy. Initial Coin Offerings (ICOs) enable anyone to start an auction for tokens (or coins) they created - the process is virtually instantaneous and several millions can be raised within a few minutes. The funds are held in a Smart Contract; the rules according to which this money can be spent are specified and the smart contract is self-enforcing. Everyone knows how the contract will behave, thereby enabling higher trust levels.

> "A KEY ASPECT OF DECENTRALISING IS THE USE OF "REPUTATION SYSTEMS", WHICH CAN BE IMPLEMENTED ON BLOCKCHAINS IN A TRANSPARENT WAY"

Another key aspect of decentralisation is the use of "Reputation Systems", which can be implemented on blockchains in a transparent way. One can imagine a marketplace for medical research where researchers would be awarded reputation, in the form of a token, proportionally to the quality of their research. This can naturally be extended to reputation-based diagnostics; a patient answers targeted questions and provides his medical data, then a pool of trusted doctors provide independent diagnostics and collegially agree on a final diagnostic. This can further be enhanced with machine learning techniques, like DeepMind Health. More generally, a healthcare prediction market could be built in which actors that are correct more often are rewarded in a transparent way.

Zero-knowledge proofs (of knowledge)

Zero-knowledge proofs were initially an obscure field of research reserved to a few high-level computer scientists. Since the introduction of Smart Contracts and Blockchain, the urgent need for privacy within peer-to-peer interactions brought Zero-Knowledge proofs to the forefront.

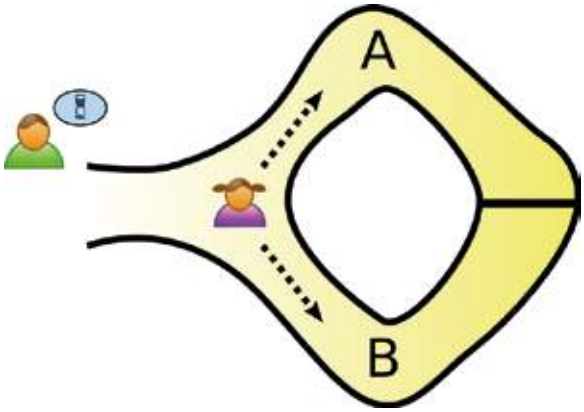
Since most healthcare applications of blockchain also require privacy, zero-knowledge proofs are a force to be reckoned with.

A zero-knowledge proof can be viewed as a mathematical programme, or statement, that should convince anyone that a specific piece of data has some property, yet no information about that data should be leaked except for this property itself. For example, a patient looking to buy insurance could give a proof that he has been diagnosed healthy by a certified doctor, without revealing who this doctor is. The patient would thereby lower his premium while the doctor's identity remains protected. The applications of zero-knowledge proofs are extremely wide reaching. To give the reader an intuition about how they work, we illustrate them through the "Ali Baba's cave" metaphor, initially presented by Jean-Jacques Quisquater in "How to Explain Zero-Knowledge Protocols to Your Children." To demonstrate, we will label the two parties in a zero-knowledge proof as Peggy (the prover of the statement) and Victor (the verifier of the statement).

A direct use case for Zero-Knowledge proofs in the context of Electronic Health Records (EHR) is the anonymous querying and aggregation of health data that preserves patients' anonymity entirely: We do not just render their identity pseudonymous, which is known to leak personal information. Instead, we use a Zero-Knowledge protocol to entirely encipher patients' data. We do this in such a way that, for example, aggregate data can be extracted out of the database, yet no actor can access all that data directly without the explicit consent of each single patient.

Electronic Health Records: Giving patients more control over their data

The patients' medical records are very valuable in two critical ways. Firstly, their structure and contents can make or break a diagnosis and they are critical for avoiding administering substances a patient is allergic to. Secondly, patient health data can be exploited for marketing purposes or even malicious



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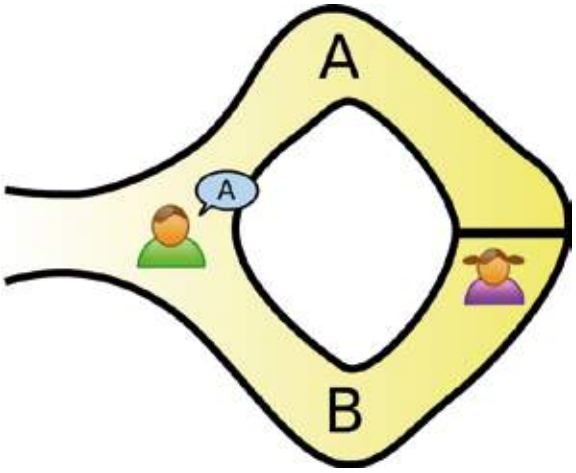
Peggy, the prover, randomly chooses path A or B. Victor does not see which one Peggy chooses.



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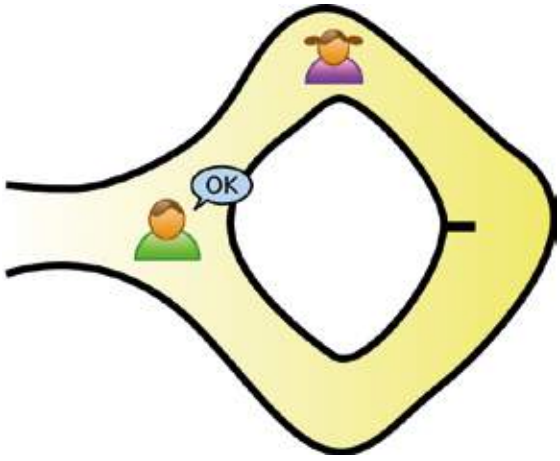
Once Peggy is inside the cave, Victor (the verifier) chooses an exit at random and challenges Peggy to come out of it. Assuming Victor chooses exit A, Peggy can only come out if she has the key -- Note that the path from A to B is locked,. If Victor chooses B instead, Peggy can come out without knowing the key.
The key symbolises the secret that Peggy needs to know in order to be able to answer Victor's challenge (i.e. unlock the door).



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Peggy comes out of the exit that Victor chose. The likelihood of this happening even when Peggy does not have the key is 50 percent. We therefore run the protocol iteratively until that probability becomes small enough. This means that, in the next round, the probability of false positive is 25 percent, then 12.5 percent and so forth for each additional round. After 80 rounds, the probability of Peggy fooling Victor becomes less than 10^{-24} - so Peggy cannot cheat Victor.

purposes by external actors, which is why it is so critical to protect this data. Giving patients control over their data will consist of a mix of blockchain technology and recent cryptographic techniques.

> “GIVING PATIENTS CONTROL OVER THEIR DATA WILL CONSIST OF A MIX OF BLOCKCHAIN TECHNOLOGY AND RECENT CRYPTOGRAPHIC TECHNIQUES”

To be clear, once data has been sent to an actor, there is no way to guarantee that this data is not copied or transmitted. Nonetheless, patients can require actors and institutions to sign a commitment that they will remove their data once the initial purpose for receiving them has been fulfilled. This is easy to do: the institution digitally signs a message containing the commitment and the patient keeps this commitment (some external server could store it as well). If the institution uses the data against the consent of the patient, the signature can serve as exhibit in court.

The data can be tainted in some identifiable way, also known as watermarking, so that leaking it can be traced back to the guilty party.

Drug provenance and integrity

According to Forbes, pharmaceutical companies incur an estimated annual loss of $200 billion due to counterfeit drugs globally (Forbes 2017). Using blockchain and Smart Contracts, it is possible to trace drugs over their whole life cycle. Each ingredient and substance is to be numbered and tracked, with geographic and other relevant information. The tracking data is then added to the blockchain (only the metadata is put in the blockchain for efficiency reasons.)

The blockchain guarantees that this data cannot be compromised or removed; giving us the cryptographic property known as non-repudiability: Once a drug has been tracked and registered, it is not possible for a malicious actor to make it disappear without getting caught. ■

KEY POINTS

- ✓ A smart contract is a computer protocol intended to digitally implement a contract
- ✓ Decentralisation is the process of distributing functions and/or powers away from a central authority
- ✓ “Reputation Systems” support transparent implementation of decentralisation
- ✓ Giving patients control over their data will consist of blockchain technology and cryptographic techniques
- ✓ Data can be watermarked so that data leaks can be traced back to the culpable source
- ✓ Zero-Knowledge proofs and Blockchain combined offer trust and privacy
- ✓ Blockchain guarantees that data cannot be tampered with

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Harnessing the power of connected care and telehealth

Major congress focuses on telehealth developments

Connected care and telehealth are playing a key role in the rapidly changing healthcare sector, but should be handled with care when implementing.

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The healthcare sector is one that is constantly and rapidly changing. Chronic disorders and complex disabilities are becoming more prevalent in certain medical fields. Maintaining a healthy lifestyle with regular visits to a local general practitioner can be challenging with the fast-paced nature of life. However, technological advances are playing a key role across all medical fields – not just from a clinical point of view with diagnostics and treatments becoming more advanced, but also from a connected care and telehealth perspective.

> "BY 2020 THE NUMBER OF CONNECTED WEARABLE DEVICES WORLDWIDE IS EXPECTED TO REACH 830 MILLION"

Patients are becoming more aware of medical conditions and their health through the vast access they have at their fingertips via mobile and wearable devices. According to the Global Mobile Consumer Trends report by Deloitte in 2016, more than one-third of mobile consumers worldwide said they check their phone within five minutes of waking up in the morning, and 20 percent of these consumers check their phone more than 50 times a day (Deloitte 2017). The launch of the Fitbit in 2007 caused a surge in wearable devices and the segment took off with key players in the market releasing smartwatches, fitness trackers and apparel to help consumers keep track of fitness levels. It is predicted that by 2020 the number of connected wearable devices worldwide is expected to reach 830 million, up from the 325 million devices currently in use (Statista 2017).

Move towards preventative medicine

As a result, wearable technologies and connected devices are transforming healthcare towards preventative care models helping both clinicians and patients to monitor and manage high risk populations, chronic conditions, as well as keep track of fitness, blood pressure, and even sleep quality. Worldwide telemedicine applications are surging due to the high prevalence of chronic diseases, rising smartphone users and the consistent need for improved quality services.

With wearable technology becoming an essential part of our daily lifestyle, Arab Health 2018 - the largest gathering of healthcare and trade professionals in the MENA region – will see the introduction of Personal Healthcare Technology Zone. This brings an essential element to the exhibition this year, as it will provide industry professionals and visitors the opportunity to explore the latest in 'Smart Healthcare Technology' that connects patients to physicians, hospitals or clinics.

For medical practices, telemedicine adoption comes with many benefits. The world's major regions are expected to see increases in healthcare spending ranging from 2.4 percent to 7.5 percent between 2015 and 2020 according to a 2017 report (Deloitte 2017). It is becoming more difficult for public health systems to sustain current

levels of service and affordability, causing many nations to explore discrete cost-containment measures. Telemedicine falls amongst these measures, along with other technology-assisted service provision and delivery methods, such as robots for drug dispensing, e-prescriptions, novel payment cards, patient administrative systems, electronic medical records (EMRs) and personal health records (PHRs).

> “IMPLEMENTING TELEHEALTH PROMISES LONG-TERM SIGNIFICANT SAVINGS FOR BOTH CLINICS AND PATIENTS”

Financial efficiency

Implementing telehealth promises long-term significant savings for both clinics and patients, whilst also providing simple, on-demand care to patients, making healthcare more convenient and accessible. In addition to this, telehealth can help boost doctors' revenue by turning on-call hours into billable time, attracting new patients, reducing missed or cancelled appointments, and even reducing overheads for physicians who decide to switch to a flexible work-from-home model for part of the week. It also leads to more personalised and patient-centered approaches, which can ultimately lead to increased patient engagement.

Whilst telehealth continues to grow rapidly and adoption rates are increasing, it is important to consider the limitations. It is paramount to ensure that all staff are technically trained and have access to the necessary equipment. As the reliance on technology increases over the coming years, it is important for patients to maintain in-person consultations, regular check-ups and care-continuity.

The 43rd edition of Arab Health will also feature a brand-new, three-day Connected Care conference, with each day covering a different theme; digital health, patient telehealth and home and long-term care.

Organised by the industry for the industry, the expert advisory board have handpicked the esteemed speaker line up who will be highlighting case studies and discussion points around the healthcare industries most pressing issues including, integration of digital healthcare, Electronic Health Record (EHR), cybersecurity, remote patient monitoring and patient satisfaction in home healthcare.

Arab Health 2018 will welcome over 4,200 exhibiting companies and 103,000 attendees from over 150 countries from 29 January – 1 February 2018 at the Dubai World Trade Centre. ■

KEY POINTS

- ✓ Wearable technologies and connected devices are transforming healthcare and have the potential to help patients and clinicians to monitor and manage high risk populations, chronic conditions, as well as keep track of fitness, blood pressure, and even sleep quality
- ✓ Implementing telehealth initiatives in medical practices can save time, reduce cost and increase revenue but should be handled with care to ensure patient care continuity and safety
- ✓ Arab Health 2018 - the largest gathering of healthcare and trade professionals in the MENA region – will see the introduction of a Personal Healthcare Technology Zone
- ✓ The 43rd edition of the exhibition will also feature a brand-new, three-day Connected Care conference, with each day covering a different theme: digital health, patient telehealth and home and long-term care

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Leading the way in patient healthcare portals

There is no "one-size-fits-all" approach to patient portals

With the European Commission's eHealth Action Plan 2012-2020 for wide digital health implementation in the works, sundhed.dk explains how to make a success of a health data portal.

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Can you summarise the current work and objectives of sundhed.dk?

sundhed.dk works according to the overall national strategy within eHealth as the state, regions and the municipalities, the funders of sundhed.dk, define it. The work and objectives of sundhed.dk are more specifically set by the strategy of sundhed.dk 2016-2018, which is defined by the political board of sundhed.dk. The strategy for the portal in the years 2016-2018 is:

- Display of more data on sundhed.dk
- A better, more user-friendly and focused portal
- More users to sundhed.dk
- Digital security and reliability of data

The number one priority is to have more patient data for general practitioners and the municipalities' home care nursing sector for more satisfied users in these fields. The last point, especially, has shown to be a tough job in Denmark.

Within this work - and as an add-on to our existing strong public sector data world - the focus for sundhed.dk is also to find a way to handle the citizens' own data extracted from wearables. There is no easy solution and the challenges for sundhed.dk is to be confident that data stays within the ownership of the general public and the citizens. This has to happen in cooperation with the public health sector and players in the private sectors, since they are designing and delivering the devices such as cell phones, tablets, smart watches used by citizens to register and collect their own data.

