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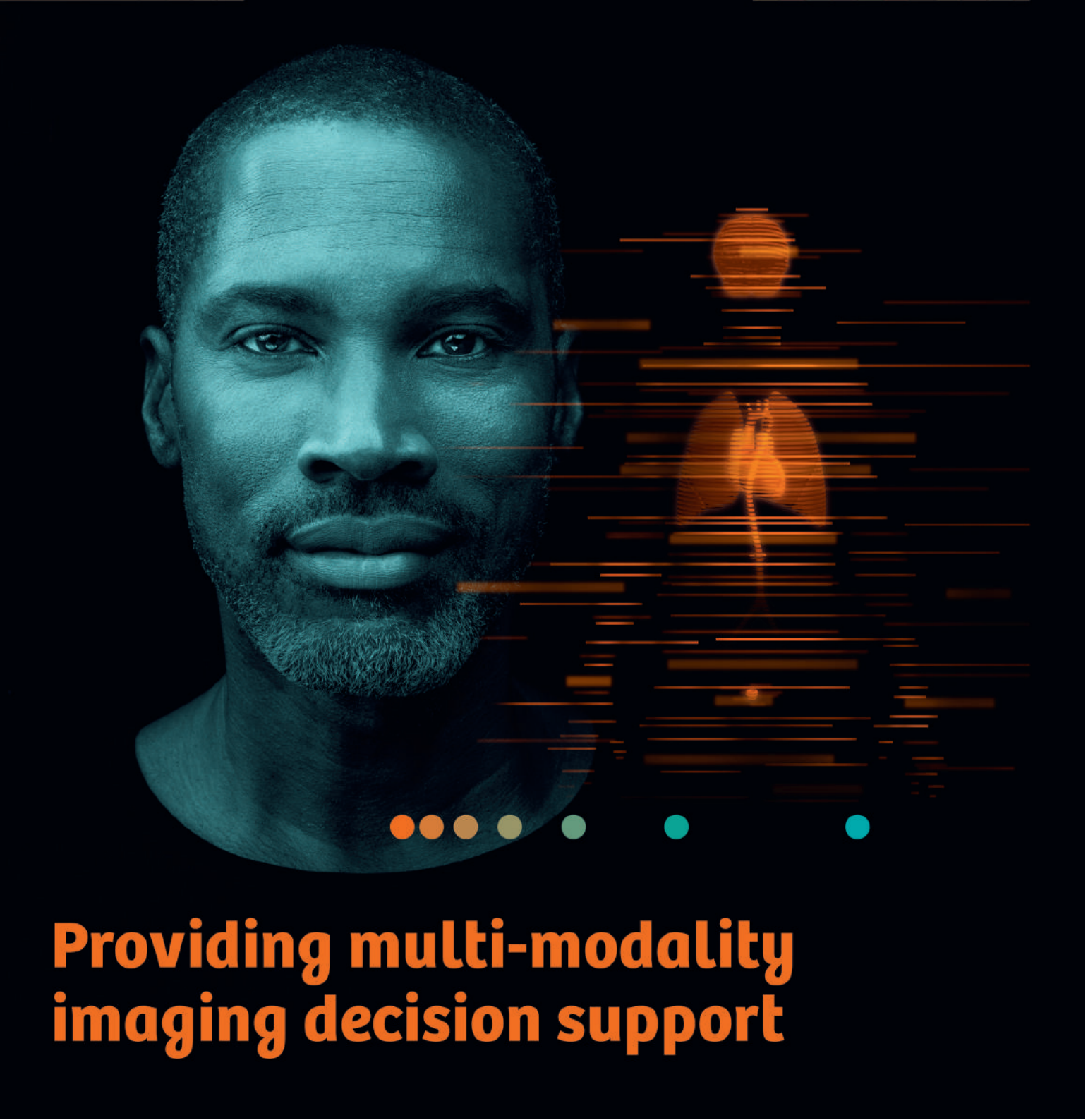

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2020 COVER STORIES

If we were to scrap out traditional ideas about the hospital what would it look like?
What game-changing models already exist?
What can we learn from other industries to adapt for better healthcare?

We have both a data gold mine and a data problem. How can we utilise all these collected data for the best treatment?
What are the best solutions and examples already implemented and what is still lacking?

Recent advances in technology has led to a major shift in prevention, diagnosis and treatment.
What fresh ideas and solutions are changing the game?

With the difficulties hospitals face in keeping up with investments, the development and the adoption of assisting technology is vital.
What are the main obstacles that come with this rocky terrain?

Today's patient is armed, informed and fully engaged in their care delivery. How does this abundance of knowledge change hospital systems and care delivery? Is he a consumer with choices?

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76 **Nurse's Health – Do You Manage This Challenge?**

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50 **Generalism as a Sustainable Model in New Healthcare Paradigm**

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46 **Healthcare 2030: Transformation in the Next Decade**

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36 **How Far Is the Future?**

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60 **Building a Better Hospital**

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66 **The Reuse of Health Data: Governance and Trust As Catalysers for Quality**

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62 **Healthcare 2030: Transformation in the Next Decade**

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74 **How Digital Transformation Can Enhance Healthcare Staff Communication**

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62 **Healthcare 2030: Transformation in the Next Decade**

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Marina Gafanovich is a primary care doctor who believes in the philosophy of patient first. She believes that attitude is everything when it comes to a patient's ability to self-heal. She is a strong advocate of using a humanist philosophy when dealing with patients.

56 **The Empowered Patient: Capitalising on Information and Technology**

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UK
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28 **Managing Change to Improve Clinical Outcomes**

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39 **Leveraging Artificial Intelligence to Elevate Narrative-Based Medicine**

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30 **How to Motivate Your Team to Accept Innovation: A Case Study**

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66 **The Reuse of Health Data: Governance and Trust As Catalysers for Quality**

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64 **The Application of Artificial Intelligence (AI) in Healthcare**

Editorial
Reimagined Hospitals

In 10 years, the healthcare system will be a different beast. The power of technology and data will change the way we face the current challenges driving us towards more integrated care based on population health and value, with increased patient engagement.

This all means the old healthcare provision paradigm is crumbling. Not that hospitals will not be there, but they will be reimagined. Like Mark Twain once said, "The reports of my death are greatly exaggerated."

Reimagining what a hospital is requires the broadest reconsideration of what a hospital's functions are and where health systems will stand in the future. How do we introduce systemic changes? How do we embrace innovation and make it sustainable? Our 'Reimagined Hospitals' issue provides valuable insights on these and other issues.

Our IT Editor-in-Chief Prof. Christian Lovis explains how harnessing technology may make overhauling the entire system unnecessary while Adam Gale from KLAS gives his forecast on what healthcare may look like in 10 years. Christopher Shaw 'reimagines a hospital' from a design and architecture perspective. Chris McCahan from the IFC urges us to rethink the entire healthcare value chain. How AI is challenging the role of a radiologist is provided by Stephen Baker and the emerging need for 'superspecialists' is highlighted by Marcel Levi. The success of Finland, a world leader in tech integration and data leverage, is described by Sirpa Arvonen, head of the state-wide Digital Health Village. We also cover the role of FAMGA in shaking up the traditional model of healthcare and a panel of healthcare experts, which includes hospitalist Robert Wachter, provide their opinions regarding the most transformational change in healthcare in the next decade.

We 'Spotlight' optimism in the imaging community on AI in radiology following RSNA 2019. In Winning Practices, a care provider speaks about innovation and change in executive management in healthcare. We also look at the urgent need to adopt a culture of safety for zero preventable deaths, a quality approach to data with four governance pillars and streamlining radiology workflow in imaging departments. The works of an innovative platform Plan Adapta, launched in Spain, is also in focus alongside the outcomes of a project aimed at promoting nurse health.

We hope this journal will provide food for thought. As always, we welcome your news and views.

Happy Reading!

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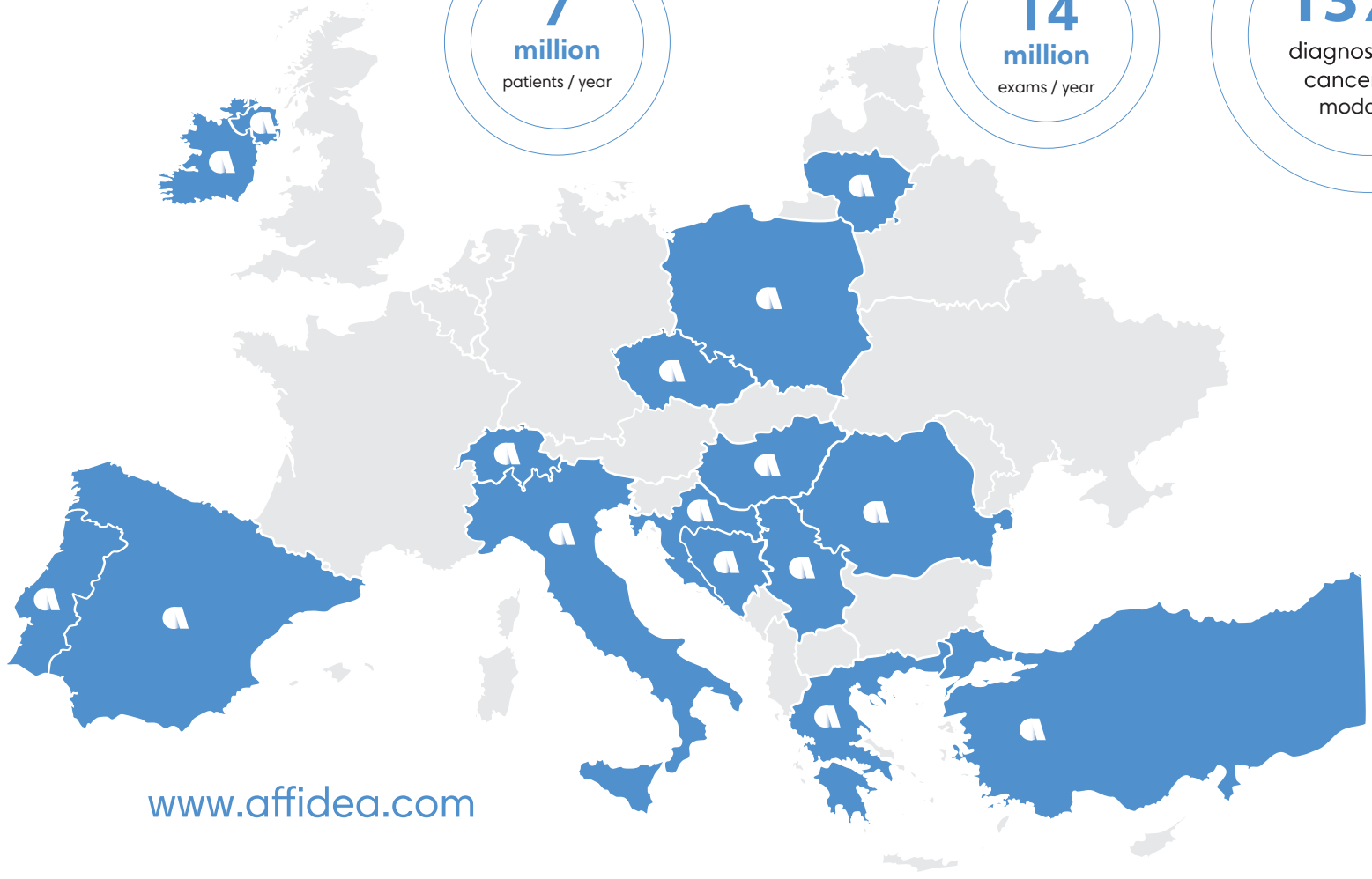

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Have your say. Engage!

If we were to scrap out traditional ideas about the hospital, what would it look like? What game-changing models already exist? What can we learn from other industries to adapt for better healthcare? We explore this and more.

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RSNA 2019: Radiologists Can Be Optimistic About AI

Summary: The technological advances showcased at RSNA 2019 pointed to a positive turning point for a leading radiologist who has seen the rises and falls of the profession over five decades.

When traveling to my nearly 45th Radiological Society of North America (RSNA) meeting in November 2019, I felt mixed emotions. As my career is moving towards its close, I feel privileged and excited that I have been fortunate to witness many of the most significant developments in modern radiology. I personally have been able to participate in the development of new radiology subspecialties such as ultrasound and the fields of health sciences research and quality improvement as it applies to radiology. In addition, I have been a witness to the onset of CT, MRI and PET scanning.

Yet in recent years when leaving the meeting, I have been saddened by the sense of burnout and dissatisfaction among colleagues and friends. I came home concerned about the lack of available jobs for radiologists and, then in time, the inability to fill openings because of the lack of interested candidates. On my return, I acknowledged the challenges radiology faces from other specialties as a result of point of care ultrasound or from competition from other competitive specialties. Most importantly, in recent years when attending the RSNA, I have been disturbed by the lack of major new developments and innovations compared to earlier meetings I attended. The excitement seemed to be gone.

This year, however, I was impressed that a new innovative atmosphere and spirit was underway involving the introduction of artificial intelligence into diagnostic radiology. In the past I have heard many friends and associates bemoaning that computers would replace radiologists or that computer innovations only made radiologists' work life more stressful and tedious. In contrast, at RSNA 2019, it appeared that AI could help practicing radiologists efficiently analyse plain films, ultrasound and CT. A whole floor of commercial entrepreneurs showcased new software applications. While of course, there will be shakeout, reduction and merger of many companies, it was obvious that a new revolution of innovation was underway. It appeared to me that if used and developed correctly, AI could be an antidote for the diagnostic volume overload, sense of weariness and lack of control that many radiologists decry and complain about. I saw in AI the ability to innovate and change the everyday practice of radiology as well as to restore some freedom to the professional life of radiologists. New opportunities and applications seem possible and feasible. I almost felt the same excitement as when I saw my first real-time US study or when CT and MR were introduced.

This time, I came away from the RSNA happy that I had attended; happy that I could envision a new era of innovation for radiologists and imagine that a less stressful form of practice was possible. I came away thinking that it is possible for the field of radiology to seize control of its future. It is up to radiologists to imagine how they want to practice and harness AI to achieve those goals. I saw applications that measured and graded thyroid nodules which many currently find tedious. I saw how nodule detection on chest CT and plain films could help tired radiologists. I imagined that in the future, many more applications would be developed such as liver nodule measurement and assessment. I saw options for radiologists to advocate positively for change and make their needs understood.

I came away optimistic for the future of radiology. I came away happy that we have forums such as RSNA where ideas can be exchanged and amplified. Here's to radiology of the future. ■

RSNA 2019 showed me that, if used and developed correctly, AI could be an antidote for the diagnostic volume overload

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RSNA 2019 Review

- The Radiological Society of North America (RSNA) 2019 was the 105th year of the scientific meeting. It featured plenary sessions on patient interaction, imaging and neuroimaging and genetics, integrated diagnostics, radio-patho-genomics and next-generation technologies for precision health.
- Delegates presented 1,662 scientific papers in 16 subspecialties: breast; cardiac; chest; emergency radiology; gastrointestinal; genitourinary; health services, policy and research; informatics; molecular imaging; musculoskeletal; neuroradiology; nuclear medicine; paediatric, physics; radiation oncology and radiobiology; and vascular and interventional imaging.
- Industry was represented through 701 technical exhibits and there were 133 first-time exhibitors at the event.
- Reflecting the thirst for knowledge about Artificial Intelligence (AI), Machine Learning and Deep Learning in the field of radiology there was an increased focus on the applications and implications of these technologies. The Assembly featured a newly expanded AI Hub. Innovations from industry leaders, AI in action at the RSNA AI Theatre, and AI solutions in the RSNA Deep Learning Classroom were showcased at the meeting.
- The meeting saw a rise in attendees to its Virtual Meeting which offered remote access to educational programming, scientific presentations, education exhibits and additional meeting content, both during and after the meeting.
- The 106th Scientific Assembly and Annual Meeting of RSNA, with the theme of Human Insight: Visionary Medicine takes place from November 29–December 4, 2020, at McCormick Place in Chicago.

Brexit Disruption Harnessed for Better NHS

Summary: The UK National Health Service (NHS) has been a cornerstone of deliberations for Brexit, Britain's exit from the European Union (EU). Proceedings have put into high relief operational problems faced by the NHS with concerns over nurse numbers at the forefront. With the UK set to leave the EU on January 31, 2020, how is the NHS addressing the nursing shortage crisis?

The Background

The UK voted to leave the EU in 2016 with a very close margin of 52% to 48%. The outcome sent shockwaves around the world and there were few places where they were felt more keenly than in the UK's healthcare system. The NHS has traditionally in part relied on migrant labour for several staffing areas – especially for nursing. Most nurses from abroad come from non-EU countries but those who have come from the EU to work, have made a significant head count contribution (Palmer and Rolewicz 2019).

In the middle of June 2015, one year before the EU exit poll, UK-trained nurses were leaving the NHS at a rate of 2,500 annually while the number of EU nurses rose by 3,500. Since the plebiscite, there has been a reversal in this trend (Gilbert 2020).

Traditional 'Solutions'

Presently, there is a shortage of 43,000 nurses across the NHS (Mitchell 2019).

While reliance on imported labour is not likely to slow significantly overnight, it is not regarded as a long-term solution for a number of reasons. The UK is not alone in relying on nurses from abroad to help fill a local shortfall and is competing with countries that offer higher salaries. Additionally, there is the ethical question of luring trained nursing staff away from their own countries where they are also needed.

Another way of tackling the nursing shortfall is employing temporary staff. However, this is unsustainable financially. At the close of 2018, NHS trusts forecast £5.6bln on temporary staff expenditure which exceeded a budgeted £5bln. Concerns about cost is not the only factor; there are worries that relying on temporary staff can be disruptive for patient care (Palmer and Rolewicz 2019).

Efforts

Experts have warned that migration alone won't solve the problem. While they acknowledge that imported labour will still contribute to nursing numbers, they also stress that more nurses also need to be UK trained and more effort needs to be made to retain the workforce (Palmer and Rolewicz 2019 n2). These are both regarded as key opportunities to come out of Brexit.

Attracting and Training Nurses

So what are policy makers doing to attract more recruits to the nursing profession?

More nurses need to be UK trained and more effort needs to be made to retain the workforce. These are regarded as opportunities to come out of Brexit.

In December last year, the new government announced a £2 billion raft of financial support measures for new students of nursing (gov.uk). Those entering degree-level nursing and midwifery courses from September this year will receive support of up to £8,000 a year (non-repayable) to help cover living costs. More than 35,000 students are expected to benefit. Nursing students will also still be able to access tuition funding and maintenance loans from the Student Loans Company.

The measures are part of the government's pledge to increase homegrown nursing numbers by 50,000 over the next five years. Out of these, 31,500 will be new, 5,000 will be nursing apprentices and 12,500 will be migrant nurses. Nurses who have been persuaded not to leave or

to return to the NHs will constitute the remaining 18,500 (Gilbert 2020).

The government action comes alongside the biggest push for nursing recruitment in decades. The NHS 'We Are the NHS, We Are Nurses' campaign (NHS Employers 2019), backed by the Health Secretary, is targeting school leavers about the choose their degrees and people switching careers.

The campaign has already seen a rise in UK nationals joining the NHS following this drive to encourage staff to return and boost retention rates (Gilbert 2020).

In addition to investment in nursing staff, the government aims to expand NHS staff further with 6,000 doctors in GP surgeries and 6,000 primary care staff, such as physiotherapists and pharmacists.

Retaining Nurses

Staff retention is perhaps where the greatest challenge is and one that is felt in healthcare across the globe. For nursing in the UK, this would mean making the profession more attractive both in terms of salary and working conditions.

Speaking to the UK media in January, Andrea Sutcliffe CBE, chief executive and registrar for the Nursing and Midwifery Council, praised the government recruitment initiative but stressed that more action was needed to address the pressures nurses and midwives face to attract and retain the workforce numbers needed by the NHS (Gilbert 2020).

"In our last survey of those leaving the register, one third cited too much pressure leading to stress and poor mental health as a reason for leaving," she said. She went on to say that challenges included effective workforce planning, a coordinated approach across health and social care and support for continuing professional development to create an attractive career pathway for both new and existing staff.

"This is why the NHS has funded thousands more clinical placements for those in training, delivered a 6% increase in nursing applications as a result of the largest ever recruitment campaign, and rolled out a successful nurse retention programme which has reduced turnover rates."

Last year, the Health Education England (HEE), responsible for education in the NHS, released a report recommending measures for dealing with staff burnout. These included provision of safe places and 24-hour helplines to help NHS workers deal with traumatic incidents and fast-track mental health referrals to prevent burnout. It also recommended appointment of a 'workforce wellbeing guardian' for every NHS organisation (Baska 2019).

Silver Lining

While attracting migrant nursing staff will remain part of the NHS recruiting policy, Brexit is contributing to forcing the NHS and policy makes to look even more keenly at addressing reasons for the homegrown staff shortage.

The UK's departure from the EU could bring short-term disruption to the NHS, but if this is ultimately harnessed for improving nurse numbers and staff retention, it can only be a good thing for one of the world's largest employers (McCarthy 2015). ■

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Bright Ideas

HealthManagement.org rounds up exciting developments that have all the characteristics of game-changers for healthcare. What do you think?

AI Breast Cancer Diagnosis Matches Two Doctors

A study suggested that AI diagnoses breast cancer from mammograms more accurately than radiologists.