The next step is to find out what to do with this data. Can it be used by health professionals in combination with other personal health data generated in the public healthcare sector systems? I'm sure this kind of data will improve quality of treatment this way and will lead to more efficient treatment. sundhed.dk could play an interesting role here as a platform for uploading personal data – and a platform for accessing data.

Within this development, it will be even more important for sundhed.dk in the years to come to consolidate our role as a 'safe place' for the citizens' personal health data. We refer to it as "safe harbour."

The last thing is the ongoing work with constantly modernising the portal. In recent years this work has been focusing on re-building the portal to ensure access to information and health data from all mobile devices. The development of sunded.dk and the technical framework is always user driven. sundhed.dk has to quickly adapt to new tendencies in the public in technological development and in the healthcare sector to keep adding value to both citizens and health professionals.

How is the work aligning with the EU eHealth 2020 aims?

The work of sundhed.dk is aligning quite well with the EU eHealth 2020 aims. We recognise the challenges presented in the EU eHealth 2012-2020 plan and, even though we have come far with the development of sundhed.dk, Denmark still faces the same challenges: striving for a more efficient healthcare sector and higher-quality treatment through use of technology while keeping the public budgets down.

As highlighted in the EU eHealth Action Plan 2012-2020, Denmark is also experiencing a decline in the number of healthcare personnel, a higher incidence of chronic diseases and growing demands and expectations from citizens for higher-quality services and social care. sundhed.dk shares the perspectives in the EU plan which are as follows: "eHealth can benefit citizens, patients, health and care professionals but also health organisations and public authorities. eHealth, when applied effectively, delivers more personalised 'citizen-centric' healthcare, which is more targeted, effective and efficient and helps reduce errors, as well as the length of hospitalisation. It facilitates

socio-economic inclusion and equality, quality of life and patient empowerment through greater transparency, access to services and information and the use of social media for health".

The overall work of sundhed.dk is in some ways reflected in the EU eHealth Action Plan in terms of its aims of empowering patients and healthcare workers, to link up devices and technologies and to invest in research towards the personalised medicine of the future. This means providing smarter, safer and patient-centred health services. Given the fast-growing uptake of tablets and smartphones, the Action Plan also includes a special focus on mobile health (mHealth).

> "CITIZENS AND HEALTHCARE PROFESSIONALS ONLY USE A HEALTH DATA PORTAL IF IT BRINGS VALUE TO THEM"

sundhed.dk provides information and data for both healthcare professionals and citizens focusing on 'patient empowerment'. sundhed.dk has gone 'mobile' to match the growing uptake of tablets and smartphones and keep bringing value and provide safe and patient-centred health services – which also support personalised medicine in the future. Personalised medicine has high priority on the political agenda in Denmark and a national strategy for personal medicine was published recently. sundhed.dk has an important role here, also in the future, supporting patients.

On the subject of personalised medicine, it is also worth mentioning that we have experienced a shift from "system data - out" (data-generated in the healthcare system and shown to citizens/health professionals) to "system data – in" (data-generated in the public, by use of devices and optionally displayed to health professionals and maybe integrated to the public healthcare systems).

When it comes to the technical implementation of sundhed.dk this approach does not necessarily correspond with the course of action defined in the EU Action Plan.

sundhed.dk has been implementing a flexible approach without a national framework and national standards to follow, but fostering a spirit of innovation. sundhed.dk recommends encouraging small pilot projects and letting them evolve in their local, innovative settings in different parts of the country in cooperation between health professionals, users and administrators.

Another key learning to be prepared is regarding data security, associations of healthcare professionals and so on. Do not step aside for arguments for keeping valuable health data a secret and do not reinvent the wheel. Instead keep a pragmatic approach. The technical solution might be the easiest part of digitalisation.

What role did sundhed.dk play in getting the Danish populace's cooperation for eHealth implementation? What would you say is the most important factor in gaining the support of the population?

sundhed.dk is established and is continually being developed from a user-centred perspective. This approach is reflected in the strategic aims of sundhed.dk: working for a more user-friendly portal. sundhed.dk was established to bring value not only to the healthcare sector – but to the people: to Danish citizens and healthcare professionals. They only use it, if it brings value to them.

sundhed.dk works with user-centred design, service design and invites citizens and health professionals to be a part of designing solutions. The aim of sundhed.dk is to meet the needs and wishes of the citizens and the health professionals.

sundhed.dk offers 'one entrance' and easy access for the individual to health information and personal health data. sundhed.dk provides transparency within the healthcare sector and empowers citizens to take part in their own treatment, plan their next visit and so on. Data can be accessed only through a high-security level and the citizens have access to "my log" which is a service that shows the health professionals who have had access to data.

Another key element to explain the success of sundhed.dk within the population is that sundhed.dk is 100 percent publicly funded with no commercial interests. Citizens have great confidence in sundhed.dk.

What have been some of sundhed.dk's biggest challenges and how did it overcome them?

sundhed.dk is publicly owned across three administrative and political levels: the state, the five regions and the 98 municipalities. sundhed.dk is founded in national political strategies and has its own political board and steering committee.

This governance structure is one of sundhed.dk's great advantages.

Implicit in this model also lies a challenge: everyone has to pull in the same direction, and this can sometimes conflict with agendas and interests. Another challenge is, that the data sundhed.dk shows to citizens and health professionals is displayed directly from the source (the clinical system) or journals written by the doctor. This means that data is presented in "raw" form, without interpretation. This is not always a very user friendly or considerate way to communicate health data. This issue is discussed regularly: on the one hand data should be displayed at once (it is the citizens' own data they should be given access to it). On the other hand a health professional interpretation and comment to supplement data could be more considerate. This "delay" in showing data has gone from three weeks to 72 hours to zero hours at sundhed.dk.

Evaluations of specific services at sundhed.dk illustrate this point of view from the citizens: "data is better than no data" and even the doctors notes are appreciated, even though they are written with another purpose in mind, rather than to communicate directly to the citizens.

Is there anything that could be happening at a policy or other level to make the process of implementing eHealth easier across the EU?

It will be very difficult if you think in terms of overall technological frameworks or standards to be followed and wait for this to be defined and ready. eHealth solutions – also when it crosses sectors or borders – is not, in my opinion "one size fit all". Technological development moves fast and keeps moving – there is not enough time to analyse, clarify, define, standardise and wait for a 'great' framework to be established.

My best advice is to follow the Danish example for one: give citizens login access to their full eHealth data anytime anywhere – worldwide. We must open up and strive for transparency in a secure way. Let the citizens be "in charge" of their own data.

A suggestion could be for EU to focus on bringing people together to exchange experience so that we could learn from each other and from 'best practice'. Furthermore, we also have to bear in mind, that each country – also within the EU – has a different starting point, different prerequisites and possibilities.

How, in sundhed.dk's experience, does successful eHealth implementation reduce healthcare costs and improve patient outcomes?

You have to look at eHealth as an investment to support patient empowerment. When you empower citizens, you might bring the number of expensive hospitalisations down.

eHealth provides people with tools that make citizens co-players and co-writers of their own health situation and treatment. eHealth solutions can also support initiatives of prevention and the quality within treatment.

Successful eHealth implementation reduces healthcare costs and improves patient outcomes in numerous ways.

When the number of hospitalisations goes down, healthcare professionals can spend time with critically-ill patients, citizens can stay at home and maintain a higher quality of life and maybe still be part of the work force.

Personalised medicine can reduce costs and bring higher quality in treatment – eHealth can provide different tools to support telemedicine.

What do you think is ahead in the mid and long-term futures for eHealth?

Combining the healthcare sector's data with the citizens own contributions, I think that personal health data collected by the individuals using smart devices will be the core focus in the years to come. The question and the interesting challenge here is how to use this data and how to combine the health data generated in the healthcare sector with the citizens' own data. It fosters, in my opinion, a new co-operation between the public healthcare sector and players in the private market. ■

KEY POINTS

- ✓ sundhed.dk works according to the overall national eHealth strategy as defined by funders the state, regions and the municipalities
- ✓ The health portal stresses being a "safe harbour" for both healthcare professionals and citizens with a focus on 'patient empowerment'
- ✓ The aims of The European Commission's eHealth Action Plan 2012-2020 align with many of those of sundhed.dk
- ✓ sundhed.dk supports fostering a spirit of innovation through natural evolution of small pilot projects
- ✓ User confidence and trust is essential for healthcare portal success
- ✓ Smart device data will be the focus for eHealth in years to come

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The lab of the future

Technology is changing the face of medical laboratory operation

As healthcare technology advances, medical laboratories need to keep ahead of the curve on trends for optimal operation and interoperability. HealthManagement.org looks at key areas where changes are happening at full tilt.

Point-of-care testing for lab scientists

There have been great strides in Point-of-care testing (PoCT) in the last ten years. Developments in the current healthcare environment is likely to see further PoCT as the drive towards decreasing care costs continues. PoCT tech is implemented in two ways. Firstly, Small Mobile Devices, often hand carried, can support medical laboratory personnel with both qualitative and quantitative data. Additionally, laboratory instruments are decreasing in size and complexity increasing their potential for analysis in critical care as well as immunology.

> “AUTOMATION IN MEDICAL LABS HAS RESULTED FROM PRESSURES TO PRODUCE QUICKER RESULTS, LOWER COSTS AND IMPROVE PATIENT CARE”

The adoption of personalised screening and assessment guidelines for patients with higher cancer risk

A recent study that analysed the medical records of 741 patients has concluded that family physicians need to adopt explicit risk assessment criteria to identify, and to optimally care for, those at increased risk for cancer. This would result in not just improved quality of care but also reduced costs. Findings conclude that detailed family history information is insufficient to permit cancer risk assessment in more than two-thirds of patients, which means that individuals at moderate or high cancer risk are often not identified. Published by the Journal of the American Board of Family Medicine, the study highlights that laboratories can play an important role in supporting physicians in these risk assessment efforts. Panels of traditional tests and key clinical data can be offered to build a cancer risk profile that is easy for physicians to understand and explain to their patients.

Lab automation

Automation in medical labs has resulted from pressures to produce quicker results, lower costs and improve patient care. A current development is specimen separation automation. The inadvertent mix of blood with plasma is a continual problem for medical laboratory scientists and separating these two elements can be a complicated process. Automation in this area is increasing efficiency.

Labs add value to physician practices through education

A major shift on the horizon is that personalised cancer care will begin in the primary care physician’s office, not with cancer specialists. In addition to ordering traditional cancer diagnostic tests, primary care physicians (PCPs) will be ordering genomic-based tests that they are far less familiar with. A key component of this shift will involve laboratories educating physicians, nurse practioners and physician assistants in various areas. One core area will be identifying patients and their families at increased risk of cancer, and how to personalise cancer screening and assessment guidelines. Laboratories will also add value by explaining the clinical utility of new genomic-based tests and how they can help the PCP identify patients at higher risk of cancer. Also significant, will be education in non-invasive alternatives to biopsy procedures that pose their own risks of infection and complications. PCPs will be

allowed to play a role in active surveillance, an area now dominated by cancer specialists who may bring a bias towards aggressive treatment for all cancers.

Biobank service expansion

Biobanks preserve biological specimens for use in the future for Research and Development, transfusion and transplants. While biobanks are most widely used for blood banking, their use is expanding to include tissues, seeds and cells. Biobanks are becoming essential tools not only for medical laboratory scientists but biotechnologists and environmental scientists as well.

> "THE ADVANTAGES OF DRONES ARE NOT ONLY THEIR TRANSPORT VERSATILITY BUT ALSO THAT SAMPLES ARE NOT ADVERSELY AFFECTED BY ENVIRONMENTAL CONDITIONS"

Laboratories as genomics resource for clinical consults

One of the biggest challenges facing laboratories in the future will be shifting the lab's role from clinical service to providing relevant genomic information to assist clinical consultants to fulfil their role in this new age of genomic medicine. The challenges that labs will face in offering panels of new tests for early cancer detection are many, and new offerings will likely affect every function of the lab. While developing test menus, labs will not only have to evaluate pricing and return on investment, but they also will require more staff and new skill sets for interpreting test results and reporting results beyond entering results into laboratory information systems. Labs will also need to stay up to date with the latest advances in these technologies and their applications. Next-generation sequencing (NGS), for example, has been quickly adopted by major academic medical centres, but reimbursement reality is still limiting its acceptance in community healthcare systems. It is only a matter of time before labs will need to integrate NGS diagnostic tests as well. The real value of new genomic test menus can only be achieved by influencing the management of patients and related clinical outcomes, which is anticipated to be achieved through this shift in the healthcare landscape.

Drone deployment for specimen transport

With their ability to carry small quantities of samples without having to navigate streets and traffic, the increase of drone use is expected. The advantages of drones are not only their transport versatility and adaptability but also that samples are not adversely affected by environmental conditions during journeys.

Drones have already been used successfully in the developing world to transport medicines and medical supplies to areas that would be difficult to reach otherwise. ■

KEY POINTS

- ✓ Medical labs need to keep on top of HIT trends for up-to-date operation and interoperability
- ✓ PoCT is impacting on lab operation
- ✓ Automation in specimen separation practice is increasing efficiency
- ✓ Biobank use is expanding to tissues, seeds and cells as well as traditional blood banking
- ✓ Drones are being employed for lab material transport to remote areas
- ✓ Lab personnel will play a key role in building panels of tests and data to build a cancer risk profile that is easy for physicians to understand and explain
- ✓ Future laboratories will shift the lab's role from clinical service to providing relevant genomic information to assist clinical consultants

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The future of augmented reality in healthcare

Smart technologies shaping the future

An overview and look to the future of how augmented reality (AR) is being widely adopted in the healthcare industry, creating business opportunities for companies with AR expertise.

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Augmented reality is the use of displays, cameras, and sensors to overlay digital information onto the real world. In contrast to Virtual Reality (VR), which creates an entirely new world, AR allows us to bring the most useful information from the digital realm into our perception of the environment around us. AR is not a new concept, but over the last few years, advances in camera and sensor technology and AR-focused software research have made it practical — we're still in the early stages of the AR revolution, but this year and into the future, we can expect to see an explosion of AR devices and applications enter the market.

Indeed, healthcare and medical fields will be among the first to embrace AR in a big way. In fact, today there are many nurses and doctors interacting with AR applications every day to improve patient education and outcomes.

Google Glass was the first AR platform to get wide public exposure. However, it's safe to say that it wasn't a huge success with consumers, largely because of the high-cost, limited functionality, and perception problems — Google Glass was attractive, but it didn't look attractive. Beyond the consumer market, Google Glass has found a home in enterprise and in the healthcare field, demonstrating the importance of AR even at that early stage of development.