A computer, specially designed and trained by a team of researchers from international bodies such as Google Health and Imperial College London, performed as well as two doctors working together.

The computer model worked on mammograms from nearly 29,000 women in the UK and US.

In the study, the computer analysed the images with no access to each patient's history but still outperformed six radiologists.

The study results indicated that the AI algorithm matched the double-reading system in accuracy and was better at spotting cancer than a single radiologist.

There was a 5.7%/1.2% (UK and US data respectively) reduction in falsely diagnosed cancer and a 9.4%/2.7% drop in false negatives, when cancer is overlooked.

Becoming a specialist in interpreting mammograms takes more than a decade and reading images is time-consuming work. While AI shows great promise in cancer diagnosis, it is largely seen as a support tool for radiologists that would tackle burnout and staff shortage.

The research team said one application could include providing automatic real-time feedback on mammography images, awarding a statistical score that could be used to triage suspected cases more quickly.

Nobel Prize for Medicine

In December 2019, the Nobel Prize Award Ceremony took place in Stockholm, Sweden. This year, the award in Physiology or Medicine was presented jointly to doctor and cancer research scientist, Dr William G. Kaelin, Jr. (Harvard University and Dana Farber Cancer Institute, USA), Sir Peter Ratcliffe (University of Oxford, UK) and Dr Gregg Semenza (Johns Hopkins University, USA), "for their discoveries of how cells sense and adapt to oxygen availability," one of life's most essential adaptive processes.

The Nobel honour was the result, in part, of ground-breaking research Kaelin had done 15 years before. It was dedicated to the understanding of the von Hippel-Lindau (VHL) gene mutations, which cause VHL syndrome that makes patients more likely to develop kidney cancer.

Kaelin's work allowed for better understanding of how oxygen levels affect cellular metabolism and physiological function, and subsequently, of the causes of abnormal cell or cancer growth which provided insights into tumour development and growth prevention. VHL patients battle a series of tumours throughout their lives, and curing VHL is one step closer to curing many other forms of cancer.

Swiss Hospitals Successfully Trial Blockchain Medical Device Tracking

Swiss hospitals have announced successful processing on a trial of medical device orders via the Blockchain.

The Cantonal Hospital Winterthur, the Cantonal Hospital Baden, the University Children's Hospital Zurich and the Spitalregion Fürstenland Toggenburg along with two medical device suppliers undertook the order trial.

Present standards of medical device traceability is inefficient and it's impossible to guarantee trustworthiness. Counterfeit scandals have highlighted the vulnerability of the medical device supply chain and the risk borne by patients.

With the European Union 2017 Medical Device Regulation, all devices require a Unique Device Identification number for identification along the supply chain.

The Blockchain system devised for the participating Swiss hospitals enables medical device route tracing. All transaction steps are stored in the Blockchain with common consensus and are immutable. The chain also makes it possible to track all transactions.

Stakeholders said that both technological and regulatory means now exist to put a vision for better patient safety into practice.

AI Predicts Future Healthcare Costs from Chest X-rays

Researchers from the University of California San Francisco (UCSF) trained deep learning (DL) applications to identify cost indicators from chest radiographs to predict future health costs covering five years.

Presented at the Radiological Society of North America (RSNA) in Chicago, USA last December, researchers said DL could pave the way for increasing the value of imaging data.

"Cost is a crucial barrier to healthcare access and cost estimation can better prepare a patient physically and psychologically," said the research team.

The team added that radiologists can presently only extract a minimal amount of data from images but the algorithm she and colleagues have developed could change that.

During the development of the algorithm, the research team used 16,533 chest radiographs from UCSF from more than 19,000 patients. The data was then broken down into sections that included patient's age, gender, postal code and cost of care to date at UCSF Medical Center within five years of their exam. This was followed

with four different models of classification which were tested on 1,877 images.

The method resulted in an accurate prediction of the patient's five-year healthcare spend and identified if they would be in the top 50% of healthcare spenders.

Machine Learning Helps Predict Risk of Heart Failure

Researchers at Brigham and Women's Hospital and UT Southwestern Medical Centre developed a machine-learning algorithm which can identify the risk of hospitalisation from heart failure for patients with Type 2 diabetes.

The ACCORD (Action to Control Cardiovascular Risk in Diabetes) trial took place over five years and analysed data from 8756 patients. The machine learning algorithm was developed by taking into account 147 different variables, including biological, clinical and demographic data. The WATCH-DM risk score took into account key factors such as weight, age, hypertension and creatinine and HDL-C levels, diabetes control, QRS duration, MI, and CABG.

Results of the study found that 3.6% of patients developed heart failure during the five years of the study. By using the WATCH-DM risk score, researchers found that the risk of heart failure within five years increased by 24% per 1-unit increment in the risk score.

Researchers are now working on developing the machine learning model to be used in the electronic health record of Brigham and Women's Hospital and also UT Southwestern Medical Centre. Implementation of the WATCH-DM risk scores in real-time could prove beneficial for centres focusing on personalised medicine as patient outcomes could be predicted immediately and prevention care initiated as soon as possible.

First Digital Clinical Trial Encourages Physical Activity

As little as a daily ping on your phone can boost physical activity, researchers from the Stanford University School of Medicine and their collaborators report. This was the first-ever entirely digital, randomised clinical trial, which sought to answer two key questions: Is it feasible to successfully run an entirely digital, randomised clinical trial? And is it possible to encourage people to exercise more by using a smartphone app? The study shows that the answer to both questions is yes.

MyHeart Counts is an app that was first deployed on smartphones in 2015, and was launched to help track physical activity and other heart-related information, such as heart rate. Now, it's the main tool for a full-on randomised clinical trial, including patient recruitment, consent and interventions. It also returns data to participants.

On a weekly, rotating basis, the digital trial "prescribed" one of four simple interventions for each participant enrolled in MyHeart Counts - things like reminders to walk more or stand up. Regardless of the type of intervention, there was approximately a 10% increase in activity compared to the participants' baselines.

Heart-on-a-Chip Technology Directly Measures In-Vivo Cardiac Performance

Data from a study of investigational candidate, MYK-491, showed that a human iPSC-derived organ-on-a-chip technology can directly measure in vivo cardiac performance. MYK-491 increases the contractility of the heart (systolic function) with minimal or no effect on myocardial relaxation and compliance (diastolic function) by acting directly on the proteins in the heart muscle responsible for contraction.

Reported at the AHA Scientific Session in Philadelphia last year, the human heart-on-a-chip technology provided confirmatory preclinical evidence already seen in other preclinical and clinical studies: MYK-491 appears to increase systolic contractility without impacting diastolic relaxation. This platform may serve as a valuable human translational model for cardiovascular drug discovery with its ability to capture the nuances of human heart contraction and relaxation mechanics, said Michael P. Graziano, PhD, chief scientific officer of TARA Biosystems.

Additionally, findings published recently in the Journal of Toxicological Sciences, show that the 3D-cardiac tissue platform predicts responses to a wide range of drugs known to affect cardiac function in humans, something that has been a challenge in pre-clinical models until now.

Deep Learning AI May Identify Atrial Fibrillation

A study published in The Lancet found that artificial intelligence (AI) technology was able to diagnose patients with intermittent atrial fibrillation even when their hearts were at a normal rhythm. The 10-second test could help identify patients at risk of unexplained heart attacks or strokes.

Intermittent atrial fibrillation can be difficult to detect and current monitoring for atrial fibrillation can take weeks to years. The challenge remains in detecting atrial fibrillation early in patients who have suffered from an unexplained stroke so that anticoagulation medicine can be administered.

This study used patient ECGs to develop an AI algorithm that could detect atrial fibrillation to an accuracy of 83%. The ECGs were first divided based on whether the patient had atrial fibrillation or not. By training a neural network, researchers were able to detect ECG signals that would otherwise be invisible to the human eye. Although further research is needed, this quick and inexpensive test could hold promise for the future of atrial fibrillation detection.

Portugal's National Telehealth Plan

Although telehealth is not a new concept for Portugal, it is often provided locally and is not homogenous. In November 2019 the country launched National Strategic Telehealth Plan (PENTS), which is aimed at bringing the country's telehealth services to a common standard. This involves work on infrastructure development, data interoperability improvement and upgrade of regulatory framework, to name a few. The development of PENTS is based on the input of 50 institutions and health experts, including patient associations.

Currently, there are various digital health tools available and widely used in Portugal. For example, over 2 million users of online RSE Área do Cidadão (Citizen Area) can access their electronic medical records, arrange an appointment with a physician, etc. The e-prescription service is obligatory with the Portuguese National Health Service and very popular in private healthcare sector. In the free mobile app MySNS Carteira important health-related information is stored, eg NHS access details, allergy registry or e-prescription. The app also plans to integrate video-calls for direct teleconsultations; the service is expected to be available soon. Meanwhile, the government has been supporting teleconsultation adoption via financial initiatives.

Light Instead of Endoscopic Surgery

MIT engineers have developed a material (proof of concept stage) that would break down inside the body when exposed to light from an ingestible LED. The light-sensitive hydrogel can be used for a variety of medical devices, inserted into the gastrointestinal (GI) tract, that currently have to be removed by endoscopic surgery.

Having tested the new material in a study in pigs, the researchers showed that devices made with this hydrogel disintegrate if exposed to light from a small LED. One potential advantage here is that light can act at a distance, so no direct contact with the material being broken down is needed and the chance of accidental triggering is minimal.

The gel includes a chemical bond that is broken when exposed to a wavelength of light between 405 and 365 nanometres (blue to ultraviolet). By changing the composition, the gel's parameters, such as the speed of decomposing or its mechanical strength, can be adjusted. It is noted that the gel and its breakdown products are biocompatible. Various shapes can be moulded out of the material, such as a seal for a bariatric balloon or an oesophageal stent (as demonstrated by the researchers) but also others, eg a potential field of application could be vehicles for delivering drugs to the GI tract.

Voice Analysis for Patients With Mental Illness

Researchers from UCLA used an AI interactive voice application, MyCoachConnect, to monitor patients' mental health by analysing their speech patterns. They followed 47 patients, treated for serious mental illnesses, for over a year. When making a phone call once or twice a week, participants were asked by a computer-generated voice: How have you been over the past few days? What's been troubling or challenging over the past few days? and What's been particularly good or positive? They were expected to speak for several minutes answering each question.

According to the researchers, the application was designed to collect personalised patient responses and offer a personalised analysis for each patient using their own wording. The main focus was on the patients' word choice and the change in their responses over time. Audio features, such as tone of voice, were also analysed.

Consequent analysis showed that the application's AI could monitor patients' mental states as accurately as their physicians. The researchers, therefore, hope that AI could enable more proactive and personalised care, eg by intervening early when relevant symptoms are identified.

Managing Change to Improve Clinical Outcomes

In 1989, Professor Andrew Walton founded Connect Health, a leading independent provider of community services to people with musculoskeletal (MSK) problems, which today serves over 300,000 National Health Service (NHS) patients per year. Prof. Walton, Executive Chair of Connect Health, Chair of MSK Partners Network (MSK PN) and Visiting Professor of Leeds Beckett University, spoke to HealthManagement.org about innovation and change in his field and the general challenges of executive management in healthcare.

Since your journey began as a physiotherapist in 1985 to Executive Chairman of the UK's largest provider of integrated community MSK services in 2013, what was the single most important lesson you've learned?

Throughout my career, like other health professionals I have focused on trying to achieve the best outcome for each patient. I have kept abreast of new evidence and endeavoured to apply that in my clinical practice. As Connect Health has grown and I have ceased my clinical role, I have encouraged and supported other clinicians to do the same. As a result, our clinical outcomes have steadily improved. Over the last few years, we have invested in systems and a data warehouse, which has given us timely information about our clinical outcomes at organisation, service and individual levels. This has accelerated our improvement in terms of outcomes demonstrating that visibility of performance enables transformational change.

How have you integrated technology into your practices and how have staff and stakeholders reacted?

Technology is changing every aspect of our lives. The benefits provided by new digital approaches are having a huge impact on our societies. However, one of the greatest business challenges is not about the devices, software or solutions – it is about how we manage the process of cultural change, particularly in health and

care, which have historically been slow to embrace new technologies. Almost everyone accepts that technology has the potential to improve the delivery of healthcare and its impact. Therefore, the management of change is critical in its implementation. We have introduced Artificial Intelligence (AI) to enhance patient care. This has resulted in streamlined processes which frees up time for colleagues to focus on the patient, rather than on certain administrative tasks. Our communication with colleagues has been key in this, sparking significant levels of interest, curiosity and ideas.

You work extensively with the UK's NHS. How have you approached partnering with such a large organisation?

An organisation as large as the NHS inevitably has significant variation both in terms of its behaviour and practice. There are numerous examples of innovation and excellent practice and impact. However, in some areas there are conflicting incentives and drivers. Where focus is on patients and taxpayers, but also a good deal for staff, then there is a better chance of optimising care.

We remain determined to work with the NHS to raise the quality and efficiency of MSK, rheumatology and pain community service provision across whole systems.

The significant reduction in patient waiting time is an impressive achievement. How have you done this?

Our services are wholly designed to focus on the patient experience and what really makes a difference to them – being seen in the right place, at the right time, by the right clinician.

Part of our clinical philosophy is to reduce the barriers for patients (and commissioners) to accessing care. We have found that the earlier a patient presents, the less pain, stiffness and weakness has developed therefore achieving an optimal outcome requires less input by the clinician or the patient. The investment in our infrastructure and referral management centre is key to reducing those barriers.

What is your primary focus for the future of healthcare management?

Our approach is highly collaborative with other providers and stakeholders in the system. The primary focus is on efficient implementation and delivery of community clinical and therapy services.

Our investment in infrastructure for community service delivery and our development of a unique change methodology, which transitions services onto our platform demonstrably improving their effectiveness and productivity, are transferable to other clinical service areas.

How do you use data to reduce the need for surgical intervention?

Our data is helping us to make better decisions earlier in the broader MSK Pathway with regard to what can be managed successfully conservatively and what we need to accelerate on to more specialist and/or surgical interventions. We consistently reduce the demand for surgical outpatient appointments (and associated diagnostics) and in some cases are reducing the surgical demand. Our biopsychosocial approach combined with improving lifestyle (promoting exercise, increasing confidence and social engagement, improving diet, etc) is improving peoples' ability to live longer with moderate to severe hip and knee arthritis. Working with our surgical colleagues helps to optimise decision-making in this regard.

How did the automobile industry change your management strategy?

Connect Health was founded by myself and other clinical colleagues in 1989 and we spent over 20 years slowly building the foundations with a clear focus on the patient. We believed that optimal care would be achieved by attracting the best clinicians and investing in their clinical development – but the supporting infrastructure was relatively neglected. This changed when, a few years ago, I visited a manufacturer of heat exchangers for cars, which was in the supply chain for a large car manufacturer, and realised the importance of a broader approach to efficient and effective delivery in a market where annual reductions in price were normal. Counterintuitvely, this was driving investment in innovation and improvement and the manufacturing business was thriving. I sought to bring the same approach to community healthcare service delivery.

Over the years, how have you dealt with mistakes and misjudgement?

From a personal point of view, learning from mistakes (my own and observing others) has been important in developing a successful business in our sector. Even better is to surround oneself with a management team that have made their mistakes and done their learning on other businesses before joining ours.

What is your top tip for managing change in healthcare?

Be resilient: there is an optimal pace for change. ■

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How to Motivate Your Team to Accept Innovation: A Case Study

Summary: Introducing innovative equipment to an established hospital department may seem like a challenge, and often is one. But the implications can be minimal if a proper management culture is in place and the staff is motivated to succeed. Head of a radiology department shares his experience of one such project.

As a community hospital, Spital Männedorf in Männedorf, Switzerland, has an emergency station, which by law is required to have a 24-hour emergency radiology department equipped with a CT scanner. So when the department's management decided to install a new scanner, the task promised to be challenging for them.

consequent patient dissatisfaction. Thus, the decision to acquire new equipment was made.

The hospital is a limited liability entity, and every new investment case needs to go through an approval process and be backed up with a business plan to receive the necessary funding. The pressure, however, wasn't primarily

to be replaced with a newer piece. Would that new machine make their work redundant? This is a question raised often in the radiology community, and the hospital's department was no exception. Nevertheless, the team trusted me as head of the department to make a decision that would not 'kill' them.

To keep the seamless provision of service, we arranged to have a transitional period of several months

Spital Männedorf was one of the first five hospitals in the world to use a new, next-generation CT scanner from a leading producer. The new unit was AI-driven and had a new user guidance system, removable tablets and many other novel features, so the staff felt uneasy about the transition from a familiar piece of equipment to a new one. However, some simple management solutions helped the department to smooth out the experience and eventually provide excellent outcomes.

Background Information

The previous machine had been in use for 13 years. Not surprisingly, the situation was getting more and more difficult due to increasing downtime of the scanner and

financial but strategic, as the plan required removing the only CT unit and placing the new one in use almost simultaneously, so that the hospital would always have an operating CT machine.

Team

The radiology team in Spital Männedorf includes 17 radiology technicians ranging in age from 26 to 60 years old. They are a multicultural group of people, partially trained outside of Switzerland, but nevertheless very loyal to the department – some of them have been working there for more than 30 years.

Having had the hands-on daily experience with the CT unit, the team knew, better than anyone else, that it needed

Implementation Process

One can imagine that a machine that old, even if it is well-maintained and its software is regularly upgraded, simply cannot keep up anymore with modern software platforms and general workflow. So the upgrade was desperately needed, but my worries were numerous. How do I, as head of the department, manage the change? Will my team be able to successfully handle working with the new platform, the new software?

Since we were going to be one of the first testing sites, my additional worry was the so-called 'child illness' of the new system, ie all those potential unexpected problems and issues surfacing when new equipment is put to clinical use. Unfortunately, we were not able to share our experience with the other four testing sites. The only contact with them was

through the vendor by means of exchanging some protocol details, so we had to deal with the challenges on our own.

To keep the seamless provision of service, we arranged to have a transitional period of several months. While the CT room was being renovated and the new unit installed, we received a mobile scanner as a temporary replacement. It was placed in a container outside the department, and we could keep on examining the patients 24/7.

Training

There were two stages of training – first, to use the temporary CT unit and later on, the new system. I can say this approach increased the trust and improved the attitude of the team members towards the vendor and myself, as the 'sources of change.'

Initially the vendor focused on training several 'teachers.' The application specialist of the company held sessions with two of our technicians for three days. Then, these two taught the rest of the team one by one, so in the end all of them knew how to operate the machine.

The first adopters were volunteers, very enthusiastic about the opportunity to get their hands on this new unit. Their eagerness proved to be infectious, and in no time the rest of the team were in, so the staff adoption aspect of the transition went smoothly. For me personally, it was a relief and a pleasure to see that there were no strong negative reactions.

Challenges

Despite the relatively smooth transition, the biggest challenge was the fear of 'the modern,' the AI and the new way of examining the patients with new protocols, new buttons and new processes. This is understandable, since all the technicians were using the same machine for 13 years and suddenly everything was different.

To address this issue, the chief CT technician persuaded the first adopters that moving on was important, and we were able to organise the training in such a way so as to eliminate any time gaps and fulfil requirements. Thus, the whole team received training on-site, and no additional staff was needed.

Furthermore, if a technician didn't feel confident to conduct a specific examination with the new scanner, they were free to examine patients in the temporary replacement unit, especially during the night shifts. For the initial training period this proved to be our 'magic solution,' which gave technicians the freedom to choose the most convenient system and thus, decreased the level of stress. Not that they used the temporary scanner often once the new unit was in place – it looked like the challenge of handling the new equipment turned out to be a strong motivation.

These technicians decided to master the new unit, the new way of work, not as a favour to me, but as a favour to themselves. They strived to show that we can be a very good hospital when it comes to working with a new system – and they succeeded. The vendor as well saw how a non-university hospital could produce nice results with less support.

Reception from Other Professionals

We made it public that we had gotten a new machine. So both the internal and external referring physicians were anxious to see how we would deal with the new system and how adequate the examinations would be depending on the clinical question for every patient. There are, for instance, multiple clinical questions in case of dyspnoea or thoracic pain – is that a pulmonary embolism, or aortic dissection, or pneumonia, or something else? With the new system we were able to get our answers quickly and efficiently.

In turn, automatic 2D and 3D reconstructions of the organs and pathologies provided images of superior quality, and we were able to easily explain the findings to clinicians who didn't have any training in radiology. Patients were satisfied as well because of the larger bore gantry and less time alone due to faster scanning. In the end this had a 'word of mouth' marketing effect.

The eagerness of the first adopters proved to be infectious, and in no time the rest of the team was in

Assessing Outcomes

We measure the progress achieved, first of all, by the number of patients examined. It is clear that with the new system the patient throughput has increased while the staff numbers haven't. Due to faster processes, more examinations are regularly planned for outside patients, and in between we examine emergency patients and in-hospital patients.

Another measurable outcome is the number of complaints we get. If you don't spend time with a patient during examination, they are left dissatisfied and complain to the management. In this sense, the innovative mobile tablets of the new scanner brought the technicians closer to the patient, allowing for more personal contact before and after the examination, which positively impacts the overall satisfaction of the patient.

Success Factors

The team's dynamics during the transition process translated into a slogan 'I can do it!' Regular practicing during the transitional period allowed both older and younger technicians to improve their skills in handling the new system and feel more confident.