Many companies are now hard at work laying the foundation of the AR revolution. For example, Microsoft's Hololens is hugely impressive and is seeing wide adoption throughout industry and the healthcare space.

AR in healthcare

Healthcare workers have been quick to realise the benefits of AR technologies. Education is an obvious application of augmented reality in the healthcare field. Healthcare workers have to learn a huge amount of information about anatomy and the way the body functions. AR applications give learners the ability to visualise and interact with three-dimensional representations of bodies.

However, it's not only healthcare workers who benefit from augmented reality. It's also proving hugely useful as a tool for patient education, allowing medical professionals to help patients understand surgical procedures and the way medicines work.

> "THERE ARE MANY NURSES AND DOCTORS INTERACTING WITH AR APPLICATIONS EVERY DAY TO IMPROVE PATIENT EDUCATION AND OUTCOMES"

Today, surgeons use several techniques to visualise the area on which they are to operate, but augmented reality, which can project three dimensional representations of the patient's anatomy into the surgeon's field of view, is likely to improve accuracy and outcomes for patients.

A practical application of augmented reality which is in use today is vein visualisation. Many patients are uncomfortable with being injected or having blood taken, the experience is much worse when it's difficult to find a vein and the patient has to be "stuck" several times.

AccuVein for example, which is in use in hospitals today, can project a map of a patient's veins onto their skin, making it easier for healthcare workers to find the vein first time.

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into applications of augmented reality. Their vision of the future of AR in the healthcare field — The Near Future, A Better Place — provides a fascinating insight into the way advances in network technology and augmented reality will radically change the quality of life for seniors and others who depend on the healthcare industry.

Although augmented reality is used every day by healthcare workers across the US, there is a way to go before the vision that's presented by CableLabs for example becomes a reality. That means there is enormous opportunity for businesses that understand augmented reality and have the vision to create innovative new AR products and applications.

KEY POINTS

- ✓ Augmented reality is used in healthcare facilities across the world today, for applications that include vein visualisation, surgical visualisation and education.
- ✓ Recent hardware and software advances have reduced the cost of augmented reality while significantly improving the experience for users and developers.
- ✓ Forward-thinking healthcare providers are investigating the potential benefits of AR to their customers and their business.
- ✓ We're in the early days of AR in healthcare, but the future will bring significant advances to the education of patients and healthcare professionals, communication, and patient outcomes.

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The challenges and opportunities of tomorrow's radiologist

Radiology facing its future head on

An overview of how smart tools such as artificial intelligence should perhaps not be feared, but rather accepted and embraced.

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The future of radiology is indeed a hot topic in healthcare today. The role that smart technologies such as deep learning (DL) and artificial intelligence (AI) play within radiology continues to spark both fear and interest, yet the reality is that they are both potentially very useful technologies that will add value to the field in many ways.

All across the field, people are questioning what this means for the traditional role of the radiologist. In fact, it's an issue that is not just limited to radiology; physicians and providers of all kinds are dealing with this issue.

This particularly trending topic was no doubt the most talked about subject at the recent Radiological Society of North America (RSNA) congress in Chicago in November last year. From Dr. Roderic, to Dr. Paul Chang, experts drew their conclusions on "tomorrow's radiology" and while there is growing concern and fear, there also appears to be an idea that such technological innovations need to be optimised in order to be used to their maximum advantage.

Various riveting sessions took place that covered the subject, however there were a few particular ones which seemed to take the lead.

During a session titled "Harnessing Artificial Intelligence," Dr. Keith Dreyer, vice chair of radiology and

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director of the Center for Clinical Data Science at Massachusetts General Hospital, Boston, and chair of the American College of Radiology's Commission on Informatics, explained to the audience the complexities involved in teaching computers to read images.

"Machines are getting smarter faster than people are," said Dr. Dreyer. He explained that radiology needs globally accepted ways to develop and incorporate AI, in order to make it easy for developers to create new applications and integrate them into imaging devices and clinical information systems. Dr. Dreyer referred to the issue of developing AI as “a "healthcare AI ecosystem."

In an another powerful session Dr. Roderic I. Pettigrew told delegates in his presentation “Tomorrow’s Radiology” that the overall goal of today’s healthcare enterprise is to achieve healthy longevity.

Dr. Pettigrew explained that tomorrow’s radiologists must work to establish themselves as imaging, information science and image-guided therapeutics experts who will play a vital role on healthcare teams.

"That bold vision requires technological innovation for earlier precision diagnostics and therapeutics," Dr. Pettigrew told the audience, "and tomorrow's radiology will play a critical role in achieving this goal.

"We emphasise innovation because we realise that like imagination, there is no end to innovation.”

Dr. Paul Chang, MD, of the University of the Chicago School of Medicine, explained to delegates in his session that due to the increasing demands on clinical imaging, radiology will indeed need these new technologies now more than ever before.

“Deep learning will help us because we are going to need something…some mechanism…to meet these new imaging challenges,” Dr. Chang said. The help that he was referring to was some kind of cybernetic help which would help radiologists’ get through a day’s work and therefore help to maintain and improve quality.

He explained that there is an increasing demand to correlate images with other clinical information in order to implement practices such as radiogenomics.

While many fear that the implementation of deep learning algorithms in image processing would drastically reduce the need for radiologists, Dr. Chang attempted to reassure the audience that “Deep Learning is not going to replace us, but instead redefine us”.

One such challenge during these early days is the fact that perhaps radiology doesn’t actually have the infrastructure to either feed, train or consume these systems.

"Other industries have really revved up for cloud computing and big data and are ready to consume deep learning, because deep learning loves that kind of environment," Dr. Chang said.

However, it seems that radiology is still struggling with electronic medical records (EMRs) and PACS and, “we generally don't have a true IT infrastructure that can feed and consume these systems,” he explained.

"The bottom line is that deep learning won't replace people — it will enhance them," Dr. Chang said, “We should be looking for the minimally heuristic use case sweet spot like workflow optimisation.” In addition, hospitals also need to be convinced that the AI algorithms work.

> “THE BOTTOM LINE IS THAT DEEP LEARNING WON'T REPLACE PEOPLE — IT WILL ENHANCE THEM”

Indeed, one can argue that reality will not allow the luxury of bringing groups of radiologists together to develop an opinion on every case. However, it’s clear that for such extreme complex cases, radiologists may be able to grab AI and other technologies by the swarm, which essentially could improve the accuracy of patient diagnoses, while also empowering team members and streamline the patient care process.

What is clear is that radiologists want a bigger role in healthcare, one that allows them a say in patient management, ideally one that goes from diagnosis to therapy follow-up. Plus, research trends and experts underline how AI will revolutionise radiology in the long term. Healthcare and in particular radiology was nothing like what it is today, so perhaps what needs to be kept at the forefront is the most common ground: taking care of patients. While these concerns across the board are no doubt valid, healthcare is seeing clinicians using AI to inform their diagnoses and care plans, rather than solely leaning on the technology.

However, it needs to be demonstrated through proof that the involvement of these devices in fact adds clinical value. Should this be demonstrated, then the opinions of experts like Dr. Paul Chang and Prof. Keith Dreyer can be understood and confirmed. ■

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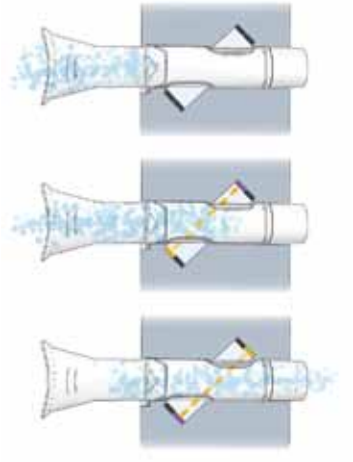

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Utility of artificial intelligence in cardiology

A step forward for daily practice

Artificial Intelligence (AI) tools are proving their utility in the evolving field of cardiology. However, it's necessary that cardiologists understand their full potential in order to use them efficiently in the near future.

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Decision making in medicine

Nowadays, the decision-making process in medicine is a complex task that in an ideal world is based on the availability of reliable and objective evidences, fast access to knowledge, as well as proper interpretation of available facts with the incorporation of patient benefit-risk ratios into every step. However, the experience of the practice of medicine in the real world has taught us that these evidences are not always available, assimilation of knowledge takes time and decisions regarding each individual case may not always be objective (Bonderman, 2017).

It is known that the most errors in decision-making have been attributed mainly to two elements, one of them is bias such as categorising minorities (social bias) and the other one is the noise, which means that decisions are prejudiced by irrelevant factors such as current mood, time since the last drink or even the current weather, that was highlighted by Kahneman (2016). If you combine all of this information, there is indeed a clear room for improvement with respect to generating evidence, structuring knowledge and translating it into clinical decisions.

The incorporation of artificial intelligence (AI) tools in the field of cardiology into daily decision-making will most likely improve care. Of course however, it is necessary that cardiologists must retain the last step in the control of the system, keep an eye on the decisions and have the authority to change algorithms in the cases that may go wrong.

Artificial Intelligence

Many definitions for this topic exist, however there is no doubt that it depends on your focus in the field of healthcare.

In Wikipedia for example, (**https://en.wikipedia.org/wiki/Artificial_intelligence**) AI is referred to as the intelligence displayed by machines, in contrast with the natural intelligence displayed by humans and other animals. In computer science AI research is defined as the study of "intelligent agents": any device that perceives its environment and takes actions that maximise its chance of success at some goal. Colloquially, the term is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".

For other authors, AI is considered a branch of engineering that implements novel concepts to resolve complex challenges (Kahneman, 2016). Another definition for AI could be a field of computer science that aims to mimic human thought processes, learning capacity, and knowledge storage (Krittanawong, 2017), that probably fits best for medical approach.

Another element with a great relation to this topic is ‘big data’, this term refers to extremely large datasets that cannot be analysed, searched, interpreted, or stored using traditional data-processing methods. Big data includes data from mobile phone applications, wearable technology, social media, environmental and lifestyle-related factors, sociodemographics, “omic” data (e.g., genomics, metabolomics, proteomics), and data from standardised electronic health records (EHRs) or precision medicine platforms (Krittanawong, 2017).

AI in cardiology

AI techniques such as machine learning, deep learning, and cognitive computing, may play a critical role in the evolution of cardiovascular medicine to facilitate precision cardiovascular medicine. In order to deal with cardiovascular big data, we will certainly need these techniques.

In cardiovascular biomedicine, there are four biomedical big data sources which are important:

1. Functional phenotypes such as demographics,

echocardiograms, electrocardiography, haemodynamics, and imaging data
2. Molecular profiles derived from large-scale omics data that may be acquired in large trials or the clinical setting
3. Medical records, including patient electronic medical records containing laboratory test results, physician's notes and other information on disease, treatment, and epidemiology that may be mined for association studies and predictive modelling on prognosis and drug responses
4. Literature knowledge: it is estimated that in cardiovascular medicine there is a new publication released approximately every three minutes. This amount of data overwhelms human intelligence, but may be mined and structured by deep learning algorithms.

Despite its fast and wide penetration of medicine in general, as Kahneman (2016) points out, "Most cardiologists today are more likely to associate the term 'artificial intelligence' with a futuristic extra-terrestrial phenomenon rather than with a tool that is just about to conquer medicine, including cardiovascular medicine."

Machine Learning

The term machine learning (ML) represents various techniques for solving complicated problems with big data by identifying interaction patterns among variables. In contrast to traditional statistics, machine learning is focussed on building automated clinical decision systems (such as readmission and mortality score systems) that help doctors make more accurate predictions, rather than simple estimated score systems.

Machine learning can be categorised into three learning types: supervised; unsupervised; and reinforcement. In supervised learning, algorithms use a dataset labelled by humans to predict the desired and known outcome; is great for classification and regression problems, but it requires a lot of data and is time-consuming because the data has to be labelled by humans. Unsupervised learning seeks to identify novel disease mechanisms, genotypes, or phenotypes from hidden patterns present in the data; the objective is to find the hidden patterns in the data without feedback from humans. Reinforcement learning can be viewed as a hybrid of supervised and unsupervised learning; the objective of reinforcement learning is to maximise the accuracy of algorithms using trial and error (Krittanawong, 2017).

A good example of the use of machine learning in cardiology is the prediction of the survival of patients with heart failure and preserved ejection fraction by Shah (2015), which was the creation of an unsupervised learning model across 46 different variables to identify intrinsic structures within patients with this type of heart failure; they identified three distinct groups. Subsequently, they performed supervised learning to predict the difference in desired outcomes (mortality and hospitalisation) among the groups. However, the limitation of unsupervised learning is that the initial cluster pattern needs to be corrected without bias; therefore, the study needs to be validated with other cohorts.

Deep learning

It mimics the operation of the human brain using multiple layers of artificial neuronal networks that can generate automated predictions from input (training datasets).

Deep learning can be very powerful with relation to image recognition (eg facial recognition in Facebook, image search in Google), and can potentially be used in cardiovascular imaging (eg 2D-speckle-tracking echocardiography, 3D-speckle-tracking echocardiography, angiography, cardiac magnetic resonance). It can also be trained in an unsupervised manner for unsupervised learning tasks (e.g., novel drug-drug interaction), and, in addition, there is no limitation on working memory. It also works well with noisy data, such as 3D- speckle-tracking echocardiography and strain imaging data.

Deep learning algorithms will also facilitate the use of artificial real-time cardiovascular imaging with better spatial and temporal resolution, potentially improving the quality of care and reducing costs (Krittanawong, 2017).

One example found that using this technique (Kannathal, 2003) through a deep neural network classified the ECG signals of cardiac patients into normal, abnormal, and life-threatening states, and found the classification to be correct in approximately 99% of test cases.

Cognitive computing

Cognitive computing involves self-learning systems using machine learning, pattern recognition, and natural language processing to mimic the operation of human thought processes. In cognitive computing, a system or device is trained by machine learning or deep learning algorithms.

The goal of cognitive computing is to create

automated computerised models that can solve problems without human assistance (Krittanawong, 2017).

IBM Watson, a well-known example of cognitive computing, continuously learns from datasets (eg EHR, social media, stock market) and can predict outcomes using multiple algorithms more accurately than humans.

One example of this use in cardiology is the research made by Dr. Partho Sengupta (2016) where he developed an associative memory classifier, a cognitive computing machine learning algorithmic approach, to classify constrictive pericarditis from restrictive cardiomyopathy, and demonstrated its feasibility for automated interpretation of speckle-tracking echocardiography data.