We also practice the so-called 'huddle,' a term from American football, and it helped us during the project. 'Huddle' was adopted a couple of years ago during which a team strategically discusses both mistakes and successes, with the intention to continuously improve their outcomes. Whenever anybody sees a mistake, including those of mine, we communicate it – without any punishment. We call it 'speak up.' For us this proves to be a very effective way to adjust and correct our actions and avoid future mistakes. In turn, successes, even potential ones, are highlighted and rewarded.

Considering the above, one of the major success factors during the transition was the team spirit. I, personally, was impressed with the will and motivation of each member of the team to eventually learn the new system and upgrade their skills. The technical innovations (mobile tablets, 3D camera, etc) helped the technicians to improve the image quality, which motivated them to use the new system more and more.

As a result, despite my initial worries, there was no opposition or sabotage on the part of the team, and it wasn't necessary for me to intervene. My role came down to encouraging them as a coach, being present for advice and guidance, and praising their efforts and engagement. For me to motivate a team generally means to persuade them that whatever new they are about to do is going to glorify them and demonstrate how efficient they are as a team. ■

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Key Points

- Introducing new equipment can pose a challenge to the team who may be afraid of change.
- Training is more effective when performed in stages.
- The role of the first adopters is important because they would lead the rest of the team.
- If during the transitional period the staff have the alternative to use the equipment they feel more comfortable with, it can help in reducing the stress.
- The initial concern may turn out to be a motivation.
- Analysing mistakes and rewarding successes as a team is crucial in change management.

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Save Lives by Focusing on Patient Safety

Summary: Preventable medical errors are the third leading cause of death in the U.S., and it's time to take action and change from a culture of deny and defend to a just culture of safety. It's the only way we can begin to save lives.

In 1999, the Institute of Medicine released its groundbreaking report, 'To Err is Human,' which shook the healthcare industry to its core. The report found that as many as 100,000 lives were unnecessarily lost each year due to preventable medical errors. Flash forward to today and that number has grown to an estimated 200,000 deaths each year in the U.S. and 4.8 million worldwide. Since we know there are proven processes to reduce, if not eliminate, these deaths, why have deaths continued to climb?

A big part of the problem is the difficulty organisations have with change. Changing from a culture of denial, blame and risk aversion to a just culture of safety that embraces transparency, open communication, trust and compassion can be diffiult, but necessary if we're to improve patient care. And it takes commitment from top-level management and the board.

In 2012, we started the Patient Safety Movement Foundation with the mission to eliminate preventable hospital deaths.

From the beginning, our goals were to:

- Unify the healthcare ecosystem (hospitals, healthcare technology companies, government agencies, policymakers, patient advocates, clinicians, engineers, payers, etc).
- Identify the process errors that are harming and killing patients, and develop solutions that are shared freely.
- Get hospitals to implement solutions and processes, like our Actionable Patient Safety Solutions (APSS), that save lives.
- Ask healthcare technology companies to openly share the data they collect.
- Promote transparency, honesty and open communication, within our organisations, and with patients and families.
- Treat patients with dignity and compassion.
- Educate providers, future health professionals, patients and families about patient safety.

Over the last eight years, we have developed 34 free evidence-based solutions (APSS) to help keep patients safe. Nearly 5,000 hospitals have committed to reduce the number of preventable deaths to zero, and approximately 100 have implemented all of the APSS. Also, 90 medical technology companies have pledged to share the data their products are purchased for to pave the way for predictive algorithms and decision support to help clinicians eliminate preventable deaths. But there's still work to do – we're not at zero.

We know from experience that solutions like our APSS can reduce and eliminate preventable deaths, that compassion reduces patient harm, that transparency and embracing a Communication and Optimal Resolution (CANDOR) approach to patient safety allows us to learn from errors and that putting evidence-based processes in place can keep them from happening in the future. And we know by making zero the goal, it forces us to do root cause analysis and improve processes in pursuit of zero. We also know that involving patients and families in a team-based patient-centred care improves patient outcomes. We need all hospitals to adopt these values and solutions to begin to improve the safety of patients.

We also know, through experience, that apathy exists. But we also know that a patient safety initiative can start with just one person, one champion with the courage to take action and, through successes, create momentum and change the organisation for everyone's benefit.

We have to take action and we have to do it now. Lives are at stake, and even one preventable death is one too many, let alone 4.8 million. ■

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Key Points

- More than 200,000 people die unnecessarily in U.S. hospitals.
- Changing organisational culture is difficult but mandatory if we're to make a difference.
- There are evidence-based processes that have proven to save lives.
- Honesty and transparency let us learn from errors and keep them from happening in the future.

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How Far Is the Future?

Summary: Endless noise about new technologies in healthcare has providers struggling to find valuable tools among the vapourware. Conversations with thousands of providers, payers, and vendors can help us predict what healthcare will probably look like in 10 years.

In healthcare, uncertainty about the future can yield damning apprehension or expensive gambles. With the industry at fever pitch over emerging technologies, leaders of healthcare organisations continually ask themselves many intimidating questions:

- Which of the market's buzzwords and rumours have substance?
- Are the hottest and newest tools worth investing in right now?
- Where can we be conservative without falling behind?
- When, if ever, will our dreams for healthcare IT materialise?

No single entity has all of the answers. That's why my colleagues and I speak to thousands of healthcare providers, payers and vendors from every continent and speciality every year. Collectively, they paint an accurate picture of healthcare's status quo and trends.

In a spirit of both optimism and realism, I'd like to give stakeholders a 10,000-foot view of healthcare's newest technologies as they are today and as I think they will be in a decade. I hope this view helps leaders make important decisions and provide better offerings for patients.

Artificial Intelligence

Current Status: *Mostly hype but some outcomes from robotic process automation.*

In 10 Years: *Increased impact from robotic process automation, major progress in image reading.*

To speak in terms of Gartner's Hype Cycle, artificial intelligence (AI) is at the "Peak of Inflated Expectations" (Gartner Inc. 2019). A lot more is being said about AI than is being done.

Nearly every vendor claims to have AI functionality; that is easy to do because the industry has no standard definition of AI. In the 2019 Healthcare AI report KLAS and CHIME published together, we included the following definition: "Software that provides machine learning (ML) or natural language processing (NLP) capabilities for healthcare-related clinical, operational, or financial areas" (Pretnik and Krotz 2019).

From this perspective, the field begins to narrow. I've been pleasantly surprised to find that some AI vendor tools are starting to show some early outcomes. However, these vendor efforts have been very targeted.

For example, one technology that is really hot now and will shape the market in the next five years is robotic process automation (RPA). This involves automating fairly repeatable processes – such as many in the revenue cycle – that are currently done mostly by people. Certain vendors are doing really well at RPA, and provider leaders are eating it up. They see deep value in saving FTEs for more high-level processes. RPA tools are already leading to positive outcomes and will have a huge impact over the next few years.

Clinical applications of AI are also stepping into the limelight. For instance, vendors are honing their tools' abilities to read mammography and other images. Widespread adoption is not in the immediate future, however; vendors need more time to improve the technology.

In addition, many radiologists and other physicians don't yet trust technology to do work that has traditionally been theirs. People are much quicker to condemn an AI tool for a mistake than they would be to condemn an employee for human error. Before adoption increases, opinions must soften. Perhaps that will happen as image-reading tools are improved. In any case, I expect to see major progress within the decade.

Patient Engagement

Current Status: *Limited patient adoption due to alignment issues.*

In 10 Years: *More patient-friendly tools, higher patient adoption.*

KLAS just finished some research for the University of Pittsburgh Medical Center (UPMC) and their Center for Connected Medicine. Ironically, this research found that the biggest barrier to progress in the patient engagement industry is the patient. "Patients are increasingly demanding a digital experience on par with what they have in other, more technologically advanced industries, but adoption is still low," the report says. "Organisations report that, on average, [only] 35% of patients have adopted the technologies that are available to them" (Center for Connected Medicine 2019).

If patients want more digital tools, why aren't they using the ones that are offered? I think one answer is that much patient engagement technology is aligned with provider desires instead of patient desires. Too many in the industry have been asking, "How can we engage the patient so that physicians can work efficiently and get paid more quickly?"

This focus has led to the creation of patient engagement tools that don't really help the patient.

I have a personal example of this unfortunate truth. I recently got a text message from my physician's office saying, "You have an appointment this week. Text Yes if you'll be there." I knew I would be unable to attend, but the text didn't tell me what to do if I couldn't make the appointment. After scouring the office's website and making two phone calls, I still hadn't been able to reschedule my appointment. It was obvious that the organisation was just trying to fill their schedule, not make my life easier.

I wished my provider's text message had included a link to a webpage where I could reschedule my own appointment. This functionality does exist, but most healthcare organisations are reluctant to offer patients the freedom of self-scheduling tools and similar abilities. Too many physicians are scared to lose control of their calendars. As long as provider organisations prioritise their own power over patient convenience, patient engagement tools will fail to please or progress.

My hope is that every vendor, payer and provider leader will begin to focus on the most important question: "How can we create a better experience for the patient?" If this happens quickly, I expect that patient-friendly patient engagement tools will be filling the market – and patient smartphones – by 2030.

Precision Medicine

Current Status: *Few provider players, clunky decision-support functionality.*

In 10 Years: *Higher adoption, more room for improvement.* Of all the buzzword technologies in healthcare today, the one with the most potential for improving and personalising patient care may be precision medicine. Providers with access to precision medicine tools could, for example, look at a cancer patient's genome and learn that certain medications would be ineffective for the patient. Imagine a world with no more unnecessary stints of chemotherapy!

Sadly, precision medicine is not currently benefitting most of the healthcare world. A few great health systems – mostly academic ones – are sprinting ahead, but precision medicine will be slow to reach everyone else. In fact, of the vendor and provider leaders who attended KLAS' 2019 Precision Medicine Summit, 80% said that it will take at least five years to achieve widespread adoption of precision medicine (Hansen and McIntosh 2019).

There are two main barriers to the adoption of precision medicine tools. One of these is a lack of reimbursement; the other is problems with the technology. There are some pretty sophisticated tools specifically for DNA testing, but oncologists and other physicians also need to know what to do with the genomic data. The decision-support tools designed for the precision medicine field are still extremely clunky. A user would almost need a PhD to read the tools and decide how to change a patient's care plan.

Will government leaders come to appreciate the value of precision medicine and set aside specific funding? Will vendors be able to simplify their decision-support tools enough for any physician to use them? I believe so. However, the industry still has incredibly far to go. I don't think 10 years will be long enough to make precision medicine a given for most hospitals.

Ambient Speech

Current Status: *Vendors in arms race to release first tools.*

In 10 Years: *Adopted by a few progressive health systems.*

The epidemic of physician burnout is often blamed on the EHR. But H.C. Eschenroeder Jr., CIO of OrthoVirginia, points out that it's not the EHR itself that's the main problem – it's the time that physicians spend using it. "To get paid, doctors are increasingly distracted and diverted from the thing that they love, which is taking care of their patients" (Eschenroeder 2019). How can providers keep the EHR but reduce their hours inside of it? Ambient speech tools have been hailed as the ultimate solution.

Stakeholders are absolutely craving this technology. Companies from MModal and Nuance to Apple and Amazon are eager to deliver, and several new niche players – including Suki and Notable – are also jumping into the space. Several tools are already on the market, and countless others are in development.

However, most of what's available now is focused on just capturing spoken data. Providers need more. Some providers are pushing to use tools like Google Glass or products that can project needed data on the wall; these tools often involve the work of on-site or remote scribes. Instead, some providers want an ambient speech tool to proactively suggest a course of action based on data from thousands of similar patients.

Those functionalities will become game-changers by giving physicians new ways to react to patients and data. My guess is that impressive ambient speech tools will be

A lot more is being said about AI than is being done

adopted by the most progressive health systems in 5 years and used by many organisations in 10 years.

Sending Healthcare Home

A wise attendee of a recent KLAS summit said, "Shifting from fee-for-service models to value-based care means shifting the centre of care out of the hospital and into the home." I think this shift will be the culmination of the technologies I've been discussing. As patients are offered easier tools, more attention from their doctors, and truly personalised care, patients will have less of a need to go to clinics and hospitals. Countless serious conditions will be prevented, leading to huge savings for health systems and payers.

Already, many provider organisations are conducting virtual visits with their patients. These virtual visits will quickly become commonplace. In addition, nurses will begin to deliver more and more care at patient homes, and not just through traditional hospice models. Health systems will start small; they'll begin offering more services at ambulatory locations instead of hospitals. Then it will be fairly simple to move from the clinic to a patient's home.

It isn't hard to imagine an Apple Health Kit with a tool to check for strep throat and a cheap ultrasound device that could be connected to an iPhone. I don't think it will be long before there are drones delivering prescriptions. However, a new perspective must precede any drastic changes.

We are so accustomed to thinking, "I sprained my wrist again – I should head to the urgent care clinic." But after some time and effort, it will be natural to say, "I sprained my wrist again – I should call my doctor on Facetime so that she can send me some pain medication and a splint."

Pitfalls and Progress

The trail to more advanced technology includes some potential pitfalls. What will privacy look like in healthcare apps? How will patients maintain control over their own data? Industry leaders can help by being proactive in these areas, but they will be most effective if they focus primarily on providing good tools and good care.

I hope it has been helpful for providers and payers to learn where the buzzword technologies currently stand and how soon they may yield significant results. There's no way to foresee everything about the future. But if vendors focus on creating patient-friendly tools and providers focus on offering the best possible tools and care, the enormous improvements to healthcare will be pleasantly predictable.

About KLAS

KLAS is a healthcare IT-focused market research firm. Our mission is to improve the world's healthcare by amplifying the voice of providers and payers through data. KLAS provides transparent insights on the software and services that healthcare leaders use every day. ■

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Key Points

- Amidst the AI hype, there are positive outcomes from robotic process automation.
- In 10 years, there will be increased automation and major progress in image reading.
- Patient adoption will only increase if R&D focuses on pleasing the patient and not just on provider needs.
- There are few provider players in precision medicine, and decision-support functionality is clunky, leaving much room for improvement.
- Vendors are in an arms race to release healthcare's first ambient speech tools with adoption likely over next five to ten years.
- The development of these and other technologies will enable patients to receive more of their care at home.

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Leveraging Artificial Intelligence to Elevate Narrative-Based Medicine

Which clinical specialty will be most disrupted by Artificial Intelligence? Will it be radiology or narrative-based medicine? Prof. Mathias Goyen explains.

The avalanche of healthcare data (clinical, imaging, genomic, lab etc) is mind-blowing and only likely to accelerate as precision health matures. Consequently, medicine will become even more data-dependent with the synergy between medicine and Artificial intelligence (AI) - technology getting more pronounced.

Whenever I participate in panel discussions regarding the use of AI in healthcare, we mainly discuss its impact on radiology, the usual suspect. But which clinical specialty will be disrupted most by AI? Is it really the field of high-tech medicine such as radiology? What about narrative-based ("speaking") medicine, where the patient visits the doctor and tells them about their ailments?

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The greatest benefit of AI is achieved where most mistakes happen

The reality is that the greatest benefit of AI is achieved where most mistakes happen. And, while we foresee major changes and tangible benefits as radiologists adopt AI, it is not the area of medicine where the most mistakes occur. The biggest source of error is in narrative-based medicine.

Take depression – which can result in pain such as back pain (mayoclinic.org/diseases-conditions/depression/expert-answers/pain-and-depression/faq-20057823) as an example: A patient consults an orthopaedic surgeon because of back pain. After surgery the back pain is still there. Then, on average, it takes more than two years for someone to diagnose depression - a lot of mistakes can be made along the way including unnecessary interventions.

By analysing Instagram profiles, machine learning can diagnose markers of depression as well or even better than a general practitioner (epjdatascience.springeropen.com/track/pdf/10.1140/epjds/s13688-017-0110-z). These results held even when the analysis was restricted to posts made before depressed individuals were first diagnosed.

When AI analyses Facebook posts to predict depression associated language markers, the quality of the diagnosis is comparable to that of a psychiatrist (pnas.org/content/pnas/115/44/11203.full.pdf).

The profile of depression associated language markers is nuanced, covering emotional, interpersonal, and cognitive processes. The growth of social media and continuous improvement of machine-learning algorithms suggest that social media-based screening methods for depression may become increasingly feasible and more accurate.

This is just one example how AI can support and augment physicians outside of radiology, by taking away the data-driven analytical portion of a physician's work hopefully enabling physicians to spend more time with their patients, thereby improving the human touch in medicine. ■

Key Points

- Medicine will beocme more data-dependent with the synergy between medicine and AI getting more pronounced.
- The greatest benefit of AI is achieved where mistakes happen and the biggest source of error is narrative-based medicine.
- Social media-based screening methods may become increasingly feasible and more accurate.
- AI can support and augment physicians outside of radiology.

Healthcare Design With a Long-Term View

In the process of 'reimagining a hospital,' one cannot overestimate the importance of architecture and design. HealthManagement.org asked a prominent figure in healthcare design, Christopher Shaw, Member of the Royal Institute of British Architects, Chair of Architects for Health and founder of healthcare planning and architects practice Medical Architecture, to share his vision of how hospitals will be changing in the future and what can be done to meet the challenges.

Our cover story's theme is 'Reimagined Hospitals.' What is a reimagined hospital for you?

It's a very wide-ranging question. The idea of the hospital can be traced back to the middle ages, but the modern hospital – not an institution for the military or indigent – is a comparatively recent innovation. Social reforms and comparative wealth in urban Europe of the 19th century led to the development of the public hospitals we recognise today. Most of these institutions are less than a couple of centuries old.

These hospitals were a product of their age and have established a deep cultural identity with astonishing rapidity. One can now navigate cities by landmark hospitals, just as you could by churches and market places for millennia.

Reimagining hospitals requires a reconsideration of the social place of the health systems as much as the knowledge, medical systems and economics that underpin contemporary hospital design.

The future hospital will need to be a citadel, a central part of our cities where we turn to for help and healing in an era, which, on the one hand, will see an increasing importance of self-care. On the other hand, healthcare will become less certain with the prospect of diminished performance of antibiotics and likelihood of rapid global pandemics.

The reimagined hospital will be placed at the centre of the city rather than on the periphery. It will serve a larger population of around one million people with the social heft of a cathedral and the engine of an airport.

What lies at the centre of a healthcare design project?

Healthcare design projects generally start with a capital business case for investment. This articulates the planned objectives for the project and should have a number of important elements including the planned clinical outcomes, workforce and revenue costs, and often some expression of the visions and values for the project. This should form the basis of a design brief.

The balance of emphasis between patient, staff and the logistical efficiency will vary from project to project. Pathology Labs or Emergency Care are very driven by process. In- and outpatient accommodation may be driven by the patient experience, and there has been a general shift towards improving the workplace experience for scarce healthcare staff.

One of the challenges of being a designer is we start with a blank piece of paper. All of these themes are important; none is exclusive. A design process takes the brief as far as it can be determined and formulates this into an organisational concept. In simple terms this often means overlaying diagrams that represent multiple drivers and looking for commonalities and unique requirements.

Healthcare systems have inertia of 20–30 years in how they operate. Architecture projects are also long-term. What helps you to envision the future in the design process?

Envisioning is a loaded word pointing towards a single objective whereas the future is often uncertain.

Nonetheless, this is a very pertinent question. Over years of design, I'm struck by how bad managers and clinicians are at expressing a long-term view. It's simply not part of the training. So an architect must adopt strategies to help organisations change and embrace new possibilities without undue risk. Today this means 'benchmarking' and asking what 'good looks like' and may mean producing images, which illustrate a shared vision of the future.

We are starting to see better digital tools emerging. They allow for 3D simulation of operational processes, staffing models, and patient satisfaction models, which can be applied where design becomes integral to scenario testing. For example, move to a seven-day operating model and a simulation model could describe the impact on staffing or logistical systems.

The environment today is rapidly changing. How is this potential change embedded in an approach to design?

Growth and change are fundamental to health systems. This has been recognised in design strategies since the 1950's. Strategies can be seen in Zeidler's McMaster University Medical Centre (Hamilton, U.S.) from the 1960's through to the recent White Arkitekter/Tengbom Karolinska University Hospital Solna (Sweden).

There is a tension between the cost overhead of long-term value and sustainability of a flexible and adaptable environment, and the pressure to cut short-term capital cost. Designers adopt a number of strategies to accommodate change:

- Allowing space for future capacity expansion or allowing for residual use for contraction.
- Catering now for change we know is coming, for example, robotics or climate change.
- Adopting planning systems and disposition strategies for 'hard' and 'soft' activities that maximise the scope for change.

There is good evidence that illustrates long-term benefits to health systems of adopting strategies to accommodate change. However, there has been limited appetite in the market to take a long-term view in a culture of short-term 'capital cost benchmarking.' This may be evolving with the climate change achieving widespread currency.

Sustainability/Net Zero is another hype tendency now, and its importance will, most probably, continue to grow. What are the challenges for design here?