Artificial Intelligence in the field of cardiac imaging

AI will have a role to aid reproducibility in cardiac imaging, for example Siemens Healthcare was the first to introduce elements as algorithms into its cardiac echo systems several years ago to speed automation.

Philips Healthcare also has introduced elements of AI on its EPIQ ultrasound system some years ago. Here, they take a 3D echo dataset acquisition which automatically analyses the image to identify the heart's anatomy, labels it and then slices the optimal standard views for presentation. This tool eliminates issues with interoperated variability, because the software will always choose the best views based on machine learning, which uses thousands of prior studies representing the spectrum of patient anatomical variations. This would take years for a human operator to accumulate the same information.

Other vendors have also introduced elements of deep learning algorithms to help analyse echocardiograms or perform auto quantifications. Next generation echo systems will incorporate more AI features to further improve workflow by auto-completing time-consuming tasks so they can become more efficient and consistently be more accurate.

All of the major imaging system vendors are either developing their own AI or partnering with AI vendors with big announcements during 2017. Siemens Healthineers announced a partnership with IBM Watson, GE Healthcare announced it will be working with Partners HealthCare, which will be executed through the newly formed Massachusetts General Hospital and Brigham and Women's Hospital Center for Clinical Data Science. In addition to its EPIQ echo software, Philips also developed its own AI software to enhance its IntelliSpace Enterprise medical imaging informatics platform, which is smart enough to pull all of the patient's relevant prior exams for the same anatomy and open the images in the exact same format and view as the current exam.

Conclusion

AI tools such as machine learning, deep learning, and cognitive computing are promising and indeed they will change the way in which cardiology is practiced, especially in the cardiac imaging field. However, physicians need to be prepared for the upcoming AI era, and clear results of the utility of AI within daily practice is essential.

I believe that AI will not replace cardiologists, but it is important that cardiologists know how to use AI sufficiently to generate their hypotheses, perform big data analytics, and optimise AI applications in daily practice to bring on the era of precision cardiovascular medicine. ■

KEY POINTS

- ✓ Decision-making process in medicine is a complex task
- ✓ Incorporation of artificial intelligence tools in the field of cardiology into daily decision-making will improve care
- ✓ Artificial intelligence tools like machine learning, deep learning or cognitive computing are proving their utility in cardiology
- ✓ In the field of cardiovascular imaging, artificial intelligence is showing a great potential

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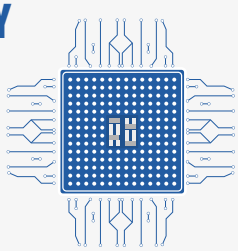
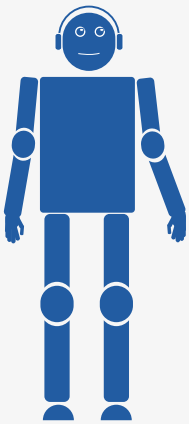
8 MOST TECHNOLOGICALLY ADVANCED HOSPITALS



- Mayo Clinic in Florida
- Texas Medical Centre in Houston
- Johns Hopkins in Baltimore
- The London Clinic, UK.
- American Hospital in Paris
- Fortis Memorial Research Institute, India
- El Camino Hospital in CA and Cleveland Clinic in Ohio
- Bumrungrad Medical centre in Bangkok and Anadolu Medical centre in Turkey

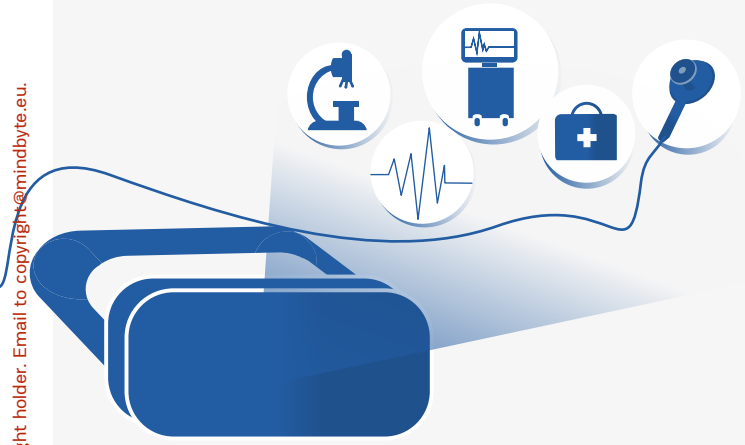
Source: Hot-oncotherm 10 Most Technologically Advanced Hospitals in the World https://iii.hm/g9

HEALTHCARE JOBS OF THE FUTURE



As in the era of the various Industrial Revolutions, many people are currently afraid that robots and artificial intelligence will take their jobs. It is without doubt that disruptive technologies are changing healthcare, medicine and pharma, as well as the way we gather medical information or how we interact with medical professionals and caregivers. It is true that robotics, AI, genomics and the wearable sensor industry will remove existing jobs. But I cannot stress enough that it will also add new ones – as it happened in previous historical eras with other professions!

Source: Medical Futurist - 10 New Jobs in the Future of Healthcare and Medicine – Part I https://iii.hm/g9h



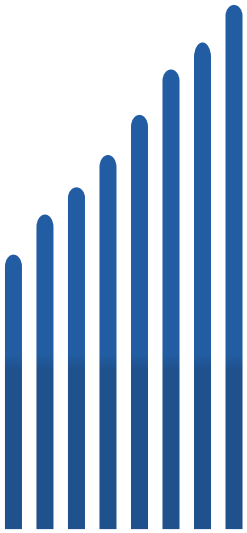
TOP TECHNOLOGIES THAT ARE CHANGING HEALTHCARE SECTOR

- **Quantum computing**
- **Robotic care**
- **Nanorobots**
- **Cyborgisation**
- **Brain-computer interfaces**
- **Medical tricorder (diagnostic device)**
- **Digital avatars**
- **Augmented/virtual reality**
- **3D printing**

Source: Ten Top Technologies That Will Transform The Healthcare Industry

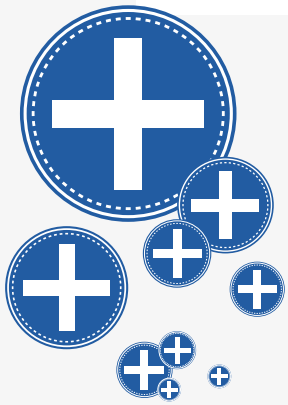
https://iii.hm/g9i

EXPENDITURE AND NEW FINANCIAL MODELS



The world's major regions are expected to see healthcare spending increases ranging from 2.4 percent to 7.5 percent between 2015 and 2020. Reimagining and reconfiguring economic incentives so that healthcare organisations are rewarded for doing the right thing at the right time to support their patients' health remains a critical frontier in the push towards risk-sharing and outcome — and value-based payment programmes.

Source: Global Health Care Outlook 2017 https://iii.hm/g9g



WHAT THE PATIENT IS BRINGING TO MEDICINE

- Richer insight
- Potential solutions
- Changing relationships
- Individual benefits
- Better quality decisions
- Changing practice
- Benefits beyond the project

Source: Future patient blog - Seven things that patients bring: the benefits of patients as partners for change https://iii.hm/g9j

Logistics robots to support care: a Finnish study

How to introduce robotics into a healthcare setting for a smooth transition

Study shows that Change Management can make or break success of robotics implementation in a hospital setting.

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Key areas in which innovative technology is contributing to healthcare include improving efficiency and productivity. Hospital hallways often become congested, which can hinder the transportation of supplies as well as the fluid movement of staff. In a busy hospital setting, this may be expected, but a recent study in Finland has focused on making improvements in this area with the use of robots.

VTT Technical Research Centre of Finland has implemented a logistics robot system at the Seinäjoki Central Hospital in South Ostrobothnia, with the aim of reducing transportation costs, improving the availability of supplies and alleviating congestion in hospital hallways by running deliveries around the clock on every day of the week. The study forms part of the preliminary steps being taken to introduce automated delivery systems in hospitals throughout Finland. Seinäjoki Central Hospital's robot system will include a total of five to eight automated delivery robots, two of which were deployed during the study.

> "TRANSPORT PERSONNEL EXPENSES AND THE PHYSICAL STRAIN OF TRANSPORT WORK HAVE BEEN REDUCED AND VIEWS ON THE DELIVERY ROBOTS HAVE DEVELOPED FAVOURABLY"

Impact on Safety, Care Quality and Jobs

Although adopting new technology to support care and nursing work is important in the transition to a hospital design that responds to modern needs, autonomous service robots and robotic systems raise questions about safety as well as about their impact on care quality and jobs, among other issues. Joint planning and dialogue between various occupational groups and stakeholders is therefore paramount to a successful change process. The VTT study involved personnel across the board and this is considered to have facilitated a smooth transition.

Experiences gained during the first six months of the study show that transport personnel expenses and the physical strain of transport work have been reduced in the hospital. Meanwhile, the personnel's views on the delivery robots have developed favourably. In terms of other occupational groups, the study has found that adoption of the system has had a varied effect on staff's perceived level of sense of control and appreciation of their work, as well as competence requirements.

By employing this forward-thinking research approach together with a systems-oriented view, this study by VTT highlights the importance of taking the interdependencies between various players into account in this kind of change process. This includes considering how the transformation affects their roles in the hospital's core task of providing high quality care.

Wider-Scale Implementation

In light of positive results from the study, other hospitals have shown plenty of interest in Seinäjoki

hospital's experiences. When considering the need for robotic services on a wide scale, careful planning, piloting and implementation are required to ensure that the adoption of new robots runs smoothly as a whole. "As the system is expanded with new robots and types of deliveries, even more guidance, communication and dialogue is needed. Joint planning that brings various players to the same table ensures that the system's implementation goes as smoothly as possible, making it easier to achieve the desired overall benefits", says Senior Scientist Inka Lappalainen of the ROSE project.

> "AUTONOMOUS SERVICE ROBOTS AND ROBOTIC SYSTEMS RAISE QUESTIONS ABOUT SAFETY AS WELL AS ABOUT THEIR IMPACT ON CARE QUALITY AND JOBS"

VTT's study is part of the Robots and the Future of Welfare Services project (ROSE), running from 2015 to 2020. The project investigates Finland's opportunities for adopting assisting robotics to support the ageing population's independent living, wellbeing and care. There is also a blog post on the topic: **http://roseproject.aalto.fi/fi/blog/32-blog8**.

Intermediate results of the project are presented in the publication Robotics in Care Services: A Finnish Roadmap, providing recommendations for both policy making and research. The roadmap is available on the ROSE project website, at **http://roseproject.aalto.fi/** or **http://roseproject.aalto.fi/fi/blog/29-roadmap-blog-fi**.

The roadmap has been compiled by the project consortium comprising Aalto University, the project's coordinator, and research organisations Laurea University of Applied Sciences, Lappeenranta University of Technology, Tampere University of Technology, University of Tampere and VTT. ■

Hospital transport robot

KEY POINTS

- ✓ Technology is improving healthcare efficiency and productivity
- ✓ VTT Technical Research Centre of Finland has developed robotics system for hallway transport in Seinäjoki Central Hospital
- ✓ The system includes five to eight automated delivery robots
- ✓ Robotic systems bring up safety concerns as well as impact on jobs and care quality
- ✓ The VTT study featured input from occupational groups and stakeholders which helped facilitate a smooth transition
- ✓ Transport personnel expenses and physical toll of transport work have been cut and personnel views on robots are favourable
- ✓ Study success has led to interest from other hospitals

Award-winning new doctors' assistants freeing time in acute NHS hospitals

Pilot reduces doctor overtime and improves efficiency

Developing staff as doctors' assistants from HealthCare assistants in acute National Health Service (NHS) hospitals is safe, efficient, high value and improves patient care.

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There is a crisis in the UK NHS, with reductions in doctors' working hours and a relentless increase in numbers and complexity of patients (HEE, 2017). Other reports catalogue that doctors in training posts spend half their time on administrative work (RCS, 2016), dominated by repetitive and menial tasks (Morrow, 2012), with 99 percent in posts which fail standards for educational opportunities (ASiT/BOTA, 2017), morale is low (GMC, 2016) and there are excessive vacant posts - an average of 9.6 percent vacancies in hospital doctor posts (HEE, 2017).

The workforce challenges, including vacancies of doctors, mean lengthy waiting times for patients in busy acute hospitals for essential tests, treatments or discharge paperwork, across seven-day services.

In the UK NHS, most staff are on pay bands of 'Agenda for Change'; Band 5 is typically for a Staff Nurse on qualification or similar degree-level staff who often have Registration with a national body; Bands 6, 7, 8a and 8b signify progressively more autonomous clinical or managerial roles with additional training, expertise and salary (NHS employers, 2017). There are many good initiatives to develop Registered autonomous staff into Practitioner level (Band 6, 7 or 8a) (HEE, 2017). Developing practitioners can be perceived as expensive and competing with doctors for training and complex tasks (Matthews, 2017) not always fulfilling the local need (Bruce et al, 2016) and depleting other staff groups. Even Band 4 roles have been criticised for excess autonomy (Bodkin, 2016). Conversely, there are very few NHS clinical roles at Band 3, an assistant role, with minimal autonomy and no requirement for registration. The Carter review (2016) and NAO (2017) recommend sustainable development of local staff, which our development of Band 2 into Band 3 staff aims to deliver.

We report a project developing a new NHS role of doctors' assistant at Band 3 (£18,000 mid-point + on-costs) and its progress through planning, successful six-month pilot, evaluation, business case development and dissemination.

> "AT BASELINE, DOCTORS' LOGS SHOWED 44 PERCENT TIME DOING ADMIN"

Methods

We undertook a six-month pilot of appointing/developing six doctors' assistants at pay Band 3 from our existing healthcare assistants, initially through a process of secondment. Initial work with a wider group of clinicians, the Education team and managers identified key delegable tasks traditionally done by ward/training/on-call doctors (cannulation, dementia screening, drafting discharge summaries, venepuncture, writing in notes, finding test results and taking requests) and devised a two-week induction course. We created robust processes, including recruitment process, pre-reading dossier, two-week induction, communication strategy, rotas, uniform and weekly tutorials. We worked across departments (initially Clinical Education, finance, IT, Medicine, Surgery

Doctors' Assistants and team at East Sussex Healthcare NHS Trust

and Cardiology; later rolled out to Orthopaedics and Urology). We acknowledge learning from other pioneers (Brighton and Southampton) (Kause, 2016).