Let's be clear. This is demonstrable science, not hype tendency. Carbon neutrality is an absolute requirement for the persistence of life on this planet. A response in the Paris accord timescale (2050) will be difficult and very costly. The challenges are:

- Logistics – reducing the carbon cost of goods, materials and food. It will mean entirely new forms of procurement, recycling and reuse of materials.
- Building infrastructure – will need to be heavily insulated and shaded with more complex hybrid ventilation systems. Some medical and diagnostic equipment will continue to need high energy input. This will have to be either self-generated or offset. For example, the very large Erasmus MC in Rotterdam has constructed a wind farm and is expanding this to meet its longer term targets.
- Transport – roughly 15% of a nation's transport carbon can be attributed to movement to and from health facilities by patients, staff and goods. Reducing the energy impact of transport will mean much more careful planning of care pathways and infrastructure to reduce patient and staff journeys. The recent Aarhus University Hospital generates around 35,000 daily transport movements from patient and staff alone. Planning includes the extension of the urban light railway system to the hospital.

Hospitals are getting larger, but care would be needed closer to home delivered in smaller facilities. What effect will this tendency have on design practices?

The effect of the 'missing middle' has been evident in system planning for the last 20 years. There is a swathe of smaller local hospitals becoming redundant as care is pushed either to larger tertiary and quaternary medical centres or to primary and homecare.

The problem is (as noted above) that the public are very attached to the 'idea' of the hospital. That is often the familiar secondary care institution that now has a diminished role.

Design practices must consider this paradox and create new clinics that capitalise on public sentiment but are able to cater for a range of transformative health systems that provide more for complex and integrated care closer to home.

Apps/telehealth is a major growing trend, which implies that the care is delivered outside of hospital facilities. What impact does it have on design?

The reimagined hospital will serve a larger population with the social heft of a cathedral and the engine of an airport

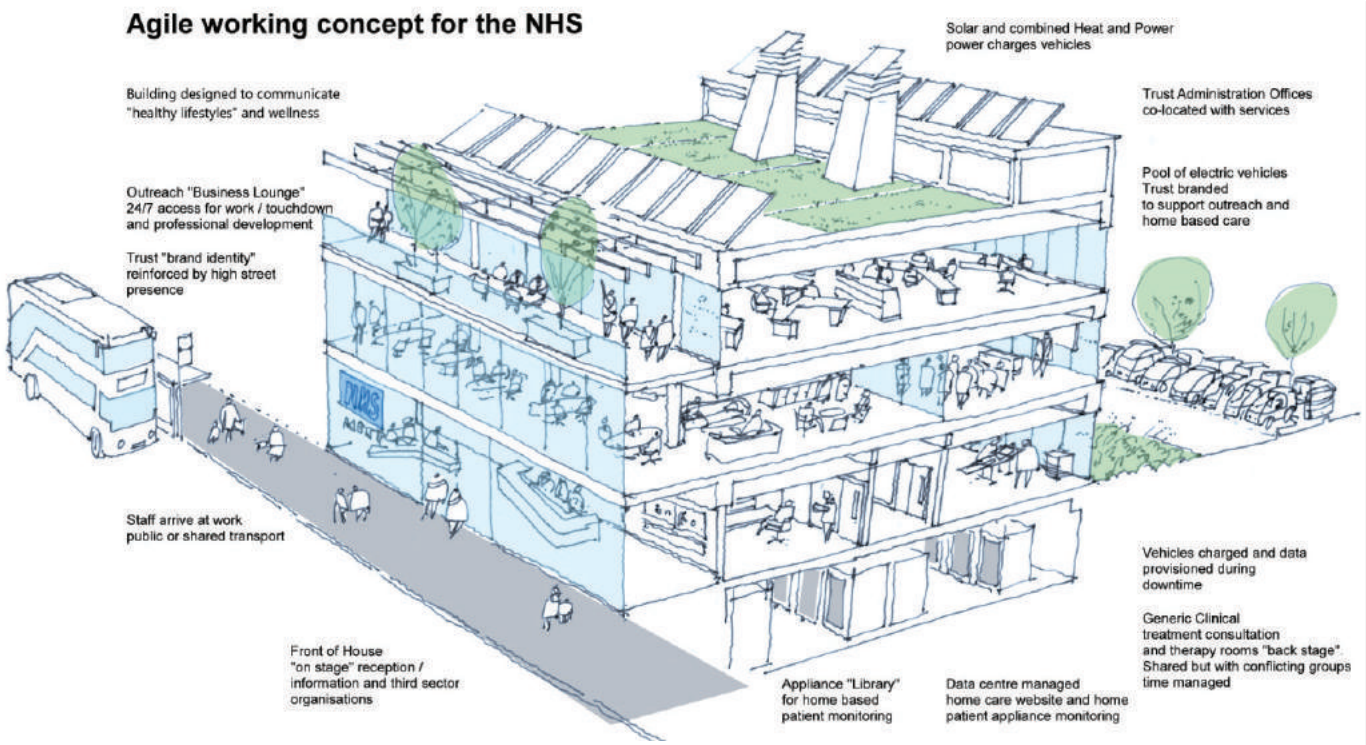

Figure 1. Concept Design for a Model Health 'Hub'

A few years ago I presented on this topic at the Kings Fund in London. The image which received the strongest reaction was one of a model health 'Hub' concept (Figure 1).

In many ways it represents a design response to what is happening in system design. There are some key issues that don't get well aired:

- The impact and control of mass health data. This means there will need to be a network of secure and managed data centres.
- Complex care and algorithmic diagnosis. This means integrated teams working in an air traffic control type environment with individuals or cohorts managed though complex health and social care.
- Transport planning. The relationship between the individual and the health system will change. There will need to be local two-way physical interaction. Public or assisted transport is significant as will be the ownership and role of the homecare team transport.

Silver Tsunami is an undeniable reality. Meanwhile, hospitals are getting more technologically advanced. How can design help older, non-tech-savvy patients to feel comfortable in such advanced environment?

An increasingly aged group of patients (and workforce) means physical frailty and reduced cognitive function. Design should cater for both with improved physical aids for moving and handling materials, and better accessibility for people with degenerative cognitive diseases. Design for dementia is simply part of universal design.

Older people are increasingly able to manage communications technologies. They were the generation that invented most of this stuff. However, technology can get better at dealing with older people. Modified intelligent speaker systems like Amazon's Alexa are already starting to appear in hospital environments providing self-diagnosis and health navigation support in multiple languages. This will be common in two to three years.

Use of chatbots in mental healthcare talking therapies is developing fast.

At the moment robotics has a minor role in hospitals, usually in distribution of pharmaceuticals and goods or materials. In the next 15 years this will expand significantly.

Domiciliary robots will take a more significant role in cleaning, making beds and providing meals.

Lean management is a popular concept, but some researches argue that traditional design of healthcare facilities is not aligned with its practices and principles. What is your take on this matter?

notes. These days some of that discipline is still there, but there are countervailing pressures.

Focus on lean process created a 'tight fit' of the building environment with the activities being mapped. Clinical pathways change on a 10–20-year cycle, medical equipment changes on a 7–10-year cycle. In the medium and longer term a tight fit will create an inflexible building.

Construction cost inflation is being driven by the fragility of the construction sector generally with low margins and a cyclical market driving out skills. Hospitals are particularly vulnerable to increases in the cost of services engineering, which in a specialist hospital can account for over 50% of the cost. Advances in regulatory standards, control systems

Over years of design, I'm struck by how bad managers and clinicians are at expressing a long-term view

Ten years ago architects were inundated with Virginia Mason and lean process mapping. It was an entertaining mode of engagement and created vast patterns of Post-it

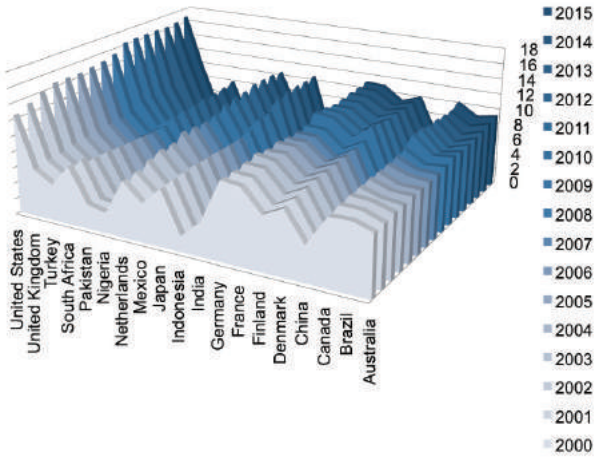

Figure 2. Health Expenditure (CHE) as Percentage of GDP (%). Data from World Bank, analysis by WHO.

The cultural barriers and desire for professional territory has not gone away. Hospital 'departments' have been viewed as obsolete since the 1960's, yet there is a

comes from socialisation and the structure of training in medical schools.

The workforce costs have increased significantly, so process needs to be considered alongside the quality of the workforce experience.

How are increasing design and building costs combined with the growing financial pressure in the healthcare sector?

This is quite a difficult question to untangle. Inflation in the health sector globally has been rising faster than the general economy (Figure 2). Demands on health systems has been increasing because of demographic pressures and changing consumer expectations. Since the banking crisis of 2008, governments have been able to throttle expenditure on health by limiting supply and in the UK by severely cutting capital expenditure. In market driven multi-buyer health systems the behaviour has been similar.

and consolidation in the supply chain have pushed the costs above general inflation.

In the UK there is particular nervousness over the collapse of two major public-private (PPP) constructors/developers over the last five years leaving major hospitals incomplete.

Because investment in health infrastructure tends to be cyclical in any region, design and planning skills need to adapt. Firms, which specialise in the sector, tend to work around the world as the demand changes. For example, Singapore became a magnet for design firms in the 2010's. Earlier there was a wave of investment in Scandinavia. Design skills tend to dissipate as key individuals follow the work.

There are a number of global standards for 'healthy' buildings (LEED, WELL, Fitwel, etc). Is there or should there be a global standard for healthcare facilities?

There has been enormous convergence in health building standards over the last 50 years. A comparison

Figure 3. Nyt Hospital Nordsjælland by VLA with Herzog & De Meuron Architects – Aerial.

Figure 4. Nyt Hospital Nordsjælland by VLA with Herzog & De Meuron Architects – Internal.

of American, European and Australian health building standards shows significant commonality. It's not surprising. Clinical measures of success are widely published in a few journals of record. Equipment suppliers are largely global and have common requirements.

There is virtue in LEED, BREEAM, WELL, etc. Each provides a benchmark for a building, most extend to operational matters. I don't see any particular reason why there should be global standards specific to health. We simply want the highest quality and most sustainable setting for medical treatment and care within the bounds of affordability.

Consider the functions of a healthcare facility. There will be clinics and operating theatres and a variety of bed types – but also offices, biomedical industrial zones, sterile supplies, goods and material handling, pharmacies, laboratories, mental healthcare settings, end-of-life care, kitchens, restaurants, lecture theatres, gardens, libraries, etc. Hospitals are like cities; they have a multiplicity of functions and it would be very difficult to construct and maintain a set of valid standards.

I'm not sure it's worth the effort.

The most important driver will be the organisation as a whole having a clear idea of itself as a place that communicates health and wellbeing to patient, staff and the community it serves. A setting that communicates a professional ethos and an environment that is sustainable and responsible. Get that working and forget about the plaques.

Architects for Health (AfH) has a global reach, and you yourself work globally. Today, where in the world is the most progressive environment in terms of healthcare design?

Architects for Health is a knowledge-sharing organisation. Its membership has grown to around 500 with individuals and companies predominantly from

Necessary Elements of Quality Design

Christopher Shaw's Shortlist

- A reasoned objective
- Location that is appropriate to the aims
- Integration and alignment with the wider physical and social fabric
- Shared appreciation of growth and change
- Resources and funds sufficient for long-term aims
- Appreciation of place and cultural value
- Respect for evidence and experience
- Enjoyment of natural light, the passing day and fresh air
- Access to gardens, nature and flowing water
- Aesthetic consistency and beauty
- Planning that accommodates hard and soft activities/equipment
- Spatial, lighting and acoustic variation
- Circulation that helps orientation and fosters social interaction
- Desire for order, pattern and economy
- Well-proportioned structure that articulates the form
- An integral logistical chassis
- Pleasure in a well-tempered environment that feels right and comfortable
- Delight in material that looks or feels attractive
- Responsibility for whole system lifecycle

the UK, but a significant number are from around the world.

There is really interesting work in Scandinavia, not only beautiful architecture, but very interesting planning. For example, in Denmark the new Hillerød hospital is part of a national strategy for developing regional super-hospitals (Figures 3, 4).

Remarkable work is being done in Africa at the moment – great NGO work by Partners in Health (pih.org) who use great architects, and an astonishingly beautiful children's hospital in Uganda by Renzo Piano.

Perhaps more interesting is the emergence of local micro-payment-based health systems in Ghana and Kenya, which provide health information, alerts advice and payment with tiny overheads. This offers a bottom-up development of a new kind of smart low-cost health system that is growing without the institutions (or infrastructure) of historic systems.

Cross-discipline collaboration seems to be high on AfH's agenda. When designing a healthcare project, who should give their input and why?

AfH are interested in topics that are interesting, and there is plenty going on in healthcare and in the development of towns and cities. We enjoy exploring and drawing out unexpected correlation across the art of architecture and the science of medicine (or vice versa). This is a reflection on the body of pooled knowledge and the international nature of the medical and architectural professions. There is a rich mix of knowledge and culture at the intersection of these two greatest professions.

Health and public architecture matters to all of us. We shouldn't be surprised that health infrastructure planning is the subject of political and judicial interest. We should consider a wide range of project stakeholders and expect energetic input. However, it's not an endlessly open forum; a project needs direction and momentum.

A successful project will map stakeholder engagement as part of the process of brief development. This will categorise those providing input by scope and importance. There will also be those who will need to be informed as agents to the wider constituency. The process must be planned and choreographed for the design to be as well-informed as possible.

A secondary role in stakeholder engagement is an important element of organisational change management. ■

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Is There an Alternative to Costly Tech For Future Healthcare?

Summary: An HIT expert gives his view on how healthcare can be revamped by harnessing technology for existing care modalities rather than overhauling the entire system.

I think the next few years will be characterised by a much better exploitation of systems that are used routinely in the care system. My impression is that we have a lot of new modalities entering the market like tele-monitoring, self-monitoring, wearables and insertables. However, from a hospital perspective, there is no clear evidence that these are changing how the system is working, even if they are well used. Impacting the care system requires much more than technology. It requires adoption. And adoption is hard to build. It is made of education, regulatory environment, societal characteristics, cost, added-value, and trust, to name a few.

The patient chart is a good example. Everybody in a hospital works with patient charts. Most of the time, they are used to record and interact with vital signs, treatments, events. These patient charts usually look like a horizontal temporal timeline with rows of information. We all have these images in mind: pulse, temperature, pressure, etc. A forerunner of the modern chart was developed in Paris and Berlin in the early 19th century for a few variables (Gillum 2013).

It is striking to see how little the concept has changed while the complexity and rate of data and information, and the analytical tools, have exploded. There are a lot of people today advocating that the patient chart and medical record should be completely redesigned and rethought for modern medicine, semantic centred, decision-support driven, interdisciplinary medicine. We are in the 21st century in the data science era, but we still interact with data in the patient records like in the early 19th century. Most of the system I see, they look modern because they are tactile, have nice charts and colours, but they reflect a paradigm from 200 years ago. It's palaeontology.

On the other hand, we have a lot of technologies that are already in place, and are used daily in medicine. Laboratory, imaging, ECGs, EEGs, etc. These technologies are constantly improved, becoming faster, and more accurate. But they also undergo a silent revolution in being "augmented" using artificial intelligence. So, in a sense, we are and will be experiencing a rebirth of existing technology. I really see advanced analytics being implemented into the existing tools we use daily

Where there is huge potential is data management. It will probably have a lot of impact on acute care and prediction and maybe a little bit less on chronic care. If we are able to exploit data scattered throughout a patient record over five or ten years and use it to predict what could happen in the next five years, we would take great steps without having to invest billions into new technology. ■

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Key Points

- Healthcare management should exploit advances in existing diagnostic and care modalities rather than overhauling system.
- Deep learning has huge potential, but is still in its infancy in the progression towards evidence-based science.
- There is much to be gained from good data use that could save billions of dollars.

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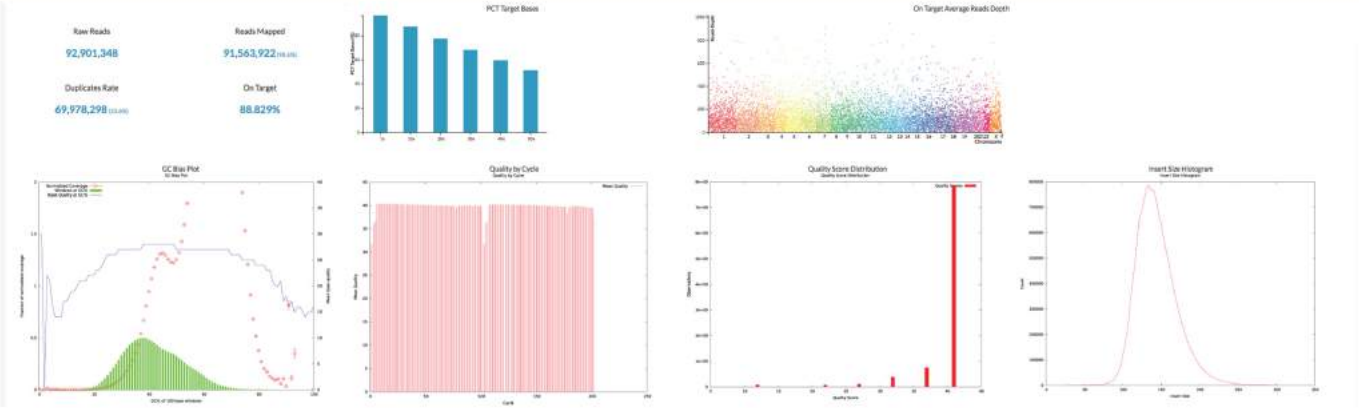

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A Gentle Warning

Professor Stephen Baker provides an overview on how artificial intelligence is challenging the role of a radiologist.

Over the past five years, I have been fascinated by the impress of artificial intelligence (AI) on the current practice of medicine and the exciting prospects it offers for the near future. The power of big data has shown itself clearly in investigations of diagnostic incisiveness. Conclusions previously drawn from relatively small samples have been challenged by the correctives gained from evaluation of much larger aggregations. And in no field of healthcare is this application more apparent, even at first glance, than in diagnostic imaging where detection and quantification of size, number, and configuration are the keystones for which determinations of disease existence, persistence, and resolution are made.

This linkage of our specialty to objective information primarily, if not exclusively, was not an inevitability but we decided years ago to define and largely confine our realm of inquiry to the pictorial manifestation of abnormality, relegating patient examination and interaction as being largely outside our immediate concern. Protestations to the contrary aside, except for interventional radiology and breast imaging, we usually don't talk to the patient whose images we diagnose. We generally don't see them and most often we know very little about their history, their attitudes towards their illness, or their appreciation of their condition. All these are essential features of the diagnostic considerations that informs the daily concerns of our referring physicians.

About fifty years ago, we hitched our wagon to exciting newly invented technologies that came our way and we largely steered those wagons to our role as the physicians' expert consultant. We serve that function largely away from caregiver-patient exchanges as we situated ourselves in distant parts of the hospital or separate wings of the clinic, or in stand-alone offices nearby, or even at remote sites.

Yet this disjunction, despite some plaintive cries for closer consultation, was amenable for the way we decided to work with the array of imaging tools at our

disposal and under our proprietorship. Moreover, by and large by dint of their cost and spatial demands, we "own" them in a functional sense if not just in a commercial sense, allowing us to enjoy the benefits accorded to the possessor of a monopoly, at least by the way American medicine allotted responsibility.

The result of this self-reinforcing notion is that imaging is ours and that every innovation related to it is perforce within our purview. There are the occasional turf wars to be sure but overall they have been relatively minor matters. We have lost some but won most.

But now AI has come along and is not just going to be another advance. It strikes at the heart of what we do. And what we do is spatial recognition. In the brain with both CT and MR, we examine the pattern of densities and their distribution. For the most part our initial evaluation is not to render a specific diagnosis but to state if an abnormal pattern is present. AI determination can be rendered after incorporating normal and abnormal images in much greater number than an individual radiologist could look at during training and beyond. In this sense, he or she is less experienced than the realisable capabilities of an AI dataset.

With chest images, we look at the presence, configuration, and number of findings that are delimited by their distinction from normal cardiopulmonary contours, vessel distribution, and extent of variation. There is

The future lies with integrating ourselves in the clinical process personally and dependably

nothing the radiologist as a pattern describer brings to the process that AI is theoretically less capable of determining. So initial recognition is surely a radiologist's function but so too will it be an AI function.

What about charting the growth, or shrinkage of masses or their number over time? Surely this is a major task of radiologists in service to oncological diagnosis and treatment but sequential imaging to chart, for example responses to therapy with AI is a simple recognition issue, one that artificial intelligence can match or exceed that of a well-trained human eye.

It is not just the chest or the brain that the competition with AI will be profound. Any area of the body where the presence and configuration of an abnormality can be observed will be within the capability of AI recognition.

Then where will that leave the radiologist? Technology

seers and other futurists, even those whose gaze is not far ahead, regard radiology as a discipline that will be severely challenged and likely to contract in the face of this new disruptive technology. Hence our old model of business as usual may be obsolete. We must change or fear becoming extinct. What to do? First off, if we remain physically remote from our colleagues we don't stand a chance. It's likely that oncologists as a group will buy or control their own CT. They will think not to need us if they sense that we provide no added value if AI is available and if we remain aloof from direct interaction from patient care.

In my view, our one hope is to become active, onsite, hospital based, or group clinic based actors, participating in the choice of tests that further diagnose and enhance treatment. This is a role that may not be congenial for established radiologists. Once chosen for the job by temperament and accustomed to be an image reader predominantly. The future lies with integrating ourselves in the clinical process personally and dependably. And not, by default, we may follow the quaint example of town criers who in the 18th century were expert communicators in urban settings but lost their value when that new technology, the telegraph, came online. ■

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Key Points

- In no other field of healthcare is the application of big data more evident than in diagnostic radiology.
- In the past, there were turf wars, but AI strikes at the heart of radiology practice.
- What radiologists do is spatial recognition - and AI does it just as well.
- To keep with the times, radiologists need to become active, onsite actors participating in diagnostics and treatment tests.

Generalism as a Sustainable Model in New Healthcare Paradigm

Summary: As healthcare enters a new decade, will it need 'superspecialists' or 'deep generalists' – clinicians with the deep knowledge of one area of medicine, but also of a range of other areas. Prof. Levi spoke to HealthManagement.org about why the current subspecialisation-oriented model is unsustainable and how it can be changed through education.

The consensus is that demand for certain specialists will change and/or decrease. What are the most 'vulnerable' areas in this regard?

It has already been clear in the past few decades that more general specialisms, such as geriatrics or acute medicine are less popular than highly specialised disciplines. This is partly due to the way we train medical students and postgraduate trainees, focusing mostly on superspecialised medicine and giving much less attention to the more general specialisms.

My view is that there is basically nothing wrong with specialisation or superspecialisation: in this age of rapidly developing medicine it is really good we have people that know a lot of a specific area of medicine and can drive innovation and research. The issue is, however, that superspecialism not only means that you know a lot of a small, very specific area, but also that you are not interested anymore in the rest. I feel that this is not beneficial to patients and leads to a massive fragmentation of medical care.

Specialisation is commonly perceived as allowing for more professional autonomy, better financial reward, social prestige, etc. In turn, generalism implies less prestige and autonomy. Is this perception a challenge?

It is how 'sexy' these jobs appear to trainees and which examples they see in practice. With strong role models in universities and teaching hospitals advocating a more holistic approach and discouraging the idea that every organ or cell needs another doctor, junior colleagues would get a better view of a general approach. And I feel indeed that we should turn remuneration upside down, so the broader you are and the larger the responsibility you take for the patient as a whole, the better your salary.

Besides the financial issues, do you agree that a systemic shift towards deep generalism would also require a major cultural shift in terms of what physicians understand to be their primary obligations?

Our focus was and is and should be to help people who are ill – not only help your favourite organ or favourite set of cells but the patient as a complete human being and not as a collection of tissues and organs. That means that if you treat a patient with heart disease, there is no reason whatsoever to not also treat a concomitant urinary tract infection instead of referring that patient to an infectious disease specialist for that problem.

Again, I feel that it is not so much about sub- or superspecialisation but much more about an attitude towards your job. It is perfectly fine to be an expert in leukaemia or interstitial lung disease, as long as you are prepared to treat co-morbidities such as diabetes, heart failure, arthritis and simple infections as well. Every doctor, however specialised, has been trained to do that. It is just a matter of willingness.

With the focus shifting to disease prevention and sustaining wellbeing, health will be defined holistically encompassing mental, social, emotional, physical, and

Superspecialism is not beneficial to patients and leads to a massive fragmentation of medical care

spiritual health. What skills other than medical, will be necessary for healthcare professionals?

I think that holistic thinking also means understanding a patient's mental situation and social issues. It actually makes your work nicer and more satisfying as well.

Due to overspecialisation within the medical professional field, regulation has become very fragmented. Have any steps towards unification of regulatory frameworks been taken yet?

In my opinion, regulation is miles behind. In fact, what you now see is all kind of restrictions that stimulate fragmentation rather than a more general approach. Why should growth hormones only be prescribed by endocrinologists or why should some (very simple) anti-cancer agents be reserved for oncologists only?

What measures can various stakeholders – hospitals, governments, education, professionals – start implementing today to achieve the needed level of superspecialism in the future?

The best way to change this is through education. If students or trainees see that their supervisors value being a highly specialised doctor with a more generalist approach, they will immediately copy that behaviour. Lack of education to keep a generalist approach is really a very poor excuse nowadays with very handy electronic support systems, such as up-to-date or similar systems, readily available.

How will 'generalism,' etc ultimately reduce healthcare costs?

Superspecialism is a form of reductionism that will lead to over-treatment because physicians will focus too much on the cure of their favourite organ or disease while losing sight of the big picture. A more general approach would actually more often lead to the recommendation to refrain from very intensive treatment in many patients. ■

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Finland's Digital Care Network: Why is it Working So Well?

Summary: Finland is leading the way in leveraging digitalisation in healthcare for a new model of care interaction and delivery. In the making for five years, the Health Village is a scalable, comprehensive digital service that brings significant cost savings and production efficiency to healthcare providers. The objective is to offer a global digital, tailored service platform that gathers the best professionals, the latest information and better digital and local care for patients, optimising impact and cost of the services. HealthManagement.org spoke with project director, Sirpa Arvonen, about why The Health Village is such a success and what the key take-aways are for providers looking to deploy digital resources effectively.

What exactly is the Health Village network?

The project was a joint project between the university hospitals in Finland. Their population responsibility and catchment area covers all Finns.

The participants in the project include Helsinki University Hospital (HUS), which coordinated the project, Tampere University Hospital, Oulu University Hospital, Kuopio University Hospital and Turku University Hospital.

Developed by the Virtuaalisairaala (the Virtual Hospital) 2.0 project, primary healthcare in the regions, the hospital districts, the catchment areas for highly specialised medical care and the hospital areas, research institutes, the private sector, and patients and patient organisations work in cooperation.

The "Health Village" project is a national project but is based in Helsinki at HUS (Helsinki University Hospital) which is the second largest employer in Finland with almost 25,000 staff. The national healthcare database provides a huge "data lake" which feeds the various developments offered by the eHealth development programme. The system is accessible to all Finns, regardless of their place of residence or income, and is a practical tool to guide them in both everyday life and self-care, and also when they are in contact with professional health services. The digital platform is supported by almost 2000 healthcare professionals who lead the development of disease pathway management, evidence-based cost control, patient and health professional education and predictive medicine.

What foundations needed to be in place to make the network a success in terms of patient trust in data use, interoperability and staff training?

It was important to include in the reform and renewal of the services all the different professional groups working in specialised medical care. The project helped produce an enthusiastic and motivated eHealth Services network of development expertise, in which customers, professionals, patient associations and primary healthcare partners were invited to assist in the planning of services and a continuous programme of monitoring.

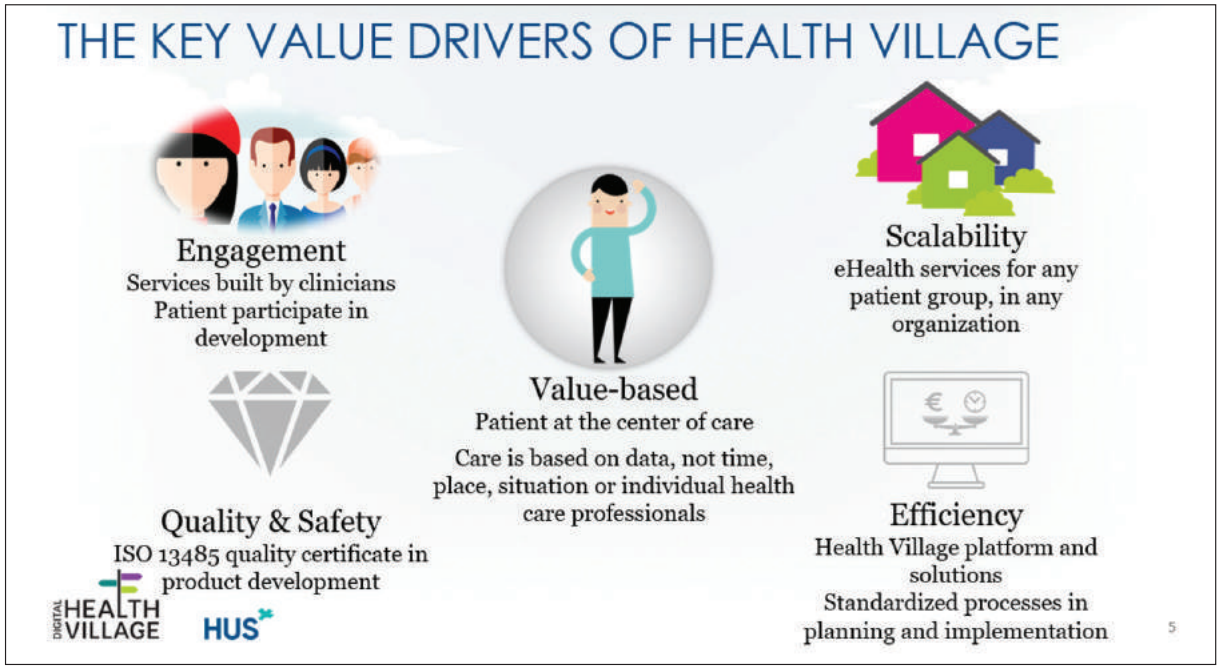
The ideas that emerged from working with patients and customer panels were central to development work. The cooperation and service network of experts from different fields exploited specialist skills and knowledge in the combined production of services and delivered safe, secure and reliable tools and related working methods. These teams should consist, for example, of doctors, nurses, therapists, social workers, behavioural specialists, researchers and scientists, information analysts, ICT experts and service design professionals.

What were the main challenges in setting up the virtual hospital network and how did your team overcome them?

The first step was to design the service architecture and service map. We organised workshops with the leaders and management of our different clinics. We asked them how they are delivering their services right now and what visions they share for the future.

We gathered the results of the workshops together and were able to outline processes common to all and a generic service map. Based on this map, we started to design a generic digital services platform.

The second step was to share the vision for the project. Our leaders in organisational and IT development shared a strong vision of the benefits of digitalisation. This created a way to work in multi-professional teams among clinicians,



Key Health Village Value Drivers

IT professionals, data analysts and communications professionals.

The third step was to establish a co-creation network. We invited representatives from different hospitals, clinics and patient associations to network where we planned together the change brought by digitalisation and what kind of issues it would be important to take care of for the change to succeed. This created an extensive network of digital agents that continues to function. At the network, we have facilitated learning together and shared stories about successes and challenges.

What challenges do you continue to face and how are you addressing them?

The most important method of development of the Health Village concept has been the idea about supporting an operational change in the health sector - instead of just digitalising old services or providing new services within the old service framework. Culture change takes time; its not easy and there is also some fear and resistance.

The planned development programme combined network and change management methods, lean methodology, service design and flexible development working methods, and inclusive work development methods that rely on facilitation. The project helped establish informal development forums, multi-professional teams, processes of innovation and experimentation, and realistic and practical training.

The eHealth Development Programme ensures that the development work and service design methods are standardised from the point of view of quality, risk management, engagement, customer focus, customer panels, communications and eExpertise development. The service development model also contains review points and criteria for putting the services into production.

The Health Village development network:

- Encouraged professionals to adopt a customer-oriented approach to development that relied on an appreciation of the customer experience.
- Promoted service innovation, introduced digital working methods and exploited new technology.
- Initiated cooperation at a national level on the innovation farm facility and to exploit jointly new approaches, new technology and data analytics.
- Provided companies, research partners and third sector partners with the Virtual Hospital network as a development environment for digital health solutions.
- Increased expertise among staff.
- Formed teams of experts in healthcare, health social work, research, data analytics, ICT and service management to create forums for multidisciplinary and cross-disciplinary research.

What management advice would you give to members of the wider hospital C-suite who are considering putting an aspect of a virtual hospital into practice?

The main principles underlying the methods and approaches employed in the development of the eHealth services were:

- The involvement of the public, patients and professionals in the social welfare and healthcare sectors in the service development process.
- The use of co-creation working methods in the formulation of ideas.
- Support for innovation processes.

It was important to include in the reform and renewal of the services all the different professional groups working in specialised medical care. The project helped produce an enthusiastic and motivated eHealth Services network of development expertise, in which customers, professionals, patient organisations and primary healthcare partners were invited to assist in the planning of services and a continuous programme of monitoring.

How have you addressed the challenge of the shortage of professionals with the digital skills needed for set up and operation of a virtual hospital network?

We planned the eHealth Development Programme and worked out web-based eHealth courses for professionals in our HealthVillagePRO platform.

Why do you think countries like Finland are making a success of healthcare digitalisation while other countries are struggling?

First of all, we have an electronic patient information system throughout the country. The electronic patient information system has been in use at Helsinki University Hospital for over 25 years, so data in a structured form is already available. The National Institute for Health and Welfare has been monitoring and evaluating population-level health data for over 20 years.

Secondly, there is the national social and healthcare repository. Finland has a national data repository, the Kanta, which collects data from different patient information systems. The stock is for professionals.

Thirdly, we have a national solution for electronic medicines and research. An electronic prescription has been in use in Finland for years. Citizens will see their own prescriptions, laboratory and imaging research results, and a record written by a healthcare professional about their visits to their personal database, called My Own Database.

Additionally, there is the national authentication solution, Suomi.fi, as well as a national email account, which is shared by public service providers, for use by every citizen.

Finally, Finnish people are used to using digital apps. Perhaps Nokia taught us to use mobile services.

Is the virtual hospital network reducing healthcare costs? If so, where have you identified savings or better use of resources?

Cost-benefit analyses for each separate unit were an integral part of the development model used in the project. The digital services produced for patients are either care packages consisting of digital components or care programmes that are delivered entirely digitally. A requirement for establishing the financial impact is how successful the reform and operational changes associated with health services are, and, for example, the step-by-step accomplishment of working methods and changes in work.

At Helsinki University level, the average predicted annual potential healthcare capacity freed with the HealthVillage, is around €208 million in the first five years. The idea is that we need to take care of more patients with the same resources.

The idea is we need to take care of more patients with the same resources

Most importantly, key value drivers for the healthcare producer's level were treatment calls, revisits, and treatment visits. The average predicted annual potential healthcare capacity freed with the Health Village is around €261 million at the Finnish level which amounts to around €1.3 billion during the first five years.

The Health Village aims to improve the equality of the citizens by increasing the availability and quality of healthcare services for all Finns with novel digital care and eHealth service practice.

From the perspective of opportunity costs, such technological revolution can produce significant effectiveness elsewhere. ■

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Reimagined Hospitals

Source: https://iii.hm/110j

WHAT WILL THE REIMAGINED HOSPITAL LOOK LIKE?

-Hospitals will no longer be set apart from surrounding neighbourhoods.
-A 21st century healthcare facility will be part of the community.
-Future hospitals will promote learning, discovery, health and wellness.
-Buildings and departments will be digitally connected.
-Hospitals will be designed based on scientific evidence.
-There will be a move from general community hospitals to specialised hospitals or nonhospital.

Source: https://iii.hm/110k

WHY WE NEED TO REIMAGINE HOSPITALS

- **Changing demand for healthcare services**
- **Ageing population**
- **Personalised care**
- **Declining financial resources**
- **Information overflow**
- **Ineffective utilisation of healthcare data**

Source: https://iii.hm/110j

GOALS OF THE REIMAGINED HOSPITAL

N Improve patient flow
O Improve access to treatments
P Reduce hospital stays
Q Curtail spread of infection
R Reduce patient and staff stress
S Improve safety, privacy, convenience and comfort

THE HOSPITAL SYSTEM

TODAY
- Physician-centred system
- Increasing units of activity
- Static, self-contained narratives and patient charts

TOMORROW
- Patient-centred system
- Increasing focus on actual job
- Smart computer software that pulls information and provides a dynamic view of patient condition.

Source: https://iii.hm/110l

BENEFITS OF REIMAGINED HOSPITALS

- **Improved patient care**
- **Increased efficiency**
- **Improved costs**
- **Fewer medication errors**
- **Better patient flow**
- **Data-driven decision-making process**
- **Better transition from hospital care to long-term care**

Source: https://iii.hm/110l

The Empowered Patient: Capitalising on Information and Technology

Summary: We might be ready for the new hospital and the new healthcare system, but are we ready for the empowered patient?

When we talk about the future of healthcare or the future of healthcare systems and hospitals, we tend to overlook one very important aspect: the patient. Yes, advanced technology, artificial intelligence, big data, machine learning, deep learning, etc are expected to change the way we practice healthcare, but at the same time, we also need to consider the fact that in this day and age of advanced technology and information access, our patient has also become empowered.

Today, patients know that they are responsible for their health. They understand that they have the right to make their own health decisions. And that is why, we see that today, more and more patients have become assertive in their demand for quality care. As we move into a new business model for healthcare, and as we reimagine new hospitals and new tools for diagnosis and treatment, we must also understand that the empowered patient has to be a partner in this transition. Empowered patients know the role they can play in the modern age of healthcare. They know that by using preventive measures, they can prevent many diseases. They also know they need to adhere to prescriptions, that they need to get the required tests done, that they need to follow-up after these tests, and that they need to follow what healthcare providers advise.

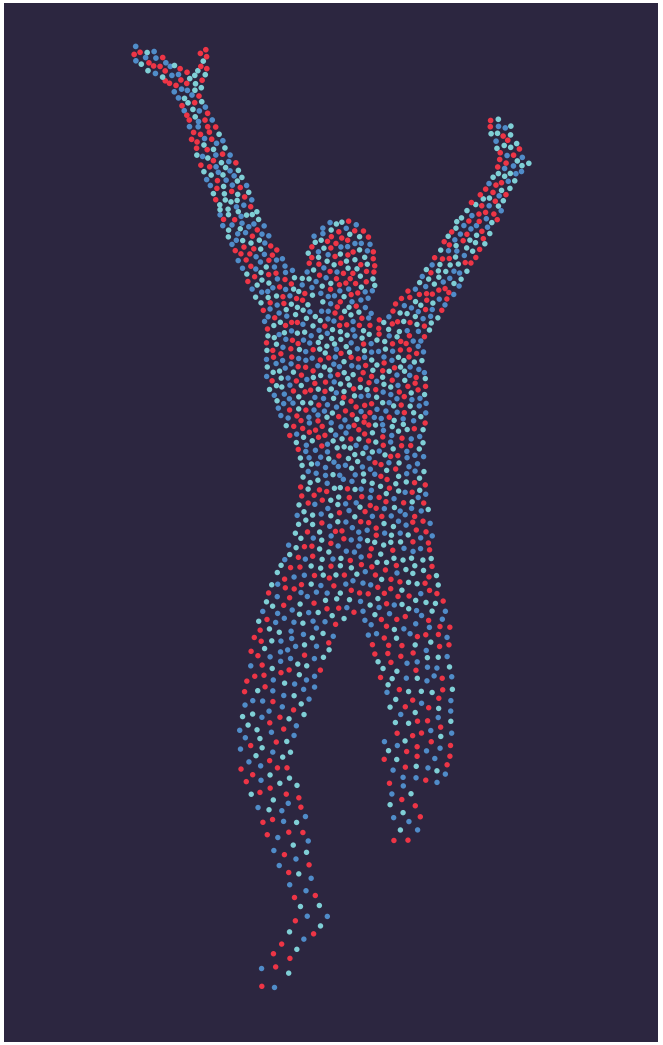
Nobody is saying that the empowered patient should replace the clinician. No. Everybody has their role in this healthcare system, and on the patient's part, they need to take an active role in their health. If they feel that their cholesterol may have gone up, but their family physician has not advised any tests, they can speak up and ask for it. Many times, it is only the patient who can understand what's happening inside their body. Many times, test results don't reveal what may actually be going on. The patient perspective is important. The patient perspective must not be ignored.

It is time to accept that patients have the power to change how we deliver care. The healthcare system, as it stands today, is suffering from a disconnect between patients and healthcare delivery. We tend to forget that all this technological advancement and all this innovation that we see today is primarily driven by patients. Healthcare systems have to adopt these advancements in order to provide the best possible treatment for patients. Why? Because that is what patients demand. Because that is what patients want. Because that is what patients deserve. After all, our job is to provide care to these patients, isn't it?

Gone are the days when the doctor-patient interaction was a one-way street. There are two major contributors to this reality. First, patients have access to a tremendous amount of health information from the internet. All of it may not be accurate, but they have access to both the good and the bad. Second, clinicians have access to advanced science and new ways to treat diseases, manage illness, and improve patient outcomes. What is the result of all this? More informed and more assertive patients, who have something to bring to the table, and who want to have a two-way conversation with their healthcare provider. We all talk about personalised medicine, but this is really what we mean by this term. Customising healthcare care decisions and practices and tailoring them for each individual patient's needs (Williams 2014).

The empowered patient has the power to generate an "e-volution" where traditional methods of communication will no longer apply

We must also address the important role information and communication technology (ICT) has played in creating the empowered patient. ICT has now inserted itself into the patient-doctor relationship, and it has resulted in a significant change in healthcare. Patients and doctors



can now communicate via computers. This e-mediated communication has changed the way doctors and patients interact. (Andreassen et al. 2006). Face-to-face patient/doctor interaction is now becoming less and exchanges through electronic devices are becoming more common. We have already seen that many aspects of the healthcare system have changed with technology such as electronic health records (EHR), biometric and telemedicine devices, smartphone applications and the Internet (Weiner 2012).