NHS Health Research Authority approval/ethics (ref 215636: REC ref17/HRS/0019) was obtained through Proportionate Review. This was an Action Research project. Quantitative data included recordings of times and activities of doctors at baseline. Similar data were collected pro-actively from doctors' assistants time sheets. Routinely collected Trust data were scrutinised. Feedback was sought from staff. Qualitative data were analysed thematically.

We prioritised communication with stakeholders including hospital staff, GPs and patients. Fears over 'dumbing down' were ameliorated with our 'no-involvement-with-medication' rule. We listened and responded to feedback (eg business cards listing tasks/bleeps, targeting teaching, checklists, ward round trolleys, etc). We had articles in internal and local press and attended team and individual meetings.

Results

At baseline, doctors' logs showed 44 percent time doing admin. 78 percent of exception reports (overtime from junior doctor contract) were for tasks that could be delegated. Doctors reported 88 percent greater likelihood of attending teaching/operating sessions if a doctors' assistant was present.

Qualitative assessments demonstrated pride, support and very positive feedback from all grades of staff. Three themes identified as vital for success were: supportive line management, communication with stakeholders and defining role boundaries (eg no contact with medication to reduce perceived risk).

The doctors' assistants were especially useful at evenings, weekends and bank holidays, when there are fewer doctors, with multiple instances of improved care or improved patient flow. For elective wards 8am-6pm Monday-Saturday worked better than long shifts.

Our new curriculum was very clear on the skills expected and the level of knowledge and attitudes required. We also involved the doctors' assistants in other initiatives: this included additional workshops on 'Making Every Contact Count' so they were empowered to discuss general health with patients; induction included sessions on behaviours, to identify behaviour that could be perceived as bullying and to have a way of dealing with this. These aspects of

Doctors' Assistant team winning Skills For Health award

culture change merit future development.

The project proved cost-effective. Doctors' overtime reduced 80 percent comparing a week with and without a doctors' assistant. The new Junior doctor contract allows for overtime to be paid if 'exception reports' are completed with a total cost including fines of £24-£85 per hour. Exception reports in Urology fell from £195/week to £0/week and in Orthopaedics from £197/week to £24/week with doctors' assistants present, but a simultaneous change of personnel reduced the clear comparison.

Analysis of doctors' assistants shifts demonstrated multiple patients whose care/discharge was expedited. This reduced the need to open escalation areas. Doctors' assistant day-time shifts were successfully redeployed to cover doctor vacancy. This saved financing day-time doctor locums at £50/hour, whilst using the doctors' assistant for any delegable tasks at £9.70/hour. (Six shifts covered in this way saved £2,500.)

For our project, the first six months were with educational funding from Health Education England. This stage proved safety, quality, acceptability, robustness of the educational package and proof of concept. The project was extended to demonstrate value. Reduced locum spend, reduced 'exception' doctor overtime, improved patient flow and attention to items on the Trust risk register all helped develop the business case for continued Trust funding. Four of our original six doctors' assistants have chosen to remain and are now in substantive posts.

Discussion

A communications strategy was essential to reinforce to staff that doctors' assistants are support staff (not Practitioners/Registered) performing delegated work and that their work needs 'signing off' by a doctor, and that they are very different from the physician associates, surgical care practitioners or other practitioners. Line management within education or the same as for the doctors was vital.

> "A NEW ROLE OF DOCTORS' ASSISTANT CAN BE HIGHLY EFFECTIVE, INEXPENSIVE AND WITH NO SAFETY CONCERNS"

Prior healthcare assistant experience and a clear task list makes a two-week induction possible. This role stimulates clinically-focussed motivated staff in the gap between Band 2 and Band 5, to contribute and develop, with future Apprenticeship opportunities.

There is a financial area of challenge, in that our Trust has devolved budgets to each department and specifies revenue items (eg staff salaries) and capital items (equipment). There is no budget for additional staff and none for 'unexpected items' (complaints, cancellations, locum spend, etc). Doctors' assistants cannot replace doctors. The Trust executive team had the vision to use regular staff at Band 3 to mitigate unexpected overspends. Although the results in surgery and urology demonstrated high workload, high satisfaction and improved patient flow, the managerial teams did not prioritise accepting them into their fixed budget. The substantive posts were created in medicine which has vacant doctor posts and in ortho-geriatrics, which has issues of excessive workload and sub-optimal documentation (Haycock, 2014).

Conclusions

A new NHS role of doctors' assistant can be highly effective, inexpensive and with no safety concerns. With healthcare assistant experience, a two-week induction is satisfactory. Communication with stakeholders should reinforce their role as support staff (neither practitioners nor registered) performing delegated work.

The doctors' assistants role should be introduced immediately at all NHS sites where doctors in training are overloaded. It fits with Carter review (2016), NAO (2016) and HEE (2017). Our two-week induction and weekly tutorial could form the basis for an apprenticeship.

So far, this workforce model has been presented at 11 national or regional events; 12 interested Trusts have requested information or visits. We have made our job description and tips available on the websites: **http://www.bit.do/dr-assistants and www.scarlettmcnally.co.uk**. Careful line management, clear skill description and good communication is essential.

The doctors' assistants project has won the Gold Award in Skills for Health for developing staff, runner-up in BMJ Awards and finalist in HSJ awards. The doctors' assistants themselves won the Trust award for workforce and the project was shortlisted for innovation. We are grateful to Health Education England (HEE-KSS) for a grant of £80,000 to cover all costs, including salaries for six doctors' assistants for the six-month educational pilot phase. ■

KEY POINTS

- ✓ Around 50 percent of ward/on-call doctors' time is on tasks that do not require a medical degree or autonomous practitioner status
- ✓ There are very few 'Band 3' clinical roles in acute NHS hospitals. The cost is half that of a doctor or practitioner
- ✓ We defined clear tasks that could be delegated
- ✓ We recruited from experienced healthcare assistants (HCAs), developing them with an empowering two-week training course, uniform, structure and weekly tutorials
- ✓ A thorough evaluation confirmed no safety issues, high quality of tasks, multiple patients who had their discharge, diagnosis or treatment expedited, doctors' time freed up to attend education and reduced exception reports from doctor overtime
- ✓ Qualitative findings confirmed excellent feedback from doctors at all levels and other staff
- ✓ Developing staff requires: good line management, regular clinical supervision, stakeholder engagement and communication (eg clear tasks on business-style cards)
- ✓ The business case was built on mitigation of over-spend: reduced need for day-time doctor locums, fewer exception reports (relating to overtime for doctors in training posts), better documentation, fewer delayed discharges and help with difficult items on Trust risk register across the seven-day acute service

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3D printing at the Jacobs Institute: an update

At the forefront of neurovascular and cardiac surgical modelling

How one healthcare innovation centre is making great strides with neurovascular and cardiac 3D printing for better, more economical care.

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The autumn 2016 issue of HealthManagement.org showcased the ways that the Jacobs Institute (JI), a non-profit medical device innovation centre in Buffalo, NY, is using 3D printing to create realistic patient-specific vascular flow models. Fourteen months on, the JI continues to use 3D-printed models for physician training, device testing, and pre-surgical planning. We have also continued to work with our partners including 3D printer manufacturer Stratasys, the University at Buffalo (UB), and the Gates Vascular Institute (GVI) to make the models more robust and clinically relevant. Further, we expanded our expertise to produce—in addition to patient-specific neurovascular and cardiac models—complex abdominal aortic aneurysm (AAA) models.

The JI partnered with Stratasys to test its next generation of rubber-like PolyJet materials that produce models that retain their realism, but are significantly stronger and easier to clean in post-processing than earlier models. One of these materials, Agilus30, was recently released publicly by Stratasys as part of its BioMimics Platform. According to Adnan Siddiqui, MD, PhD, chief medical officer at the JI, "The BioMimics capabilities enable a level of biomechanical realism and clinical sophistication not previously available in any vascular model."

Recently, the JI turned its efforts to creating 3D models of AAAs, using Agilus30 material. In this new frontier of 3D printing in medicine, the JI already had three to four years of experience in creating 3D models for neurovascular and cardiac intervention, such as transcatheter aortic valve replacement (TAVR) and heart attack intervention. Given the JI's location above a vascular hospital and the complex technologies being introduced to treat vascular disease, the vascular surgeons joined the neuro- and cardiac-interventionists in asking the JI to make 3D printed vascular models for training and planning purposes.

What is AAA and How Is It Treated?

The abdominal aorta is the main vessel in the abdomen, carrying oxygenated blood from the heart to the abdomen, pelvis, and legs. An AAA occurs when portions of the walls of these abdominal arteries become weakened and bulge out. In some cases, when the aneurysm grows rapidly and causes symptoms, they can rupture leading to bleeding and often death.

AAAs at risk of rupture can be treated either surgically or minimally-invasively. In surgery, a portion of the vessel is replaced with a graft made of a synthetic material. In a minimally invasive procedure, a graft is delivered through a small tube called a catheter in the patient's femoral artery and up to the aneurysm where it is expanded against the vessel wall causing blood to bypass the aneurysm, shown here in **Figure 1**.

> "THE NEXT GENERATION OF MATERIALS PRODUCE MODELS THAT RETAIN THEIR REALISM, BUT ARE STRONGER AND EASIER TO CLEAN THAN EARLIER MODELS"

History

In cases where the aneurysm is located close to where smaller arteries, collectively called visceral arteries, branch off from the abdominal aorta to supply blood to the kidneys or the duodenum and colon, a graft could block the flow of blood into these vessels. In order to treat these aneurysms, patient-specific grafts with special openings, called fenestrations, are used. Small stents are placed from the graft through the fenestrations where the smaller arteries branch off, in order to keep these arteries open. This procedure is known as a fenestrated endovascular aneurysm repair (FEVAR) shown here in **Figure 2**. Since FEVAR procedures are new and involve the concurrent use of a number of

Figure 1. Endovascular Aortic Repair (EVAR) [1] (Medtronic)

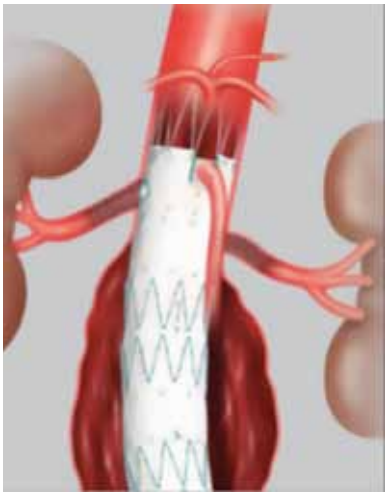

Figure 2. FEVAR to Treat AAA [2]

[1]Medtronic website: http://www.medtronic.com/us-en/patients/treatments-therapies/stent-graft-aaa/getting-a-device/surgery.html
[2]Cook Medical website: https://aortic.cookmedical.com/visceral/

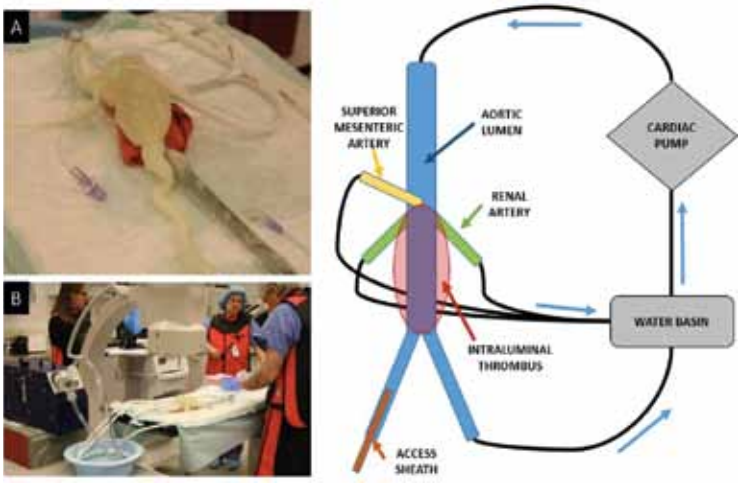

Figure 3. Experimental set-up at the JI including 3D AAA model with flow loop and system diagram depicting fluid recirculation system [3]

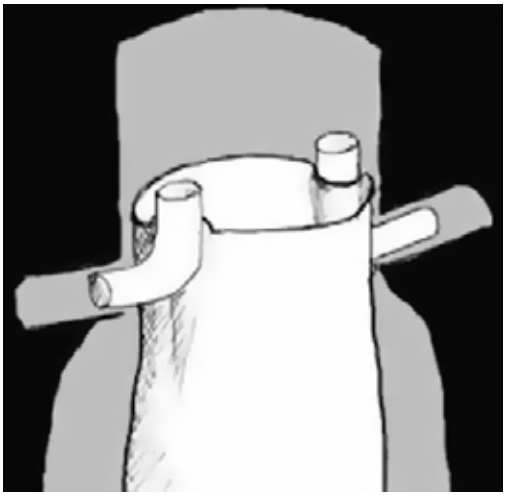

Figure 4. Example of two vessel (left and right renal) snorkelling technique[4]

[3]Meess, KM, Izzo RL, Dryjski, ML, Curl RE, Harris LM, Springer M, Siddiqui AH, Rudin S, Ionita, CN. 3D printed abdominal aortic aneurysm phantom for image guided surgical planning with a patient specific fenestrated endovascular graft system. Proc SPIE Int Soc Opt Eng. Proceedings Volume 10138; 101380P (2017).

different devices, as well as particular graft orientation techniques, 3D-printed models made from patient CT scans have been used by several GVI vascular surgeons to practice the procedure before performing their first FEVAR cases. The experimental set-up is shown in **Figure 3.**

Current AAA Challenges

Recently, the JI printed two AAA models using Stratasys' Agilus30 material. The models were used by GVI vascular surgeons to practice and plan for upcoming cases and to assess the feasibility of minimally invasive solutions to repair AAAs on patients with complicating factors. Traditional pre-surgical planning and feasibility assessments of treatment involve the review of patient CT scans and CT 3D reconstructions. The issue is that the precise geometry of the aorta and distances between the aneurysm and branch vessels may be difficult to appreciate in these scans. The models offer the physician the opportunity to gain a better understanding of

these spatial relationships. One of the vascular surgeons requested a patient-specific model to see whether a FEVAR would be possible on a patient whose aneurysm had a very small diameter and two severe angles. The physician wanted to see if the graft would be able to navigate the 3D-printed model's angles and expand once it reached the proper location. In the course of the simulated case (**Figure 2**: Meess KM 2017) the physician not only learned that a FEVAR would be possible, but also what to do in the event of a twisted graft.