When we talk about patient-doctor communication in the context of e-health, and in the presence of health information technology (HIT) tools, we need to keep one thing in mind. Modern healthcare systems have now transitioned from a single-physician model to a multidisciplinary team of doctors, who interact either physically or virtually. Similarly, a patient is no longer just a patient. A patient is now part of a family or a social network (Weiner 2012). That is another aspect of the empowered patient that we must consider - the presence of their families and the need to improve healthcare's response to this fact and the need to improve how we, as clinicians, engage with patient families.

The empowered patient has the power to capitalise on information and technology. The empowered patient, thus, has the power to generate an "e-volution" where traditional methods of communication will no longer apply and where interactions between clinicians, healthcare systems, patients, caregivers, and the overall community will change significantly. The components of this e-volution, be it EHRs, ICT, HIT, mHealth, or eHealth, will change healthcare as we know it. As hospitals adopt technology and implement new systems to improve their operations and their efficiency, patients, with the power of information and technology, will also play their part in changing the dynamics of the patient-doctor relationship and forcing healthcare providers to take them seriously and to understand that they don't intend to remain silent partners anymore. ■

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Key Points

- Patients have the power to change how we deliver care.
- Information and communication technology (ICT) has now inserted itself into the patient-doctor relationship.
- Modern healthcare systems have now transitioned from a single-physician model to a multidisciplinary team of doctors.
- A patient is no longer just a patient, but a part of a family or a social network.

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How Will FAMGA Shakeup Healthcare?

Summary: The big tech players are all making inroads into healthcare, bringing their industry know-how into a sector that is traditionally slow to adapt to change. Whether their impact will ultimately result in better resource management and cost savings remains to be seen, but they are definitely a force to be reckoned with.

There is no doubt that technology has and will continue to disrupt healthcare. In the midst of this disruption lie five big players - Facebook, Apple, Microsoft, Google, and Amazon. Referred to as FAMGA, these five companies are implementing new technologies and introducing new products/services that are designed to shake up the traditional model of healthcare.

Combined together, FAMGA has a market cap of $2.7 trillion (Investopedia). The key point of entry in healthcare for FAMGA is through the route of Artificial Intelligence.

Five big players - Facebook, Apple, Microsoft, Google, and Amazon are together referred to as FAMGA

All five are leading acquirers of AI start-ups (CB Insights Report). Combined together, FAMGA has contributed to 124 AI start-ups, with Google being the top equity investor so far. The end goal for FAMGA appears to be health data, as they aim to fix the lack of open standards around it.

Facebook, Apple, Microsoft, Google, and Amazon want to build healthcare tools that will allow easy access and exchange of healthcare information electronically. Patient data has been a challenge for the healthcare industry. Significant investment has already been made into this but without much progress. However, with these big players jumping into the mix, it will be interesting to see how things change.

One of the key breakthrough areas that could potentially help healthcare is voice technology. Voice assistant devices could be an important tool for patients to manage their medications, communicate with family, and alert for help in case of an emergency situation. Amazon's Alexa is HIPAA (Health Insurance Portability and Accountability Act) compliant, which means it can work with health developers that manage patient health information. Already, Amazon has been working on improving Alexa's health skills in terms of helping patients make appointments and check their health status (HIPAA Journal 2019).

Apple Watch is another example of a breakthrough waiting to happen in healthcare. While the latest version of the Apple Watch has all the usual "flavours" for Apple lovers, this version also has several advanced healthcare options, including medical diagnostics and screening. With three new healthcare diagnostics and screening apps in the Apple Watch, Apple is moving forward with its goal to change the future of health screening and diagnostics. These three apps include:

1. Fall Detection through a built-in accelerometre and gyroscope that analyses a person's wrist trajectory to determine if they've taken a fall based on impact acceleration. If the person is unable to move for a minute, the watch can call emergency services and even send a text message with the location. This could be an excellent tool for elderly patients.
2. Heart Data which detects irregular heart rhythms and sends an alert if any disruption is detected. A normal person's heart beats at 60 beats/minute, but in case of atrial fibrillation, it can go up to 300 beats/minute. Apple Watch can detect that.
3. The Electrocardiogram App takes an ECG if you put your finger on the crown for 30 seconds. There are two electrodes in Apple Watch, one on the back and one on the crown. Your ECG is recorded and saved on your profile. You can send this information to a doctor, and they proceed to take action if required.

These may seem like just some new apps, but offer serious benefits for patients. However, some experts feel that these screening tools may result in unnecessary doctor visits as results/alerts from Apple Watch could concern users without any basis. Only time will tell if this turns out to be the case, but for now, all three Apple Watch healthcare apps seem to be beneficial for patients. It is important to remember that Apple got clearance from the FDA for both its electrocardiogram app and the heart rhythms app. There is also a clinical trial already underway. The Apple Heart Study

is designed to evaluate how well the Apple Watch could pick up an event that looked like atrial fibrillation when compared to a wearable heart monitor. Preliminary results with over 40,000 participants show that wearable technology can identify heart rate irregularities that were later confirmed to be atrial fibrillation (Stanford Medicine News Center). Apple is also working on new healthcare apps for glucose monitoring, blood pressure, respiration, and UV detection.

Google is also making big changes in the healthcare industry. There are several Google initiatives that are designed to shake up healthcare, including Google Brain that focuses on deep learning, Google Fit in the wearables sector, Calico the anti-ageing company, Verily involved in life-sciences research, and Google Cloud aiming to disrupt the way patient data is managed. Google Cloud has recently partnered with NIH on the STRIDES initiative that is designed to help improve data storage, data interoperability, and data accessibility (datascience.nih.gov/strides). Google acquired Apigee in 2016 that helped companies design application interfaces to manage data. Major companies already use Apigee, including Cleveland Clinic, Kaiser Permanente, Rush University Medical Center, McKesson, and Walgreens. But Google is not just interested in storing data. It wants to use machine learning to analyse this data and gain insight from it. The Apigee Health APIx solution enables organisations to securely handle personal health information(apigee.com/about/cp/fhir-api). While healthcare has been slow to adopt API stnadards, the Fast Healthcare Interoperability Resources (FHIR) standards for data exchange are expected to facilitate adoption. Google's Apigee is an early mover in adopting and building FHIR-based APIs, putting another feather in Google's cap when it comes to innovation in healthcare (Padmanabhan 2016).

Microsoft's Healthcare NExT initiative is designed to accelerate healthcare innovation through AI and cloud computing. Microsoft is working on several interesting healthcare solutions including Microsoft Genomics providing cloud-powered genomic processing services, Microsoft Azure Security and Compliance Blueprint providing end-to-end application development to healthcare organisations; AI Network for Healthcare for creating an AI-focused network in cardiology; Microsoft 365 Huddle Solution Templates designing tools to drive quality and care outcomes; Project Empower MD creating a system that listens and learns from what doctors say and do, and Project InnerEye focused on medical imaging (Lee 2018).

Facebook is not staying behind either. The company has been working with the American Cancer Society, the American College of Cardiology, the American Heart Association, and the Centers for Disease Control and Prevention to develop digital prompts that would encourage Facebook users to get tests that might help detect medical conditions at an early stage. These efforts are primarily designed for heart disease. The goal is to incorporate prevention reminders into commonly accessed social media platforms so that people can find check-ups that might be recommended for them based on their age and gender.

All these five players are big and successful. Over the years, we've seen them achieve major things, and there is no doubt that with the right approach, these companies can make a difference in healthcare. ■

Key Points

- Combined together, FAMGA has contributed to 124 AI start-ups, with Google being the top equity investor so far.
- Amazon's Alexa is HIPAA compliant, which means it can work with health developers that manage patient health information.
- Apple is working toward a goal to change the future of health screening and diagnostics.
- Google Cloud has partnered with NIH on the STRIDES initiative designed to help improve data storage, data interoperability, and data accessibility.
- Microsoft's Healthcare NExT initiative is designed to accelerate healthcare innovation through AI and cloud computing.
- Facebook is incorporating prevention reminders into commonly accessed social media platforms so that people can find check-ups that might be recommended for them.

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Building a Better Hospital

Summary: Unsustainable increases in healthcare costs make it imperative that we rethink how the entire healthcare value chain is organised. This rethink includes the role of the hospital, which lies at the centre of the value chain.

Big changes in mindset are essential to harness technology to lower costs

Costs have been soaring, with people living longer and their care needs increasing as they turn to the healthcare system more to manage chronic conditions like diabetes and heart disease. Costs are increasing also because more countries are embracing universal health coverage as a national goal and are expanding available health resources to meet the growing demand. This poses a particular challenge for developing countries, whose health budgets are far smaller than those of developed nations.

With the rise of artificial intelligence and digital health, which is reshaping how healthcare is delivered, technological innovation is frequently touted as an antidote to increases in healthcare costs. Technology does offer enormous potential to drive down costs while also improving the quality of care. Many functions of the traditional hospital can be unbundled and done more efficiently or moved entirely out of the hospital to lower-cost settings. While a rethink of the hospital's core functions is needed across markets and regions, it is most critical in the emerging market countries where the International Finance Corporation, the World Bank Group's private sector-focused arm, invests and advises.

A couple of big changes in mindset are essential to harness technology to lower costs. First, payment mechanisms must be reformed to get incentives right. Hospitals need to be at the frontline of these reform efforts. Instead of charging patients for every procedure they undergo or product they receive, which tends to be quite costly and leads to over-servicing, bundled payment models or, better yet, capitation models should be advanced. Costs can be best controlled when lump sum payments are allocated to a provider for tending to all the care needs of a particular patient population. Capitation models incentivise providers to deliver the care that the patient actually needs.

A second critically important area for action here is process improvement. Technological advances create efficiency gains in a wide range of healthcare functions – including patient and workflow administration, diagnosis and delivery of care – but only if the technology is appropriately integrated into well-designed processes and workflows. Technology dropped into traditional hospital settings, without rethinking who does what and how, will not drive down costs. Furthermore, medical equipment must be made interoperable, working in unison like – an analogy often used – the controls of an airplane cockpit.

As processes are re-engineered, many functions can be moved to external settings to save costs and increase patient safety. Picking up infections in the hospital environment is all too common and can have serious, even fatal, consequences for patients who are already in a weakened condition. Certain functions can be done in safer places as we have seen, for example, with the rise of urgent care facilities, same-day surgery centres, specialty care chains, or – as we are seeing more and more – in the patient's own home with the help of telehealth tools.

Whether technology fuels or curbs costs will be determined by whether providers are given the right incentives and by whether clinical processes are adapted to align with the new technologies introduced. The name of the game will be integration: the integration of care, patient pathways and the systems behind them to achieve a true multidisciplinary approach to healthcare; the integration of technology into these well-designed systems; and the integration of payor and provider to maximise the potential of data analytics and care programmes. The health value chain must be seamlessly connected. Technology, if integrated well, holds enormous potential to improve care and lower costs, building a better kind of hospital – and healthcare system – for the future. ■

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Key Points

- Healthcare costs have been soaring worldwide, and technology can be a useful tool in containing the cost.
- Remodelling the payment models is the first priority.
- Upgrade of traditional processes and workflows for smooth technology integration is also important.
- The above will allow the transfer of some links of the work chain from a hospital to safer places elsewhere.
- The integration within the health value chain is a foundation for building a better kind of hospital.

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Healthcare 2030: Transformation in the Next Decade

2020 marks the start of a new decade and, with factors such as the Silver Tsunami, digitalisation and emerging technologies that still have to prove their worth in the mix, it's one which will be game-changing. HealthManagement.org spoke to four experts on what changes they think will lead to the most beneficial transformation in healthcare over the next ten years.

The change in hospital care that I'm most excited about involves reimagining subspecialty consultation. Most hospitalised patients are cared for by generalists – such as hospitalists and intensivists. While these physicians perform crucial oversight and coordination functions, many patients have problems in which subspecialty expertise would be helpful. Currently, the main way to enlist subspecialty help is through a formal consultation, which involves the specialist reviewing the chart, seeing the patient, and writing a note with assessment and recommendations.

In the reimagined hospital, some specialists will mine the hospital's database looking for certain diagnoses or lab abnormalities, such as high glucose or low sodium. When they see opportunities for improvement, they'll offer recommendations. In other cases, a hospitalist will recognise that she could use the help of, let's say, a cardiologist in answering a question or determining the best strategy. She will call up the cardiologist (who may not be in the building) via telemedicine, perhaps while in the patient's room. The consultation will involve a three-way video conversation involving hospitalist, specialist, and patient.

The current duality – either a full-bore traditional consultation or no help at all from specialists – needs to be replaced by more nuanced and flexible models in which technology is leveraged to allow varying levels of subspecialty input at lower cost and less friction. The barriers to this are no longer technological, they are political, cultural, and, of course, economic.

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A lot of new technology is coming into the market, like tele- and self-monitoring, wearables and insertables, artificial intelligence and numerous connected devices, to name a few. However, there are so many determinants affecting how these will really impact patient autonomy and care processes, such as education, legal and regulatory frameworks, and interoperability, that it is not clear how this technology will be adopted. Overall, the technology is there but the culture, the care processes and the environment will have to change accordingly and they will most probably change more slowly than many expect.

There is a lot of discussion about the regulatory framework around the technologies out of the digital era, but still too little is being done about the education of care professionals in order to prepare them to use, to understand, and to master these technologies. And this is what I see as one of the most important challenges we have to face.

On the other hand, many tools that are used daily have been progressively enhanced without disruption. One example is imaging, where a growing number of historical players and suppliers of devices, such PET scans, MRIs, ultrasound, etc have started to embed advanced analytics in their tools. These include artificial intelligence. In a sense, we have had a rebirth of this type of existing technology and I see this continuing in the future.

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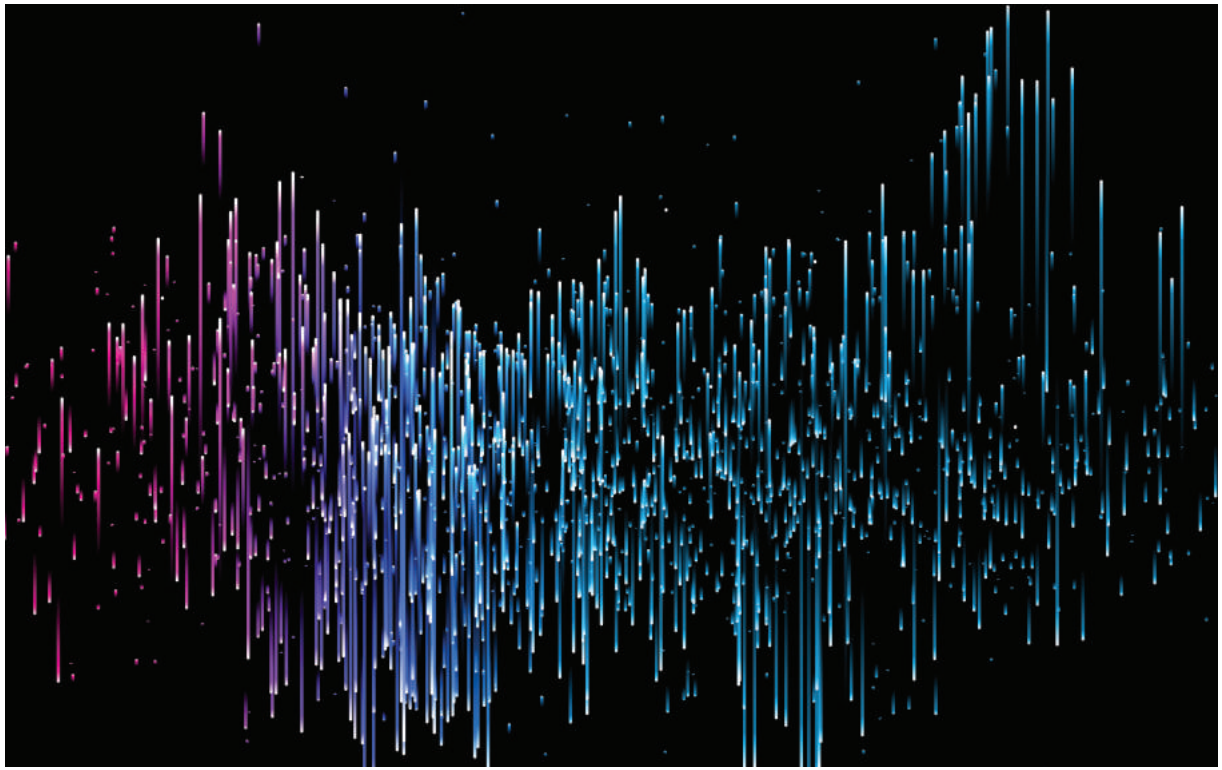

With the explosion of direct-to-consumer businesses using technology to empower people to personalise their experiences with companies such as Amazon, healthcare has much to learn. Within cardiology, Apple and AliveCor have taken the lead with at-home ECG monitoring devices that are bridging the gap between consumer tech and medical diagnostics. As doctors and healthcare systems gain more experience integrating these remote, off-site modalities into more traditional practice models, I think we will see a redefinition of what each patient's medical journey looks like. Instead of going to a doctor's office for appointments and testing, telemedicine and at-home diagnostics will likely streamline healthcare systems into a more patient-oriented, modern industry that rivals what we are seeing in the business world.

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One of the most cost-effective ways to reinvent hospitals will be through information technology. Over the next decade we can give hospitals the digital equivalent of brains and nervous systems. The fully digitised hospital of the future will become a healing machine, sensitive to the precise needs of each patient, seamlessly supporting human caregivers and allowing them to focus fully on the individual. Similar care, delivered virtually, will continue to surround the patient at home after discharge. And digitisation can create significant cost-savings as well.

It may sound Utopian, but it's within reach. The technology – smart sensors, ubiquitous wireless networks, artificial intelligence and automation – will advance rapidly and inexorably. But healthcare institutions must require and enforce digital data standards that allow devices and software to interconnect seamlessly. Security is a similar priority: strong cybersecurity is attainable but it will require pressure on the technology suppliers as well as better execution on the hospital side.

In the midst of this transition, we must be careful not to replace caregivers with automation and AI. Too often management sees automation as a way to reduce staff. But the emotional essentials of caregiving are human. Displaced staff can be retrained and redeployed for additional attention and support for individual patients.

By the end of the next decade, smart technology, intelligently deployed, can make hospitals very different places. The fundamentals of healing will still apply – but with more time and resources to deliver truly patient-centred care.

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The Application of Artificial Intelligence (AI) in Healthcare Systems

The value proposition of artificial intelligence solutions in healthcare have been well described[1] and it is apparent that 'narrow AI' will have a role in every stage in the clinical workflow; in Radiology this means optimisation of every step in the pathway from the appropriateness of clinical requests for imaging[2] to ensuring that recommendations from the radiology report are followed up.[3]

While there is great promise, with examples of successful AI implementation in single centres or most commonly in retrospective datasets, substantial barriers to implementation remain. Some of these are practical, others are more philosophical.

The first step is to identify which 'narrow AI' to focus on. For health systems embarking on clinical AI integration, criteria must be developed to narrow the scope of products under consideration. An example of some of these criteria are given in Table 1.

Table 1. Possible criteria for the selection of AI into a health system

- CE Marked
- Addresses a common disease entity
- Potential to be 'productised' to grow the business
- Allows access to new/better payors
- Clear articulation of equitable value proposition between partners
- Able to articulate/share own business model
- Infrastructure compatible with existing systems
- Algorithm can be embedded in clinical workflow

Any engagement of a third-party software provider to a health system begins with a comprehensive legal review. Groups developing AI solutions must classify their algorithms as medical devices for them to become used in routine practice, and as such should obtain CE marking in Europe or FDA clearance in the U.S. Until mid-2020 the level of CE marking obtained may be defined by the developers themselves, meaning that similar algorithms may be classified as Class I, Class IIA or Class IIB depending upon how they view their own product. In most cases, AI that assess 'pixel data' and may influence the physician is classed under 'Rule 10' as Class IIA Active devices and require external certification, whereas AI that influences the patient pathway (such as smart scheduling) is classified as Class I under 'Rule 12' (ce-marking.org) and may be self-certified. Unfortunately, this is not always consistent, so it is down to the healthcare system itself to review the documentation and decide whether the level of certification is sufficient. Even then, product may be certified for use on specific imaging systems, and this needs to be validated prior to implementation. From 2020, the new EU Medical Device Regulations will be enforced, necessitating far greater scrutiny of 'software as a medical device' (SaMD). Another key element of the certification is the intended use of the software in the clinical workflow; most AI developers are certifying SaMD as a 'decision support tool' ie it should not be used as a stand alone system. It is also important from a deployment perspective whether a clinician is allowed to use the software at the time of reporting or must use it only after the primary report is authorised (as a 'second read').