> "THE IMPROVED FEEL AND REALISM OF THE JI'S 3D PRINTED MODELS ARE SAVING TIME FOR THE PATIENT AND MONEY FOR THE HOSPITAL, WHILE ENSURING BEST TREATMENT"

Another anatomical challenge is stenosis, or narrowing, of arteries. With the much smaller, visceral arteries, stenosis precludes the use of a fenestrated graft. In these cases, physicians may opt to use a 'snorkelling' technique (figure shows "snorkel" stents enabling blood flow to branch arteries 2013) whereby the distal ends of the stents are placed within the smaller, visceral arteries and the proximal ends extend in to the aorta alongside the aortic graft so the kidneys and intestines can continue to receive blood. **Figure 4** illustrates the snorkelling technique.

Another vascular surgeon recently used a patient-specific, 3D-printed model to assess the feasibility of using the snorkelling technique on a patient with severe stenosis in her visceral arteries. The surgeon wanted to assess if access to the visceral arteries was even possible and verify if the selected sizing of the grafts would form a seal that would prevent endoleak, which is persistent blood flow outside the graft and into the aneurysm sack. The surgeon learned enough in the planning to decide that it was worth attempting to access the patient's visceral arteries, before resorting to the more invasive surgery.

The improved feel and realism of the JI's 3D printed models, developed in partnership with Stratasys, are making them increasingly valuable not only for surgical training and medical device testing, but also as a way for physicians to assess the feasibility of certain procedures before performing them on their patients. This saves time for the patient and money for the hospital, while also ensuring that the best treatment is selected for each patient. The JI will continue to advance 3D printing in vascular medicine, aiming to benefit, patients physicians, industry and start-ups. ■

KEY POINTS

- ✓ JI has several years experience in creating 3D models for neurovascular and cardiac intervention but further development was necessary to move into vascular intervention
- ✓ Treatments for FEVAR and stenosis cases were given focus
- ✓ The precise geometry of the aorta and distances between the aneurysm and branch vessels may be difficult to appreciate in these scans. The models offer the physician the opportunity to gain a better understanding of these spatial relationships
- ✓ The JI partnered with Stratasys on models that retain realism, but more robust and easier to care for in post-processing
- ✓ Improved realism of JI's 3D printed models are making them valuable for surgical training, medical device testing and procedure feasibility assessment
- ✓ More realistic models results in time and money savings while ensuring best patient treatment

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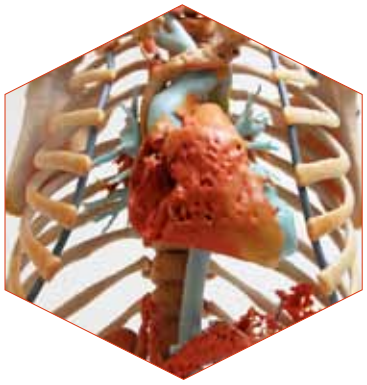

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Deep interoperability in healthcare

The view from KLAS on the state of data access for better care

According to a report by research body KLAS, "deep operability" has doubled but 86 percent of healthcare organisations have yet to report success. HealthManagement.org spoke with report co-author Colin Buckley on what this means for healthcare.

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Can you define 'deep interoperability'?

There are many different ways that one could measure interoperability progress. Frequently, metrics are rather technical in nature. They might include the number of data-sharing connections between organisations or the number of documents transferred from one location to another over a period of time or even the number of organisations or systems that are certified as compliant to some interoperability standard.

The challenge with these metrics is that they don't get to the ultimate goal of interoperability: ensuring that individual clinicians can access meaningful data that improves patient care. To measure this, KLAS interviewed clinical and IT leadership about their clinicians' experience across four stages:

- How often do clinician have electronic access to the outside data sources they need?
- When accessing outside data, how easy is it to locate specific patient records?
- To what degree is outside data integrated with clinicians' EMR workflow?
- Once retrieved and viewed, how impactful is outside data for patient care?

Within the scope of this study, "deep interoperability" is a designation for organisations that have achieved an ideal state across all four stages of interoperability. That is, clinicians can reach data sources nearly always or often, they can easily or automatically locate specific patient records, they can view the data inside their EMR workflow and the data is nearly always or frequently impactful.

What is your snapshot view on the state of interoperability in healthcare? What are the challenges and opportunities?

We found that provider organisations often do well in two or three of these stages, but when we narrow the field to those that are successful in all four stages the number is quite small: only 14 percent of those interviewed in our 2017 research fit the "deep interoperability" description when accessing data from outside organisations using different EMRs.

On the bright side, this is a significant improvement over our 2016 benchmark result of 6 percent. A more critical view, however, says there is a long way to go before we reach a place where the ideal is commonplace.

Our research highlighted many different challenges, large and small. I would highlight two overarching ones:

First, interoperability is expensive. Organisations speak most often about the cost of interfaces, but there are a whole range of technological and personnel expenses needed to create meaningful data sharing. Because of this, interoperability progress largely depends on the existence of specific business cases for each participating organisation in order to justify the expense. This is why some public Electronic Health Information Exchanges (HIEs) have sustainability problems: they don't always solve the specific needs of the specific organisations that are asked to fund them.

An opportunity here is for HIT vendors to deliver more cost-effective interoperability solutions that lower the bar for justifying investment by provider organisations. In our research, vendors that build interoperability tools directly into their EMRs and provide low-cost access to shared networks see greater interoperability progress among customers. Examples would include Epic's CareEverywhere HIE and the multi-vendor CommonWell network. The latter is still in its early growth stage, but providers say it is promising.

Second, the data we share is often not helpful to clinicians. Even when data moves freely between provider organisations, clinicians too often find that they are overloaded with static care summaries that contain pages and pages of disorganised patient data. Often, they don't have time to comb through it all in order to find the few nuggets of information that they need. The most common culprits, providers say, are Continuity of Care Documents and Clinical Document Architecture standards that are too broad and too flexible.

This is going to be a difficult problem to solve as it will take a great deal of focused cooperation between providers and vendors. A possible helper may be the Fast Healthcare Interoperability Resources (FHIR) Application Programming Interface standard. It is being implemented into EMRs and other interoperability solutions, but actual use of FHIR to solve these data format and integration issues is still experimental at this point. In the meantime, it's likely that we will see continuation of a trend highlighted in our recent report: provider organisations are making progress on the first three interoperability stages, but hitting a wall when it comes to positive impact on patient care.

> "ONLY 14 PERCENT OF PROVIDER ORGANISATIONS FIT THE "DEEP INTEROPERABILITY" DESCRIPTION WHEN ACCESSING DATA FROM OUTSIDE ORGANISATIONS USING DIFFERENT EMRS"

Where would you like to see the healthcare interoperability situation five years from now?

KLAS really isn't in a position to predict where we will be five years from now, but it's pretty safe to say that interoperability will not be solved in the immediate future—if by "solved" we mean that most organisations have achieved the ideal of "deep interoperability". In many ways, interoperability is not a technology problem. In fact, we could say that providers and vendors have not caught up with the technology that already exists. It will take years to implement and refine the options that we already have.

How could data be streamlined to improve deep interoperability?

Aside from less expensive technology options, providers would like their tools to be "smarter." For example, instead of having to interrupt patient care

in order to search for outside data, they would like their EMRs to recognise the patient they are working with and the context of the problem they are trying to solve and then search outside sources in the background. If data is found, the EMR could extract only the most relevant pieces and alert the clinician of its availability. Today, that type of artificial intelligence is extremely rare.

What are some of the risks connected with substandard deep interoperability?

To put it simply, the risk is that nothing will change. The problems we need interoperability to solve are not new—they are just becoming more obvious. Interoperability can help lower costs, improve treatments, increase safety, and can ultimately deepen the engagement of patients in maintaining their health. If we don't make progress with interoperability, these goals will be difficult to reach.

> "IT'S PRETTY SAFE TO SAY THAT INTEROPERABILITY WILL NOT BE SOLVED IN THE IMMEDIATE FUTURE—IF BY "SOLVED" WE MEAN THAT MOST ORGANISATIONS HAVE ACHIEVED THE IDEAL OF "DEEP INTEROPERABILITY"

How does healthcare compare with other sectors (eg, finance) when it comes to deep interoperability standards?

This is not an area of expertise for KLAS, but it's clear that interoperability in healthcare is a very complex problem. When it comes to a typical financial transaction, the volume of data is often small and is always very well defined. In healthcare, clinicians often don't know for any one patient what data is available or would even be useful to their current diagnosis and treatment. As suggested previously, we are seeing progress on the technical aspects of moving whole documents from one point to another rather than discrete data elements. The sharing of health data, today, is more akin to transmitting a painting: it takes a human on the receiving end to determine its meaning and value.

What steps can healthcare organisations take to improve deep interoperability in their organisations? Would staff training be a part of any moves towards improvement?

At a fundamental level, organisations could explore what their opportunities are. That includes collaboration with partners and competitors in their regions to determine where and how the sharing of data would benefit their patients and their organisations. This would naturally lead to conversations with EMR and other HIT vendors about what their technology options are. Providers should hold their vendors accountable for the promises they make in their contracts and marketing materials. Transparency around how well vendors perform for their customers is the heart of what KLAS does—sharing feedback with KLAS is a way providers can help move the industry forward.

User training is definitely helpful in making the most of interoperability tools. Today, many clinicians are completely unaware of the access they already have in place. With training and experience clinicians can become more consistent and efficient in finding and using outside data. In addition, the interaction with end users that happens during training can also help IT staff better understand how tools might be reconfigured or customised to better meet needs. Training for end users should also be part of early discussions with vendors who don't always understand the important role they can play in driving user adoption—and thus value for their customers. ■

KEY POINTS

- ✓ Interoperability progress is generally not allowing outside data access for better patient care
- ✓ KLAS defines "deep interoperability" as one where organisations have achieved an ideal state across four key stages of interoperability
- ✓ In 2017, only 14 percent of provider organisations met the "deep interoperability" criteria, although the figure was up from 2016
- ✓ Making shared data impactful is the chief obstacle
- ✓ Providers report the most common culprits are CCD/C-CDA document standards which they say are too flexible
- ✓ Deep interoperability can help lower costs and increase healthcare efficiency
- ✓ The biggest risk is that nothing will change in the face of substandard deep interoperability
- ✓ User training would help boost interoperability in healthcare facilities

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Virtual reality clinic: a case study

The growing role of VR in healthcare

How has VR developed and what potential does it have for future healthcare?

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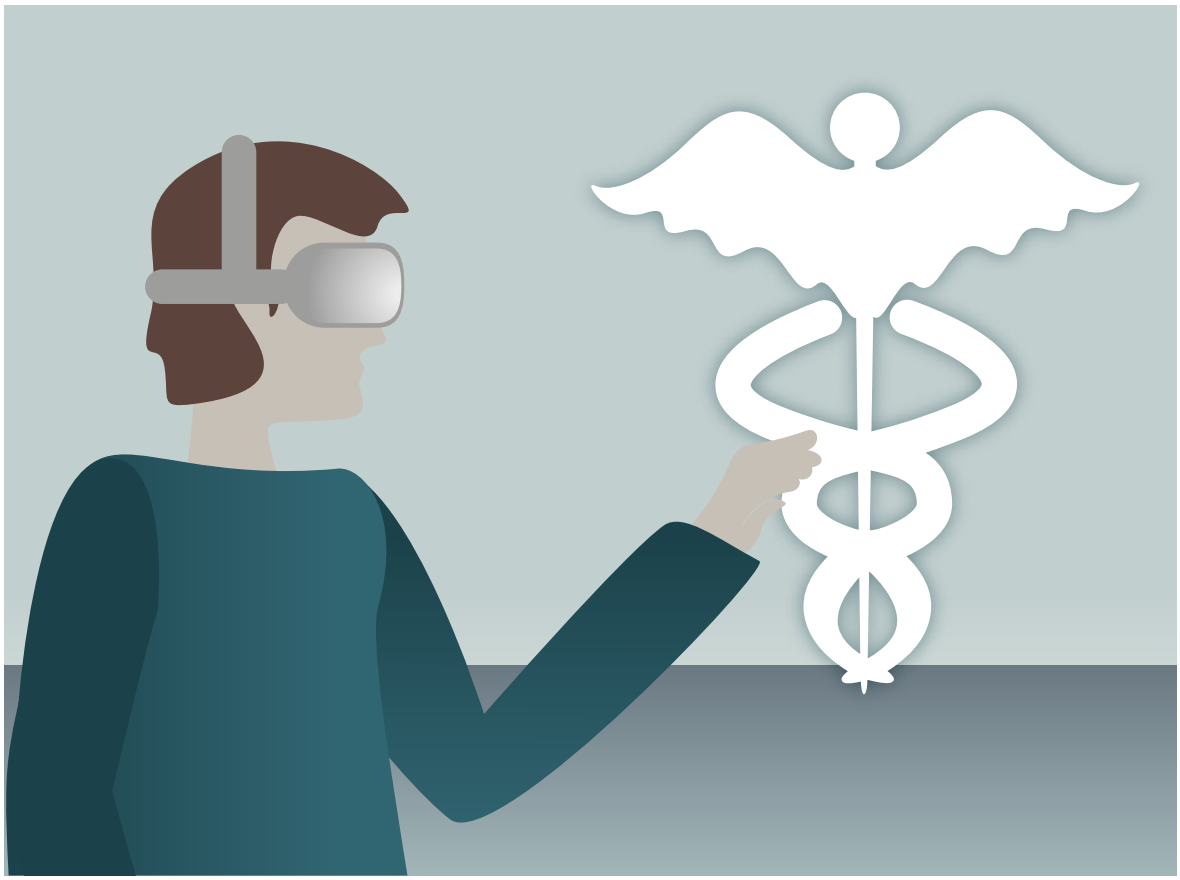

In the 1990s, there were no resources dedicated to virtual reality (VR) and behavioural healthcare – no journals, no clinics, no conferences, no training programmes, and only few advanced technologies. Today, we find ourselves in the midst of a new exciting and challenging era of technology-enhanced behavioural healthcare.

Some of us have been involved since the beginning, when what we were envisioning was years ahead of its time. Now, as we embark on our third decade of VR and behavioural health, it is important to recognise how far we have come: from helmet-style head-mounted displays that cost thousands of dollars to a VR headset that clips on your cellphone for less than $200; from FTP, Usenet, and something called the World Wide Web to Facebook, Twitter, and Instagram.

It's also worth noting that the field has become much more cohesive, with its accomplishments now including a Medline journal, a magazine, an international conference, an international association, VR clinics, and American Psychological Association accredited clinician continuing education and training programmes.