Once validated as a suitably certified medical device, a Data Protection Impact Assessment (DPIA) process must be undertaken to ensure that data privacy is maintained – in Europe this being the standard of the General Data Protection Regulations (GDPR). Alongside this is a Solution Architecture Review (SAR) which can be performed in parallel and scrutinises the proposed IT architecture. These may take several days and require on-site visits to the provider, to ensure the data processing pathways and physical environment is secure. Local rules must also be followed regarding use and storage of patient data, with every country interpreting the GDPR slightly differently. Privacy concerns and the requirement for a coherent digital infrastructure has been called 'the inconvenient truth' about AI in healthcare.[4] Robust processes must also be in place to ensure that de-identification of personal data (if and when permitted) must take place before transmission to third parties.

The process of digital integration depends upon the maturity of the AI company and their product, the size and heterogeneity of the health system and the process by which data is transferred from provider to processor and vice versa. Mature companies with stable product may be integrated over a matter of days, but timescales get longer with heterogeneity of electronic systems (Hospital and Radiology Information Systems [HIS & RIS], Picture Archiving and Communication Systems [PACS] and Vendor Neutral Archives [VNA]) and data inputs (naming and standardisation of imaging sequences). When considering 'pixel data' AI (those algorithms concerning the images themselves rather than the workflow), data may be sent directly from the modality to be processed on a local server ('on prem') or transferred automatically to a virtual server for processing in the cloud ('on the edge'). Alternatively, pixel data may be sent from the modality to PACS first, and then forwarded

to local or cloud processing from there. Processed data is usually returned to the PACS for scrutiny, which necessitates integration with the PACS system itself. This is challenging across networks, unless there has been harmonisation not only of the PACS itself, but also the process of data coding and handling built within it.

Standardisation of data is as contentious in radiology as it is in any other branch of medicine, yet it is highly advantageous when it comes to data processing. Computer scientists would be delighted if imaging requests would be made using a clinical decision support system to ensure appropriateness, that the correct code is given to the procedure based upon an agreed standard such as RADLEX or LOINC.[5] All similar procedures would be undertaken according to the same, agreed acquisition protocol (irrespective of vendor and model), and all reports would be structured in the same way using agreed terminology, for instance, RadReports.org from the ACR. Without these ideal conditions, it may be that complex mapping and integration has to be undertaken on a per-modality basis, even within the same health system. Depending upon the maturity of the algorithm, programme bugs may then become apparent due to heterogeneity of data input.

The use of each AI solution then needs to be taught to the community of professionals who interact with it; this may be fine for an AI developer who is training a small group but may be more problematic for a start-up facing training of a large health system. Even then, physicians may regard the solution with distrust unless proven to be completely accurate. One solution that we have adopted is to build a Radiologist feedback tool into the PACS interface, that allows clinicians to score the perceived accuracy of any given algorithm – in most cases check boxes with the legends 'agree/ AI overestimation/ AI underestimation/ Both over and underestimation' are sufficient to allow users to flag potential discrepancy that can be followed up subsequently.

Patients may have their data processed by certified medical devices as part of routine clinical practice with no additional consent required, however if the AI vendor would like feedback to improve the algorithm, specific data consent must be obtained from the patient prospectively. The right to share and use these data may also be denied post-hoc, meaning processes must be in place to identify those patients who have granted consent and to rescind it when necessary.

Once the practical barriers to AI implementation have been overcome, the question remains: Who pays for the AI? Pharmaceutical companies have become purchasers of AI systems used for the quantification of imaging biomarkers, but these tend to be used for batch processing in an offline setting. As yet, no national health systems or private health insurers have provided an additional tariff for the use of AI, meaning that space has to be found in already diminishing tariffs to support its introduction. While AI may hold the promise of efficiency gains and workload reduction, there has been no published evidence of this 'in the wild'. Some hope comes from the development of specific patient-centric services that may be driven by AI-enabled insights, such as a bone health service in the UK which pays for the identification of patients at risk.[6] In this instance the business case is made on the basis of the whole service rather than paying for a specific AI product as the early identification of patients at risk enables early intervention and downstream cost savings by reducing the number of subsequent fractures – an example of AI and value based health care coming together.

In less joined-up health systems, certainly those in which imaging services remain 'component providers' of care, local metrics will have to be obtained that justify introduction. For instance, improved accuracy of reporting, such as reducing the recall rate for women undergoing mammography[7], improved reporting speeds and ultimately improved revenues. It will only be by trialling new AI solutions in multiple different healthcare markets, using all combinations of payor model, that widespread adoption will finally become possible. ■

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The Reuse of Health Data: Governance and Trust As Catalysers for Quality

Summary: The European Institute's for Innovation through Health Data (i~HD) total quality approach to data: four governance pillars designed to boost the quality of learning health systems and research to advance personalised medicine.

The value of the massively growing health data volumes to advance healthcare and clinical research is beyond dispute. The question that is often posed is rather: how can we simultaneously meet the needs of healthcare, research and patients? And the one posed less often is: what about the quality of the data?

Creating a neutral and independent community, after a wide consultation and engagement of many stakeholder groups, is the way i~HD went about to leverage trust and ensure that health data reuse solutions serve the collective needs.

Health Data Governance Ecosystem

Without owning any data, The European Institute for Innovation through Health Data (i~HD) has set up a comprehensive and coherent health data governance ecosystem based on four complementary pillars (Figure 1). This total quality approach to data includes not only the intrinsic data quality but also the trustworthiness of Electronic Health Record (EHR) systems and research platforms, as well as the promotion of interoperability standards to connect different systems. Furthermore, i~HD experts provide tutorials and promote codes of practice in data protection and the General Data Protection Regulation (GDPR) compliance.

i~HD started its activities in 2015 as a sustainable entity arising from EHR4CR (an Innovative Medicines Initiative project) and complementary EU projects supported by the European Commission. Via its founding members (EuroRec, RAMIT, empirica and TMF), it brings together over 30 years of coordinating experience and is a partner in more than 90 European projects. Its core team is rapidly growing; the latest three recruits are listed in the 'Contributors' section. Its current experts are surrounded by European thought leaders in each field of governance, so that i~HD is constantly at the top through monitoring emerging legislation and R&D projects.

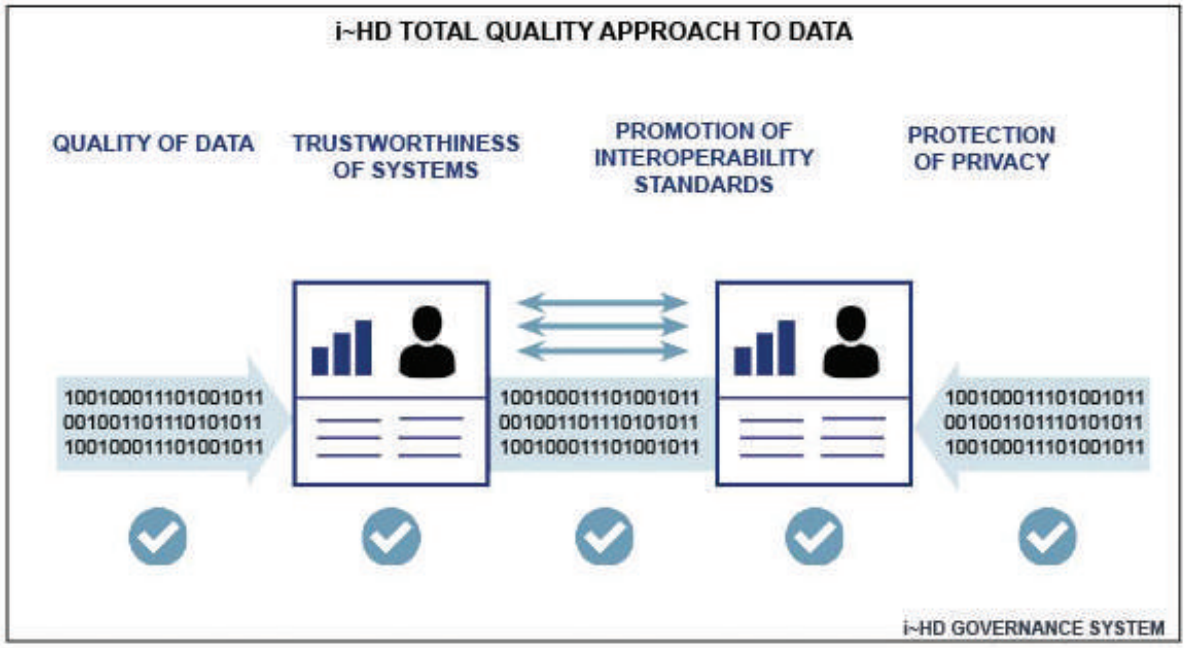

Figure 1. Four Governance Pillars Designed to Boost the Quality of Learning Health Systems and Research to Advance Personalised Medicine

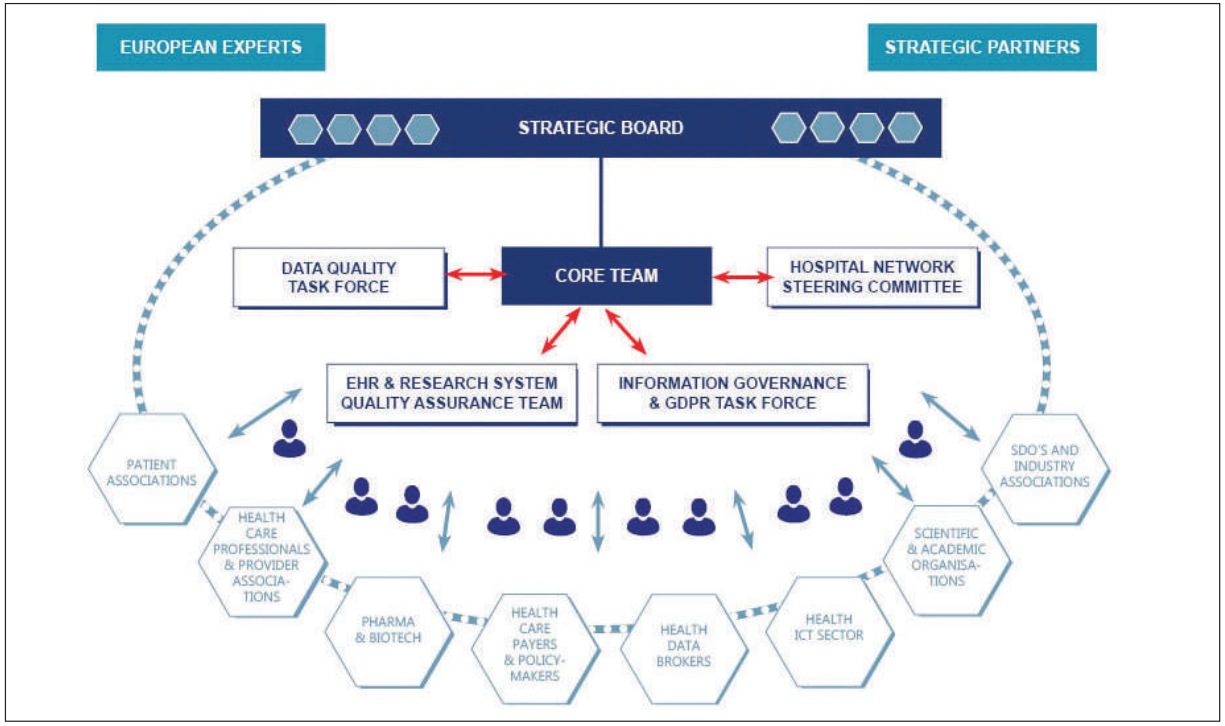

Figure 2. i~HD Eco-System

Connecting Is the Name of Their Game

Besides developing collective methods and guidelines, and delivering insightful tailor-made advice, i~HD aims to boost collaboration between stakeholders and knowledge sharing through conferences and awareness campaigns, to exchange perspectives between stakeholders whose interests may not always seem aligned (Figure 2).

For instance, interests of healthcare, research and patients are often thought to be opposing. However, 73% of EU citizens want to share health data on the precondition that data are secure and only accessible by authorised parties (European Commission 2018). i~HD responds with a two-way plan of action:

1. Assist data users (such as research organisations) to develop quality and privacy codes of practice that give assurance to data providers (such as patients).
2. Raise awareness about these codes and the benefits of sharing health data with data providers.

Empowering Patients

To overcome the barriers to collecting a maximum of useful real world health data, patient involvement and empowerment are crucial. To keep closely in touch with patient organisations, i~HD also includes patient representatives in its team. Pieter van Galen, member of the MS Data Alliance, educates patient organisations on the benefits of sharing health data, countering fears such as privacy issues, insurances going up and data not being anonymised.

Real World Data

The explosion of interest and initiatives for reusing routinely collected health data (Real World Data) for research and healthcare improvement spans a wide spectrum of opportunities: from accelerating the design and conduct of clinical trials, to deep population stratifications using big data and artificial intelligence methods to accelerate personalised medicine, studying clinical outcomes and advancing value-based care, optimising care pathways and empowering patients. But how reliable are the conclusions for clinical, strategic and operational decision making?

Pillar 1: What About EHR Data Quality?

Good EHR data quality is imperative for valid and reliable clinical decision-making and inference. However, most Real World Data are captured by healthcare staff who have almost never had any training in data management. As a result, several studies have demonstrated that Real World Data today are of variable quality, much of them barely fit for any reuse purpose.

In order to address this poor data quality issue, i~HD has developed a Data Quality Service for Hospitals (DQS4H). This service entails a comprehensive data quality analysis using a set of up to nine data quality dimensions. This set has been developed by expert review of state-of-the-art literature combined with multi-stakeholder consultations.

For each of the data quality dimensions, dedicated methodology and corresponding assessment tools have been developed in collaboration with domain experts at the Valencia Polytechnic University. Moreover, i~HD has statistical and medical expertise to interpret the findings. Based on the results of data quality assessment, customised data quality improvement strategies can then be developed, tailored to the specific needs and problems observed within the hospital, to support hospitals in improving their data quality.

In addition, i~HD wants to raise awareness about data quality issues and potential risks of (re)using data of poor quality through collaboration in various European projects.

functionalities. These comprise security, confidentiality, trustworthiness, etc depending on the use-case: is the EHR used for the provision of routine daily care, for the reuse of EHR data for clinical research, for big data analytics?

Assuring quality audits of systems can be approached through several methodologies, ranging from self-assessments by the system vendors to quality labelling and certification processes. The latter preferably consist of system audits conducted by third parties (so-called conformity assessment bodies), which report back to certification bodies. Depending on whether they are accredited or not by an accreditation body – these certification bodies can grant a certificate or quality seal to the EHR system.

safe continuity of care for individual patients between different care actors. At a more collective level, pooling data at a population level can show how well a health system is performing. Large quantities of pooled health data, on thousands or millions of patients, are also very valuable for research. Hence there is a need for interoperability standards, which define how clinical information, such as parts of the patient EHR held at the hospital or general practice, should be transferred to other similar systems.

There is a long history of developing international standards to enable such mappings. Bodies such as CEN, ISO, HL7, IHE, WHO, LOINC, SNOMED, CDISC and OMOP are examples of organisations that have defined relevant parts of the standards landscape for the kinds

73% of EU citizens want to share health data on the precondition that data are secure

Pillar 2: Quality and Trustworthiness of Systems

Producing quality health data goes hand in hand with the quality of the system (software) and the level of training and awareness of the system end users. Even the best system cannot escape the aphorism 'garbage in, garbage out' when data quality is inadequate. Conversely, the system should feature the functionalities that allow the capture and management of high quality data. Finally, end users should be properly trained to use the systems correctly.

Quality assurance of systems is essential to ensure the presence of a number of correctly implemented

i~HD has followed the latter methodology and has developed a strategic partnership with its sibling, the European Institute for Health Records (EuroRec). EuroRec has a longstanding history in quality labelling and certification of EHRs in Europe. It has developed a repository of functional quality criteria for EHR systems and several tools (web applications) to assist in the quality labelling and certification process. The i~HD Quality Seal for Research Platforms is the latest example of the collaboration between i~HD and EuroRec.

Pillar 3: Interoperability Standards

In a digitally connected and collaborative health environment, sharing health data is vital to enable the

of data transfer they specialise in. However, despite this rich array of available standards, the experience of most healthcare professionals and patients is a lack of connectivity. People undertaking large-scale research struggle to bring together the data they need, on enough patients, and their data harmonisation costs are a substantial part of the total cost of undertaking research.

This landscape is changing, thankfully. Healthcare funders (health ministries, health insurance) increasingly want care to be connected. They are starting to demand better clinical outcomes and to financially incentivise those outcomes. This stimulates, for the first time, a business case for hospitals to be more interoperable. Secondly, countries are now making substantial

investments in research infrastructures that aggregate the data at large population levels. These investments are gradually also trickling down to healthcare organisations as incentives to have better connected and better quality data.

i~HD and its member organisations play an important role in the development and promotion of interoperability standards, and in promoting the importance of good quality interoperability data across the health ecosystem.

Pillar 4: Data Protection

Sharing and pooling of health data inevitably raises questions as to protection when reusing it for healthcare and research. These questions have always been of the highest importance to the health data innovation community. The recent arrival of the GDPR was a rallying cry for the innovation community to not only redouble our efforts, but also to ensure that we could demonstrate our excellence and commitment to this area.

The GDPR put data protection centre stage of societal discourse, but it also tried to help clarify various complex areas and provide consistency across EU and EEA states in how data were protected. As it has arrived, we are nevertheless seeing divergence across member states and uncertainty around how to honour consent to participate in research, understand the regulatory impacts of artificial intelligence, uphold newer rights like erasure and portability, and to truly understand how data uses can be made transparent for patients and the wider public.

To answer these challenges, i~HD has formed a GDPR Taskforce composed of leaders across Europe in law, information governance and security, engineering and regulatory oversight. Together, they are helping to provide best practice as it develops and emerges through tailored workshops and tutorials, supporting an Observatory of how different member states and regulators are handling GDPR as it lands. They are actively engaging with the health data innovation community as a sounding board to help understand the challenges that are surfacing and how to meet them.

Be Part of a Responsible Health Data Community

Collating and studying millions of quality-checked health data currently stored in separate silos, in secure ways, is expected to lead to a growing number of new insights, which can speed up diagnosis and the development of new medicines, new medical devices and smart applications.

Leading the way to a responsible and trustworthy health data community by breaking down the existing governance barriers, that is i~HD's mission. Therefore, we call all health data providers and users alike to liaise with, contribute to and benefit from dialogue and thought leadership on data sharing and reuse. ■

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Key Points

- The reuse of health data is crucial for enhancing healthcare and speeding up clinical research.
- Poor data quality, untrustworthy and disconnected systems, and misunderstanding of data protection issues can jeopardise optimal clinical, strategic and operational decision-making.
- A comprehensive and coherent health data governance ecosystem is an essential condition for quality and trust.
- Connecting all stakeholders in a responsible and united health data community will boost a collaborative ecosystem where the needs of data providers and users alike can be met.

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2020: Year of the Nurse and the Midwife

Summary: The World Health Organization designated the year 2020 as the 'Year of the Nurse and the Midwife' in honour of the 200th birth anniversary of Florence Nightingale. President of the European Nurse Directors Association explains why it is so important to global health.

World Health Organization (WHO) is the collaborating partner in the three-year 'Nursing Now!' Campaign (2018–2020). This campaign aims to improve health globally by raising the status and profile of nursing, demonstrating what more can be achieved by a strengthened nursing profession, and enabling nurses to maximise their contribution to achieving universal health coverage.

WHO is leading the development of the first-ever State of the World's Nursing report, which will be launched in 2020. This report will describe the nursing workforce in WHO Member States providing an assessment of 'fitness for purpose.' Also, it is expected to support country-level dissemination and policy dialogue around the State of the World's Nursing report. Strengthening nursing will have the additional benefits of promoting gender equality (Sustainable Development Goal 5 [SDG5]), contributing to economic development (SDG8) and supporting other SDGs.

Key findings of WHO identified a major threat related to global health workforce: the estimated shortage of health workers, particularly nurses and midwives, exceeds 50%, with largest needs coming from South East Asia and Africa. With all Member States aiming to reach SDGs on health and wellbeing, , an additional 9 million nurses and midwives will be needed by the year 2030.

The estimated shortage of health workers, particularly nurses and midwives, exceeds 50%

Various Roles of Nurses

Nurses and midwives play a vital role in providing health services and are key contributors to the achievement of universal health coverage. They devote their lives to caring and often stand as the first and only point of care in their communities. Nurses play a critical role in health promotion, disease prevention, emergency care and primary and community care delivery. Midwives are unique professionals who provide specialist nursing care and stand at the forefront of providing primary care for women and their babies. They play an important role to a pregnant woman and the baby during antenatal, intranatal and postnatal periods. Their various roles as caregivers, coordinators, leader communicators, managers, family planners, educators, counsellors, record keepers and supervisors are appreciable.

Themes for Collaborating Centres

It is essential to acknowledge, appreciate and address their contribution in challenging global health and nursing care. WHO have designated 43 academic centres as Collaborating Centres for Nursing and Midwifery. These academic centres are affiliated to the Global Network of WHO and set out four broad themes to guide the contributions of the nursing and midwifery workforce to improve global health. These themes are:

- Ensuring an educated, competent and motivated workforce within effective and responsive health systems at all levels and in different settings
- Optimising policy development, effective leadership, management and governance
- Maximising the capacities and potential of nurses and midwives through professional collaborative partnerships, education and continuing professional development; and
- Mobilising political will to invest in building effective evidence-based nursing and midwifery workforce development.