Treatment in a VR clinic

Our centre opened its first VR clinic in southern California in the mid-1990s, initially focused on the treatment of specific phobias (flying, driving, public speaking, etc.), post-traumatic stress (PTSD) due to motor vehicle accidents and panic disorder and agoraphobia. Prior to opening the clinic, our approach to treating patients with anxiety disorders had been either imaginal exposure (in combination with biofeedback and cognitive behavioural therapy techniques) or in vivo (real life) exposure.

The ability to perform the exposure session in the virtual setting, allowing a combination of senses to be stimulated (visual, auditory, tactile), while still allowing for the monitoring of the patient's physiology, permitted therapy to progress more quickly, and in most cases more successfully. In addition, the patient was able to "push the envelope" in a protected setting, since suspension of disbelief (the individual felt "present" or "immersed" – e.g., like they were on an airplane, taking a flight; instead of still sitting with the therapist in an office) was elicited. This necessary therapeutic component provided an innocuous setting, whereby emotions could be accessed and processed to move towards altering cognitions and physiologically desensitising to previous anxiety-provoking stimuli.

> "AS INTEREST CONTINUES TO GROW IN THE USE OF VIRTUAL REALITY (VR) THERAPY FOR PATIENT CARE, THE NEED TO TRAIN CLINICIANS IN THIS NEW APPROACH IS BECOMING MORE IMPORTANT"

Key to effective therapy

Since the first one-room clinic in San Diego, VRMC has expanded its offerings in the USA, Europe, and most recently into Asia, but has always remained grounded in its guiding principle: VR is only a tool to assist the therapist in providing more effective treatment to the patient.

One of the key components that continues to bring success during therapy is when the therapist, programmer, and end user (patient or trainee) work together to build an environment containing the correct cues for eliciting the arousal or the correct scenario needed to learn a skill set. The triad is essential. The therapist does not wish to learn programming skill sets or to spend more time with the computer – at the expense of the patient. The computer is a tool and should not take away from the therapeutic alliance between patient and therapist. Working to meet this goal, successful programmers will create a few keystrokes that the therapist can easily master while remaining focused on the patient.

The VR, together with physiology, should also serve as a backdrop to guide the therapy session. It is, as we discovered in our first randomised controlled clinical trial in the 1990s, that adding the physiology allows for more effective treatment short-term as well as for long-term sustainability of treatment results (three year follow-ups showed no recidivism in this group).

Top 10 developments as we move into third decade of VR

1. VR-enhanced therapy can treat a wider range of conditions including phobias and anxiety disorders, acute and chronic pain.
2. VR can be used as an assessment tool for Alzheimer's and PTSD.
3. The use of VR is now evidence based.
4. VR can now be used at home as well as clinical settings through mHealth implementation.
5. The use of VR is now patient driven rather than therapist driven with smartphone apps a means of engagement.
6. Patients are now empowered to treat themselves but for realisation of full potential, apps must be well-designed, efficacious through evidence-based research and must meet established evaluation and recommendation criteria.
7. The cost of VR wearables has dropped significantly while becoming more widely available.
8. The use of objective measures is becoming ubiquitous.
9. With the growth of mental health parity, growth is now possible - although the resource of big data needs clear protocols for device data and more funding.
10. All of us are riding the wave of technology development as the healthcare sector uses tools created in other domains.

We provide a careful and systematic approach for exposure, teaching the patient a set of skills which they can then practise in the VR setting. We are always accessible if patients should need a refresher course or a booster session, but in most cases, patients have reported that they are able to transfer the skills they have learned to deal with other areas of their lives. This kind of empowerment is exciting and achievable for most of our patients.

Training for clinicians

As interest continues to grow in the use of VR therapy for patient care, the need to train clinicians in this new approach becomes more important. There are three components for success: a broad knowledge and familiarity with CBT, comfort with computer-based and technology-supplemented practice, and knowledge of basic human physiological responses to stress and relaxation.

> “TECHNOLOGY DOES NOT TAKE THE PLACE OF GOOD CLINICAL SKILLS OR CLINICAL JUDGMENT BUT ACTS AS AN ADJUNCT”

Technology does not take the place of good clinical skills or clinical judgment. In our case, it serves mostly as an adjunct to cognitive behavioural therapy techniques or to stress inoculation training techniques, depending on whether we are training personnel to perform in stressful situations (first responders, medical personnel, police officers, military personnel, students, etc.) or teaching patients to overcome anxiety in previously anxiety-provoking scenarios.

VRMC's affiliated 501c3 nonprofit, the Interactive Media Institute, has been certified by the American Psychological Association to provide continuing education and training for psychologists and other mental health professionals wishing to learn this new skill to add to their clinical offerings.

We are also working on several new models of care delivery that look at the continuum of patient abilities, range of experience, and individual coping mechanisms. Continued individualisation of the therapy session while preserving the key components of the CBT foundation is key to creating an effective model that will survive the evolution of medical care.

Data protection and other challenges

It is clear that the appropriate use of advanced technology can greatly improve mental healthcare delivery and clinical outcomes. Previous barriers continue to be eliminated as cost, simplicity, and ease of use dramatically increase the availability of these tools. Overall, our approach has been patient centric, and as such we have consistently achieved successful results with both analytic and therapeutic outcomes.

There are additional challenges however. The evolution of the current healthcare system will demand strict adherence to patient privacy, security of medical records, and adherence to ethical policies, cognizance of new Federal regulations, and synergy with new requirements of payers. While this new universe of requirements may appear daunting to those who wish to add technology tools to their individual or group practice, we and others are making free resources available to all who seek enquiry, support, and guidance. Please visit www.vrphobia.eu, vrphobia.com or www.interactivemediainstitute.com to begin the quest for knowledge. ■

KEY POINTS

- ✓ In a matter of decades, VR has become central to technology-enhanced behavioural healthcare
- ✓ The cost of VR has dropped significantly as technology has developed resulting in increased potential implementation within healthcare
- ✓ VR is a tool to assist in providing more effective treatment to the patient
- ✓ Successful VR training depends on a knowledge of CBT, comfort with computer-based and technology-supplemented practice, and understanding of human physiological responses to stress and relaxation
- ✓ Advanced healthcare technology results in improved mental healthcare delivery
- ✓ Challenges include patient privacy, medical records security, and adherence to ethical and policy-making criteria

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Machine learning detecting early brain tumour presence

Machine learning algorithms in brain tumour identification

How machine learning is being utilised to characterise aggressive gliomas in a scalable analysis system.

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By tapping the power of supercomputers, combined with machine learning algorithms, a team led by University of Texas at Austin researchers have developed a method to automatically identify brain tumours. This novel method, the product of nearly a decade of research, can characterise gliomas, the most common and aggressive type of primary brain tumour.

The technique uses biophysical models of tumour growth and machine learning algorithms for the analysis of magnetic resonance (MR) imaging data of glioma patients. Results of the new fully automatic method were presented by the research team at the 20th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2017) held in Canada. All the components of the new method were enabled by supercomputers at the Texas Advanced Computing Center (TACC).

Collaboration and recognition

The team's scalable, biophysics-based image analysis system was the culmination of 10 years of research into a variety of computational problems, according to George Biros, professor of mechanical engineering and leader of the ICES Parallel Algorithms for Data Analysis and Simulation Group at The University of Texas at Austin. Biros worked with collaborators from the University of Pennsylvania (led by Professor Christos Davatzikos), University of Houston (led by Professor Andreas Mang) and University of Stuttgart (led by Professor Miriam Mehl) to develop the new system, also known as "image segmentation classifier".

Biros' team tested their new method in the Multimodal Brain Tumour Segmentation Challenge 2017 (BRaTS'17), an annual competition where research groups from around the world present methods and results for computer-aided identification and classification of brain tumours, as well as different types of cancerous regions, using preoperative MR scans.

Their system scored in the top 25 percent in the challenge and was near the top for whole tumour segmentation.

"The competition is related to the characterisation of abnormal tissue on patients who suffer from glioma tumours, the most prevalent form of primary brain tumour," Biros said. "Our goal is to take an image and delineate it automatically and identify different types of abnormal tissue—oedema, enhancing tumour (areas with very aggressive tumours), and necrotic tissue."

Two-step analysis process

The image processing, analysis and prediction pipeline that Biros and his team used has two main steps: a supervised machine learning step where the computer creates a probability map for the target classes ("whole tumour," "oedema," "tumour core"); and a second step where they combine these probabilities with a biophysical model that represents how tumours grow in mathematical terms, which imposes limits on the analyses and helps find correlations.

Biros and his team were able to run their analysis pipeline on 140 brains in less than four hours and correctly characterised the testing data with nearly 90 percent accuracy, which is comparable to human radiologists.

The image segmentation classifier won't be a substitute for radiologists and surgeons, but it will improve the reproducibility of assessments and potentially speed up diagnoses.■

KEY POINTS

- ✓ Supercomputers and machine learning algorithms have developed a method for automatic identification of brain tumours
- ✓ The technique uses biophysical models of tumours with machine learning algorithms for MR imaging data analysis
- ✓ The two-step pipeline includes supervised machine learning with a computer probability map and combination of these probabilities with a biophysical model for analysis

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Founder, Chairman & CEO, Masimo

Rt. Hon. Jeremy Hunt MP
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Our top 10 twitter followers

A round-up of our most collaborative, impressive followers

HealthManagement.org is proud to hold such a large number of followers on Twitter. From doctors, to medical engineers, to some of the world's most innovative technological giants, we hope 2018 continues to provide us with even more collaborative partners and followers.

Over the last few years HealthManagement.org has developed into the leading European business healthcare platform optimising in management, leadership and collaboration. And within this time, we are proud to have become reputable within our community and managed to build a number of top followers along the way.

Twitter has fast become an efficient social platform where healthcare experts, leaders, doctors, patients, as well as your everyday individual, all use the space to express their thoughts and views, no matter the context. Twitter is certainly evolving quicker than ever before. With that in mind, we have prepared a list of our top followers who pride themselves in leadership and best practice, and we are fortunate enough to have them follow us on Twitter. From technology geniuses such as Toshiba, and digital experts like John Nostra, to reputable journals like JACR, our followers range from independent medical agencies to large, corporate brands. It was a hard job since there are plenty of well-known names out there, but out of 3,671 followers, we've rounded up our top 10.

We're proud of all of our followers and honoured that more than 3, 500 find our articles, blog and news posts worth keeping up-to-date with. Here's to the next 3, 500!

1

First up, is Forbes Health, a key influencer whose name speaks for itself. Their Twitter page boasts an impressive 73.9K followers, as they continue to provide insightful news covering the business of big pharma, healthcare and science. HealthManagement.org is proud to have them as a follower.

2

With a whopping 54.9K followers, Philips Healthcare, has proved to be a key influencer in the healthcare world. They continue to innovate and shape the future with inspirational devices and carefully executed ideas, which is demonstrated through their high number of followers.

3

Known for empowering the health systems of tomorrow with better analytics, improved collaboration, and safer devices for real impact and better health today, Microsoft in Health hold a long-standing reputation within the technological world, emphasising their energy and expertise into much-needed medical devices.

4

Having worked closely with The European Society of Cardiology (ESC), we're not surprised they have over 48K followers. The society is well-recognised for their established annual congresses as well as partnerships across the EU. The ESC aims to reduce the burden of cardiovascular diseases not only through congresses, but also surveys, journals, and clinical practice guidelines.

5

In addition to the line of highly-esteemed followers that HealthManagement.org holds, Skills for Health is a key leader in E-rostering, E-Learning, workforce planning, consultancy, standards, and supporting the NHS.

6

With 20.4K followers, EUR-Lex is also on a similar journey as it offers tips and tricks to the public. It's the home of the official EU law database and home of the EU Official Journal, putting them in a promising and trustworthy position.

7

Next, we have Open Heart, an online-only, open access cardiology journal, published by BMJ & the British Cardiovascular Society. With over 16K followers, they present key ideas which naturally coincide with HealthManagement.org's core principles.

8

In recent years, the Middle East has presented itself as a dominant contender in the healthcare and medical industry. Even with tight competition, Arab Health has empowered itself for being the gateway to the healthcare world in the region and is popular for its innovative congresses and large community of intellectual experts. And their 16.7K knit of followers will no doubt continue to increase.

9

Similarly, touching on a series of influential subjects in radiology, Diagnostic Imaging, has formed thousands of followers due to compelling news and commentary for radiologists and medical imaging professionals.

10

And finally, we present Hologic. A key leader in innovative medical technology, Hologic focuses on improving women's health and wellbeing through early detection and treatment. The use of powerful and next-level technology puts Hologic at the top end of technology, ensuring their existence continues to excel.

Are (world) rankings the best way to determine healthcare systems?

Uncovering the truth behind healthcare rankings

World healthcare rankings have been published since 2000 but have they made any difference? This article reviews the literature available and focuses on the media's attention to the latest rankings issued in 2017.

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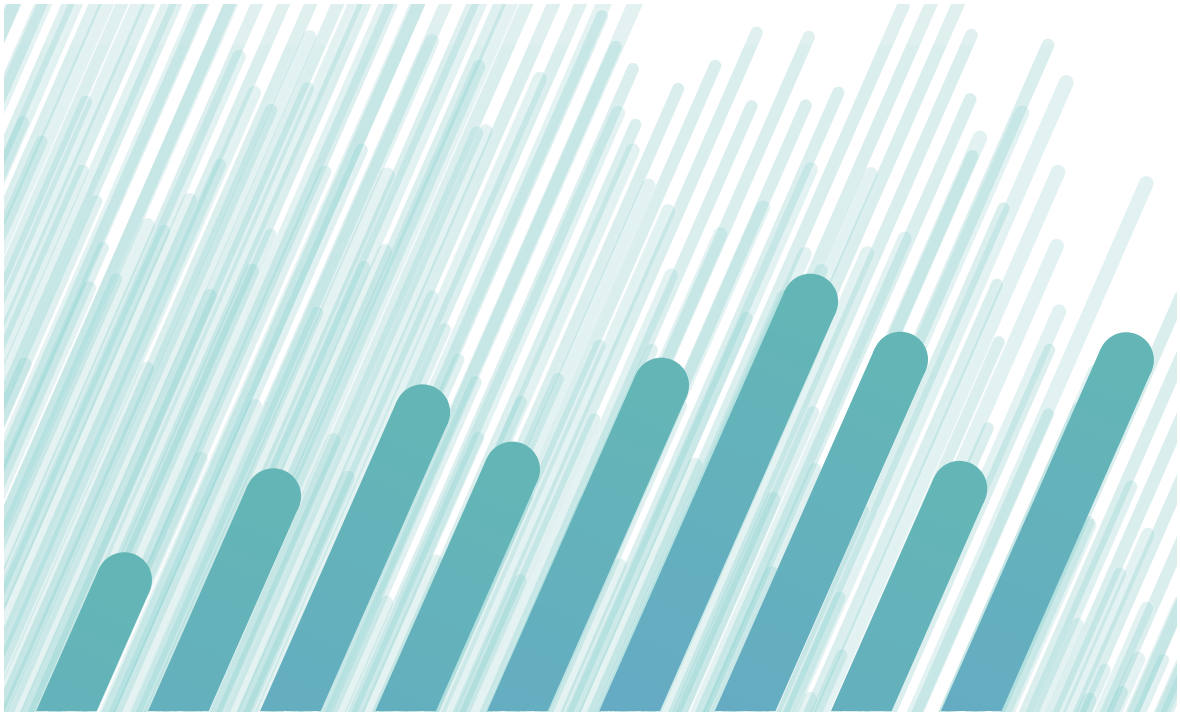

When it comes to healthcare, we just adore and perhaps relate easily to league tables stating who's the best or worst at things. Our belief is that this is just disproportionate to the actual work that takes place within healthcare systems. Is it realistic to actually rank countries that have a vast array of health services, different demographics, different payment methods and different levels of qualifications?

No matter what the methodology used to determine the league table, it often does not offer the public any useful information, as each healthcare system is fundamentally different. For example, a recent study by Schneider et al. (2017) for the Commonwealth Fund, demonstrated that the United Kingdom (UK) was the best healthcare system; number one out of the 11 countries reviewed. In the same month, The Lancet (2017) published a study which ranked the UK 30th out of 192 countries, with nine of the 11 countries identified from the Schneider et al. report being higher than the UK. How could this be possible when the studies were published so close together?

A study into healthcare rankings in 2014 found that the input of specific data could bias the results (Gearhart 2015). In fact this study alluded that policymakers could alter the desired input or output measures to obtain a required result (pg 140). There are many possibilities

that determine the outcome of the rankings and this is exacerbated when you factor in the limitations to available data, the various demographics of countries including, for example, access to healthcare and the actual services available. The question of validity is important when considering the healthcare rankings of countries, as identified by Kim and Kang (2014) who found that no two studies utilised the same measures. Interestingly, Appleby (2011) suggested that despite the frustration of the results being important for policy making, they are mostly for headline news and offer little direction on how to actually improve the healthcare of these countries. Though it can be argued that the rankings are not designed to evaluate each country against one another but to stimulate action that improves the health system in a country (Tanden et al. nd). However, for those at the top of the list, a counter argument not discussed is the fact that does this not create complacency and a lack of willingness to improve?

> "IT IS QUITE OBVIOUS THAT THE UK GOVERNMENT, AND OPPOSITION POLITICIANS USE HEALTHCARE AS A KEY BARGAINING TOOL IN ANY ELECTION OR DEBATE"

As demonstrated, the introduction of world health rankings in 2000 incited much criticism regarding the methodology, transparency and data selection. This debate is still ongoing and the continuous changing of rankings amplifies this argument. Do the rankings inspire creativity and innovation, or are they a side-line for countries to use as propaganda?

July 2017, media widely reports NHS is the number one health system, but why is this wrong?

As with anything these days, media viability of what's being said needs to be verified. 'Fake news' is the headline of the moment, being repeated frequently. When a British media organisation proudly published an article on the UK's National Health Service (NHS) in July this year, its headlines were "NHS ranked 'number one' health system", why not healthcare system as per the actual title in the Commonwealth Fund report? (Schneider et al. 2017). One cannot help but to be sceptical on articles written and presented about this amazing yet complex healthcare system that was initiated in the UK some 69 years earlier, in July 1948 (NHS Choices 2015), with the aim of bringing 'good healthcare to all'. Yet perhaps to the untrained or less sceptical eye, the media's title on the face of it makes you feel proud to be British with this apparent number one leader of health(care) systems.

The unfortunate truth of the matter is that it is not. It's very important to realise that the document the British media refer to is one written for the United States (US) healthcare, entitled "Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care". Clearly from the title the information within was aimed at comparing the US system to gain ideas for its improvement, by looking at a number of other worldwide systems, the NHS being one of ten they compared against. The key findings were that their 'top-ranked' countries were the UK, Australia and the Netherlands, to which they continue to say were based on a broad range of indicators. Now this already appears to be a very different angle to what the media reported on, especially when the report states (p5) that the UK in general terms, achieves superior performance compared to other countries in all areas except, healthcare outcomes, where it ranks 10th (out of 11). Even a non-medical person can understand that healthcare outcomes are probably the most important factor for any patient, accumulating all previous factors such as treatment, waiting times, access to latest techniques and drugs, for example, are important to assess but if your outcome is poor, (or the worst of 10 countries) then why do major reports state that the UK is the 'number one' health system? Because, paradoxically, caring is not the actual media focus perhaps? Nor is to streamline administrative or medical resources?

This media report in question, inform that the NHS is centrally directed and has more direct management accountability to its government than any of the other

The Perfect Health System (Britnell 2015, pg 2)

- Values and universal healthcare of the UK
- Primary Care of Israel
- Community Services of Brazil
- Mental Health and Well-being of Australia
- Health promotion of the Nordic countries
- Patient and community empowerment in parts of Africa
- Research and development of the US
- Innovation, flair and speed of India
- Information, Communications and Technology of Singapore
- Choice of France
- Funding of Switzerland
- Aged care of Japan

countries health care systems compared. It is quite obvious that the UK government, and opposition politicians use healthcare as a key bargaining tool in any election or debate. The research by Gearhart (2015) reaffirms that, in this case, the healthcare system has a political motivation to be the best, especially in the current political environment of the United Kingdom. This is despite the legislation for less political micro-management of the health service in the UK with the enactment of the Health and Social Care Act 2012 (Department of Health 2012). The US system is currently undergoing its own turmoil, with the current Trump administration trying fiercely to undo its predecessors 'Affordable Care Act', more affectionately named 'Obama Care'. Does this indicate the US taking more of a political bias towards healthcare? Therefore, is the information swayed to support its own political agenda in the US?

The Commonwealth Fund has reported previously on worldwide healthcare systems and reports annually on each US state. For a worldwide account though how can the comparable factors exist? The authors of the article state major differences exist such as government accountability, or private health insurance premiums versus taxation collection when these few variables alone bring their own sets of conflicts and priorities into question, let alone access, equity or administration efficiency. The only easily measurable outcome that matters to the population of a country is the 'Health Care Outcome'. The question any population should ask is "Did my country's healthcare system improve the quality of life following injury or illness?" What else could matter to the electorate? So when the UK media reports the UK as the 'number one' health system, the populations of each country in the study need to ask how it achieved the ranking it did? As discussed above, one's thought process should not forget the other report published at the same time that shows the UK in the overall ratings at 30th out of 192 countries (The Lancet 2017). It does raise questions as to why the Commonwealth Fund only chose these specific countries.

Conclusion

In conclusion, care must be taken when reading (or reporting) on issues with such wide and different reporting parameters. It's probably fair to say the UK has a good healthcare system by comparison to others and has good practice to share with other countries. However, this is very different than stating that the UK is simply ranked the number one health system.

Clearly from both reports there are many factors in which the UK can improve, most notably health outcomes but there are many variables in each health system that contribute to its ranking level. Each country's health systems have many strengths and weaknesses (Britnell 2015). Perhaps if you could take the good elements of each country, you'll have a wonderful healthcare system for the global population and no longer need a politically motivated report? Perhaps learning from each other's systems and sharing best practice would be more beneficial than rankings? Perhaps we need to alter our thinking and research from rankings to what can improve the entire healthcare system? Maybe the best suggestion would be to rank countries who implemented the highest number of best practices from another country, with an emphasis on benefits for the population as a whole instead of scoring political points.

KEY POINTS

- ✓ Healthcare ranking systems are unfit for purpose as there are too many variables that exist
- ✓ World healthcare rankings are incorrectly interpreted by the media
- ✓ There are debates that the rankings are politically motivated rather than representative of the actual healthcare system
- ✓ Patient outcomes appear to be undervalued in the overall rankings

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AMIT N. THAKKER

CHAIRMAN - AFRICA HEALTHCARE FEDERATION, KENYA

TOP QUOTE FROM BLOG:

Healthcare revolution in Africa through public-private partnerships.

"A successful investment is not defined solely by financial input, but also by additional critical factors such as collaborations, robust frameworks and policies, scalable economies, targeted opportunities for development, and effective resources, that would bring it to fruition. Public, private and development partner cooperation is required for solutions surpassing borders, that will drive the investments into sustainable health outcomes, maximise the returns on those investments, and in turn create a stronger African health sector. " See more at: **https://iii.hm/g9d**

ANGELA MAAS

PROFESSOR CARDIOLOGY FOR WOMEN, RADBOUD UMC, NIJMEGEN, NETHERLANDS. GYNECARDIOLOGIST & CARDIOFEMINIST. INITIATOR RADBOUDUMC FUND HEARTFORWOMEN, THE NETHERLANDS

TOP QUOTE FROM BLOG:

Why I'm a Cardiofeminist.

"In the Netherlands around 75 percent of medical students are women, but what we hear from the female students here and in other countries is that the atmosphere that cardiology departments have, the macho behaviour that is still hanging around, meaning that they don't want to work there for the rest of their lives. Women still have to be fighters to get in and to survive, and it is not very easy for women to persist in a career in cardiology." See more at: **https://iii.hm/g9f**

MAGED N.KAMEL BOULOS

HEALTH INFORMATICIAN AND SCIENTIST, PROFESSOR OF DIGITAL HEALTH - ALEXANDER GRAHAM BELL CENTRE OF DIGITAL HEALTH, UNIVERSITY OF THE HIGHLANDS AND ISLANDS, UK

TOP QUOTE FROM BLOG:

How can the Internet of Things and people help improve our health, wellbeing and quality of life?

"While research was successful at documenting and highlighting the risks associated with IoT deployments in health and care, the industry has somewhat failed to follow and tackle those issues, focusing more on rapid profit generation and usability (user convenience). Device and service security and user privacy are often addressed as an afterthought, if at all. "See more at: **https://iii.hm/g9e**

LORI FONTAINE

GLOBAL VICE PRESIDENT OF CLINICAL AFFAIRS, HOLOGIC , U.S.

TOP QUOTE FROM BLOG:

Reinventing breast tomosynthesis.

"As a woman who participates in breast cancer screening and is passionate about ensuring women have access to the best technology available, I know first-hand how important it is to develop equipment that factors in insights from both radiologists and patients to improve the experience. These insight-driven advancements in technology must be supported by strong clinical evidence, and I look forward to continuing the work on the next innovations that aim to do just that." See more at: **https://iii.hm/g9l**

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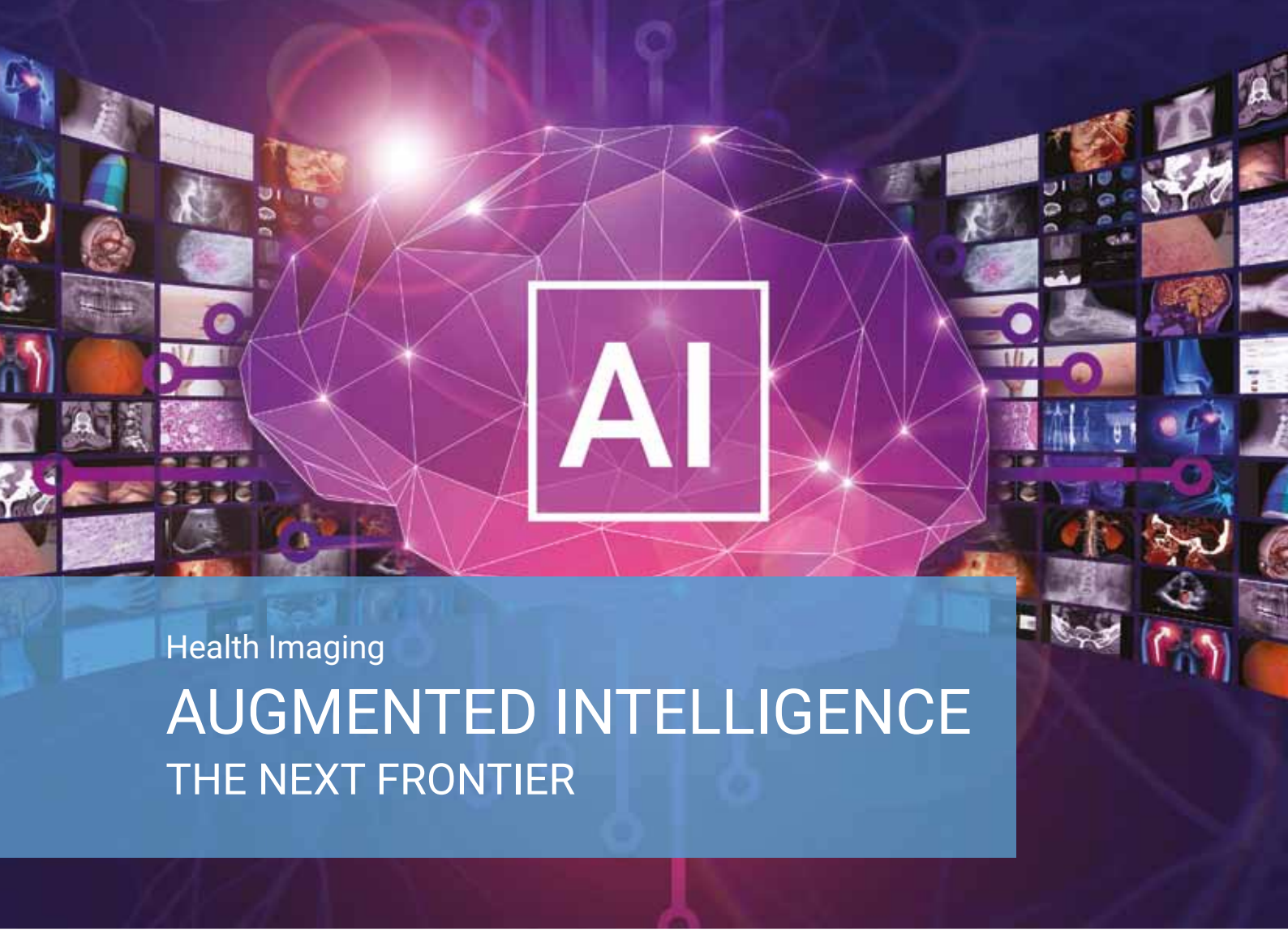

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