Welcome Recognition

According to International Council of Nurses, it is a unique time for the nursing profession. The global spotlight currently shining on the nursing profession offers a once-in-a-lifetime opportunity to address some of the key issues threatening its future. The 20 million nurses around the world will be thrilled to see their profession recognised in this way. Designation of 2020 as the International Year of the Nurse and the Midwife will provide us with a new, 2020 vision of what nursing is in the modern era, and how nurses can light the way to Universal Health Coverage and healthcare for all.

Investing in nurses and midwives is good value for money. A UN report says that investments in education and job creation in the health and social sectors result in a triple return of improved health outcomes, global health security and inclusive economic growth.

An Important Year

Year of 2020 is all set for Nursing and Midwifery, and will raise the profile of nursing, investing in recruitment and retention, removing the barriers to the development of advanced nursing roles that are proving highly effective at expanding global healthcare coverage.

Let us join WHO and partners, including the International Confederation of Midwives (ICM), International Council of Nurses (ICN), Nursing Now! and the United Nations Population Fund (UNFPA) in a year-long effort to celebrate the work of nurses and midwives, highlight the challenging conditions they often face, and advocate for increased investments in the nursing and midwifery workforce.

"Patient smiles make nurses the happiest people in the world.'' ■

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A Mobile Solution Easing Imaging Workflow and Burnout

Summary: Streamlining radiology workflow is critical for reducing burnout and making imaging departments as efficient as possible. A developer of an innovative app focusing on easing daily radiology tasks spoke to HealthManagement.org about the thinking behind the creation and the effect it's having on an imaging department.

At present, the app focuses on improving five core daily tasks: communication, education, networking, workflow efficiency, and patient safety. Do you see any other necessary areas into which the app may expand in the future?

The greatest feature about our app is that it is easily customisable. We are always adding features and are able to customise the app to meet the needs of the target practice or hospital. For instance, a current area we are working on is adding a host of tools in the app to integrate in system downtime protocols such as when the electronic medical record or other critical systems are down. In addition to the built-in features, our app easily integrates with an institution's existing resources and systems to allow the user to access these areas directly in the app. In addition to customisation at the user level, we are also able to add any features requested for a group of users. Our main ethos is to have this solution function as a one-stop-shop for the users' needs and daily responsibilities.

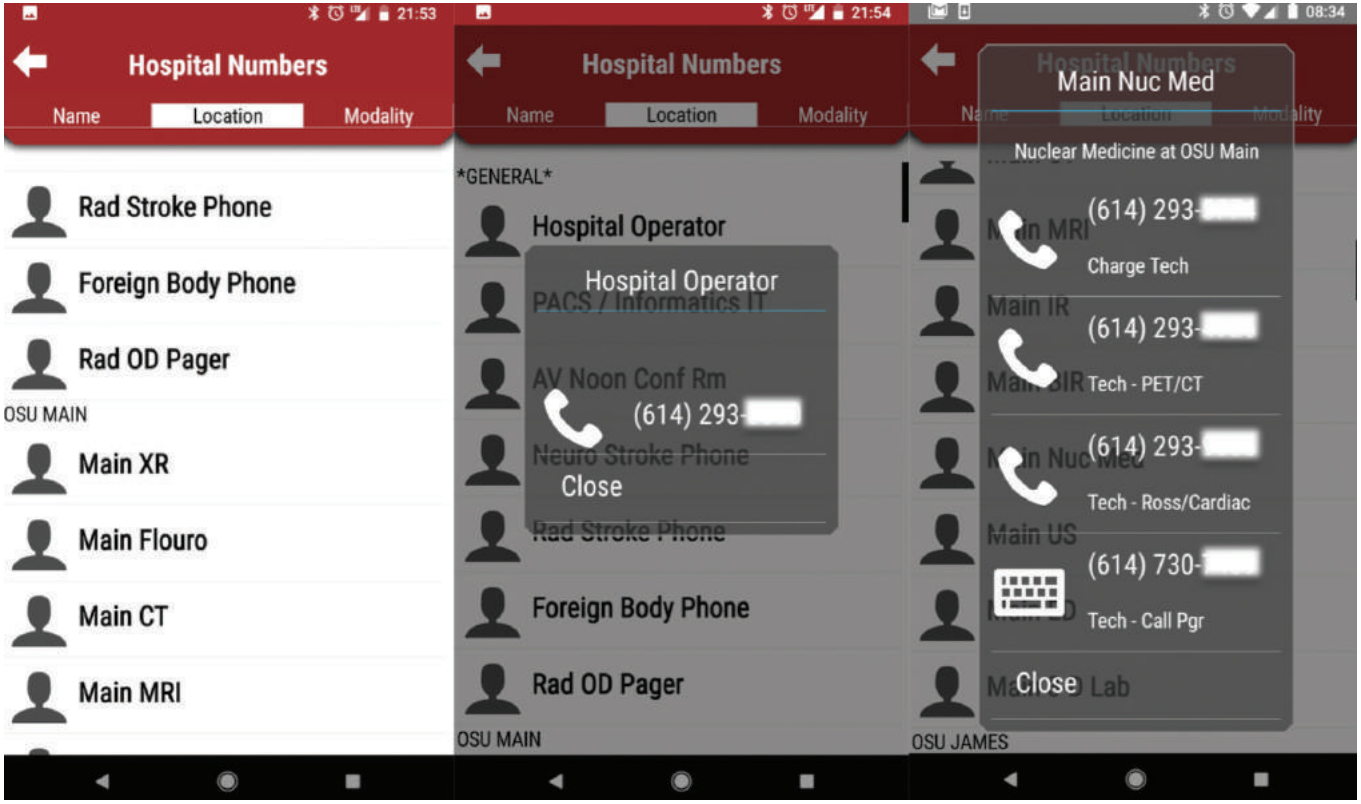
The functionality and ease-of-use central to the app are especially interesting. How did you devise RadAppTM in such a way that no programming experience is required for maintenance?

Being developed on the frontlines by end-users like me and my partner, the app was designed with a robust understanding of how the healthcare system works and how physician groups and medical centres function. We understand the current administrative bureaucracy of healthcare and need for cost-effectiveness. We wanted to be part of the solution and to develop a tool that didn't require additional administration (time and costs). As a result, one of our key design requirements was to have this app self-sufficient and easily maintained by a designated 'super user' once in a while if significant changes occurred, without the need for coding or software experience. Changes can be made very easily to the app software database and can be quickly applied to all users, without requiring coding or programming. We did all the coding and work upfront to simplify both the user interface and the maintenance interface on the backend.

Can you provide some background on how RadAppTM was devised? Who are the radiology and technical team members and who did you consult on both a technical and professional level?

RadApp was devised out of the need for a user-friendly centralised solution that brings together a wide variety of resources for communication, education, scheduling, daily work requirements, and networking in order to improve workflow efficiency and patient safety. While in residency training, my partner, Dr. Egbert Nitin, and I met several times a week brainstorming ideas on what would be the perfect tool that would help us provide effective, efficient, and evidence-based care in an increasing demanding work environment. It took us a year to develop such a tool to meet our requirements for improving daily workflow by providing quick access to essential tools and information as well as being secure and compatible with Android and iOS devices

While our original primary goal was to improve the workflow, the app had positive effects on the stress of the work environment



The user-friendly app was developed by radiologists seeking solutions for workplace inefficiency.

including phones and tablet devices. Following extensive development and testing, we trialled the application for the more than 130 users in our Radiology Department with great success and positive feedback.

RadAppTM has an impressive and comprehensive reference section. How are these references sources updated?

One of my favorite features is the reference tool. This section includes a variety of pertinent national and society guidelines as well as hospital and local guidelines. These references are formatted in a user-friendly format to allow quick efficient reference for the on the job use. We include references such as the Fleischner society guidelines for pulmonary nodules, society guidelines for thyroid nodules and ovarian lesions, the ACR recommendations for incidentalomas such as pancreatic and renal lesions, and much more. We also have local guidelines for contrast administration in the setting of renal insufficiency, management of contrast reactions, treatment of contrast extravasation, and foreign body/implant identification/recommendations for MRI, to name a few. We set up the software to automatically check for and update these references every time the user opens/uses the app, without them needing to do anything.

Did you face any obstacles/resistance from anyone both during 'onboarding' and continued use?

We were lucky enough to have broad enthusiastic support and near unanimous adoption of the app by our users. We attribute this to the extremely user-friendly and versatile nature of the app providing access to many resources that are often cumbersome to find or require accessing multiple areas. The app even provides access to these tools offsite

and offline in some cases, which allows users to be efficient whether they are on-call or on their way to a meeting. Even for the slow adopters, once the app was demonstrated and the tools shown, this group of users became some of our greatest fans. We made sure we had something for everyone from the most sophisticated tools and references to fun items such as social media, specialty-specific news feeds, and even daily cafeteria menus.

What measures have been taken to ensure RadAppTM is not vulnerable to cyber attacks?

In addition to simplicity, versatility, and ease of use and maintenance, another requirement we had was security which we take very seriously. Firstly, the app is only provided to target users and is not available publicly on the Apple or Android app stores for anyone to download. Secondly, we do not include patient information or medical records in our app. Thirdly, confidential areas such as departmental policies, phone numbers/pagers, and schedules are protected by a one-time login once the app is loaded to protect the information. The app has Base64 encoding, high-grade encryption, and accesses the most sensitive files using an institution's usual security protocols to protect the data. Lastly, we also have the ability to deactivate a device's access to the app. For instance, if a device is lost, anyone who tries to open the app won't be able to due to the above security measures and login requirements, but we can deactivate the software remotely as well.

Has RadAppTM had any notable beneficial impact on radiologist burnout?

While our original primary goal was to improve the workflow and efficiency, we've noticed that the app had positive effects on the work environment. Many of our users provided positive feedback that the app helps reduce the demands and stress of trying to reach the appropriate tech for a study acquisition, paging a referring physician for a critical finding, finding a useful reference or hospital policy quickly, or dealing with administrative tasks on the go. The feedback we've received and lessons we've learned further reinforced the role of tools such as our app solution to meet the increasing demands on physicians and trainees to multitask and be able to access, synthesise, and apply evolving and growing amount of data and knowledge.

Has RadAppTM encountered any implementation roadblocks?

The biggest challenges we've faced were during the development of the software. From the beginning, we set lofty requirements of developing a solution that is user-friendly/versatile, easy to use and maintain, secure, customisable, and pertinent to daily work. It also had to contribute to the user's efficiency, effectiveness, education, networking, patient safety, and evidence-based care delivery. We built upon our experiences as physicians and trainees who worked in a variety of healthcare settings and used a multitude of electronic medical resources and available software tools. Once we achieved these goals and created our prototype, our next challenge was to ensure operability on both iOS and Android based devices and the functionality of the software on both phones and tablets with various screen sizes and hardware specifications. Lastly, we went through countless layers of testing and evaluation of our security measures prior to internal evaluation by our own medical informatics department, then ultimately our department-wide implementation. I really enjoyed every step of this journey, and I find it extremely rewarding when I see users rely daily on this solution for optimal healthcare delivery. ■

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How Digital Transformation Can Enhance Healthcare Staff Communication

Summary: An initiative in Spain is tapping into the wealth of digital and non-digital communication amongst staff for streamlining information in an innovative interconnective platform called Plan Adapta.

Communication among healthcare professionals: what a challenge. Innovation propelled by technology is one of the most significant opportunities that big organisations, such as our hospital, have as tools to fuel change.

When it comes to supporting the flow of daily information and putting digital transformation on top of the cultural change journey in a hospital, traditional help, like EMRs, email, intranets and others do not show enough flexibility, adaptive behaviour or focus on team building and management to provide the soundness necessary to follow the path of clinical conversation.

On a day-to-day basis, the real steady stream of clinical information, despite the intensive use of EHRs, comprises the vast number of telephone calls, countless instant messages, thousands of face-to-face conversations and many multidisciplinary meetings among carers. A wealth of clinical information is hidden there, so the temptation to apply secure technology to those scenarios is as strong as the benefits of habilitating our nurses and physicians with sufficient tech to act on these concepts.

With this kind of strategy in mind, in the summer of 2018, the Hospital General Universitario Gregorio Marañón launched a regional initiative, called Plan Adapta, to deploy a platform that could cover as many different scenarios as possible. The aim was to promote the use of tools to maintain staff interconnection, either through instant messaging, audio or video-chat, video and document collaboration, anywhere at any time. This covered doctors, nurses, management staff or IT personnel, in a secure way, and with the possibility of sharing historical or new documents.

It can be argued that "there's nothing new under the sun," but the ordered professional usage of these tools is challenging and brings a fresh perspective to the conversation. Technology in itself does not open doors for improvement, and therefore implementation and adoption must be complemented with transition change management and establishment of use of protocols following good practices of methodologies driven by the leadership of the Information Systems Area. This has been our approach. The use of the corporate application promoted regionally, in its instant messaging functionality, implies use cases that involve redefinitions in the field of Human Resources, security and services organisation. This implies a complete change management application, with a common benefit that ends in an improvement in the quality and safety of patient care.

How Does It Work?

What is given to staff is 1 TB per person in the cloud, plus a complete platform that performs with desktops or any mobile device, the features to stay connected and secure interchange of information via calls, messaging, channels, teams and collaboration. Last but not least, we are also offering the staff integration with other apps in order to draw process diagrams, event approval diagrams, information analytics, planners, task and event programmers, and others.

This change raises the need to create specific clinical protocols for use of the application and rules of use for professionals, the signing of specific clauses for use of mobile devices and how to behave on and off duty. This is critical to adapt ourselves and the staff to the advancement of technology itself. The intention is to facilitate the adaptation of the possibilities offered by technology to the operation of the hospital and not vice versa.

On the other hand, and already more specific to the Information Systems Area, we must ensure compliance with the security of the Spanish National Security Scheme (ENS), keeping information accessibility on a 24/7 basis, and providing enough support to anticipate misfunctionalities.

Outcomes

First, the immediacy of a secure connection from any location, even outside the hospital, to any clinical session of the clinical services or in a multidisciplinary manner, such as Tumour Committees.

In addition, the system allows the sharing of documents instantly (no more versioning of documents by email), the sharing of medical diagnostic tests, direct communication between professionals of different services to communicate transfers of patient clinical information, second opinions, questions and inquiries about protocols and procedures.

The system also offers immense new opportunities like the improvement in the quality and safety of patient care, fullfilment of the EMR and other applications live in the hospital.

Finally, we should emphasise the ease of adoption of these tools within the Plan Adapta, given the great similarity with other existing tools available in the market for these purposes and extensively used in private life. The main aim is to cover a real need demanded by professionals with the possibilities offered by technology and within necessary security limits.

For the Hospital General Universitario Gregorio Marañón, keeping leadership in Digital Transformation is much more than maintaining a framework of corporate applications; it must be combined with tools that really support change of hospital culture, creating the road of quality of care and safety on the care we are providing.

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Key Points

- Streamlining communication amongst healhtcare personnel is an ongoing challenge.
- Plan Adapta offers a secure platform that comprises multiple communication modalities.
- Plan Adapta complies with security of the Spanish National Security Scheme.
- Staff are given Cloud gigabytes and access to a platform with the features to stay connected both within a hospital and externally.

Nurses Health – Do You Manage This Challenge?

Summary: Patients rely on healthy nurses for optimal care – but who is looking after this staff of carers in a demanding work environment? A veteran nursing expert describes the outcomes of a project aimed at promoting nurse all-round health held at Hannover Medical School.

Various statistical surveys show that the workload of nurses in hospitals and outpatient care services is high. Although the average length of stay in hospitals has fallen (Lower Saxony 2005: 8.6 days, 2017: 7.1 days) and the number of cases continues to rise (Germany 2005 16,873,885, 2017 19,442,810), there has been a below-average increase in employment in nursing services. In comparison, other medical professions (doctors, medical-technical services, and functional services) have significantly increased their personnel (Figure 1) (Federal Statistical Office Destatis 2017).

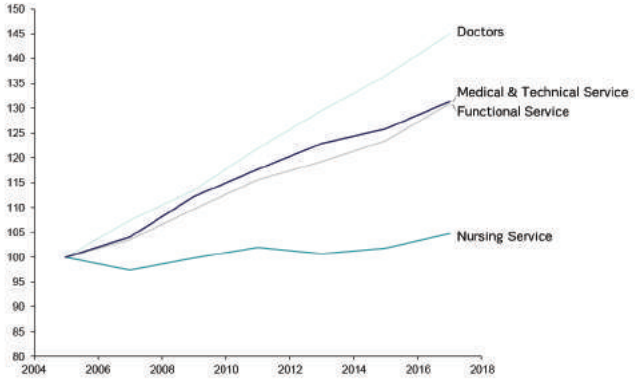

Figure 1. Medical Staff Growth Index, Lower Saxony 2005-2017 (2005=100)

Accordingly, it is important to counter these developments with adequate management methods in order to identify and reduce burdens and, consequently, set up a comfortable workplace for consequently carers.

Caregivers who receive support in their competencies development can optimally meet the demands of the workplace

Accordingly, the number of nurses per 1,000 cases reduced from 24.7 in 2005 to 22.1 in 2017. Although statistical variables are of limited use in assessing the workload of caregivers, they do indicate that caregivers work under increasingly tense conditions.

These are probably the reasons for the high part-time rate of 53.2% (Federal Agency for Work 2019) and the above-average number of days of incapacity for work of carers [30 days/year for carers, compared to an average of 18 days/year for all insurance members] (Grobe et al. 2019).

These developments can be observed on a small scale in every work organisation of a hospital. For me, as the responsible nursing manager at the Hannover Medical School (MHH), the connection between workload and downtime is indisputable.

In the following, a practical project is described which started in November 2016 on ward 42, Department of Haematology, Haemostaseology, Oncology and Stem Cell Transplantation. The core elements of this project are modified employee manager interviews (MVG) and a series of further training courses based on current needs.

Baseline Situation

In November 2016, there were high absenteeism rates (15.5%) and, as a result, the impact on the environment was an increased workload for the nurses of ward 42. These manifested themselves in a low level of motivation on the part of the nurses. For the responsible nursing managers, this meant an enormous amount of work in the area of reorganisation of staffing.

Project Course and First Measures

In the following, the individual milestones (Overview 1) of the practical project are described in more detail.

- **12/2016**
  Information collection and literature research
- **02/2017**
  Expert advice
- **05/2017**
  Coaching Return talks
- **06/2017**
  Psychological risk assessment
- **12/2017**
  Change in MVG

In order to be able to deal with the situation adequately, the management team carried out a collection of information and a literature research at the beginning of the project. In addition, in February 2017, experts from the MHH's Health Promotion, Personnel Development and Occupational Safety departments provided in-depth advice to the divisional and group management.

As a result, the management team was coached in May 2017 by the personnel development department on the topics of life-phase oriented planning, appreciative dialogues and presence-promoting leadership. Increasing knowledge and changing the attitude of the management team are the first goals to be achieved within the framework of coaching. Already at that time, further talks were held on the subject of attendance and absenteeism after a prolonged period of incapacity to work. The scheduling of the talks was carried out according to the urgency.

In order to obtain further specific information from the nursing team, the Occupational Safety Department carried out a risk assessment of the psychological stress of nurses at the request of the Haematology, Haemostaseology, Oncology and Stem Cell Transplantation Department in June 2017. The evaluation of the survey was multi-professional. Concrete measures were introduced (eg changes in night shift times, case discussions) in order to reduce the burden on nursing staff. In addition, the previous steps were reflected on in order to be able to derive further measures all round.

Method Description: The Employee Superior Interview

In December 2017, the content of and processes in the MVG's existing management toolbox were worked on in addition to the measures initiated. A needs-oriented cluster for the systematic assessment of caregivers was synthesised from the current literature. Components of this cluster are operationalised contents from the area of competencies as well as the area of motivation (Table 1).

The development status of the respective employees is located using the Benner competency level model and varies in this case from advanced beginners to nursing experts (Benner 1982). In preparation for the MVG, carers carry out specific self-reflection.

In addition, all employees were discussed by the management team in a personnel conference. On this basis, each MVG was carried out individually, corresponding objectives were planned and appropriate measures were initiated.

Caregivers who receive adequate support in their professional competence development can optimally meet the demands of the workplace. Conversely, the burden on caregivers can be reduced, which in turn can have a positive effect on attendance and motivation.

The connection between competence development and stress has already been presented for other service occupations (Schmitt 2005) and is a guiding thesis of this practical project.

Appraisal Range	Example
Professional Competence	Current state of knowledge on the most common health disorders
	Proximity and distance behaviour
	Guidance of learners
Social Competence	Communication with patients and relatives
	Conflict management
Methodological Competence	Time management
	Prioritising
Personnel Competence	Self-reflection
	Critical faculties
	Cooperation within the nursing team
Motivation	Readiness for further education and training
	Order

Table 1. Contents of the Competence-Oriented Cluster

In addition, the MVG was expanded to include the subheading of presence-promoting resources and stress. With regard to the health promotion of caregivers, it is essential to identify individual and general stressful experiences at the workplace and to identify resources that promote attendance in order to strengthen them. This assumption represents the second guiding thesis of this practical project.

Random Sample

Talks were held with 24 employees, including 22 women and two men, on the above-mentioned topics. The participants were on average 31 years old and had an average work experience of 5.7 years. The nurses had various formal qualifications (two had professional training in oncological care, two were practical instructors for nurse students, two were in palliative care, one had a Bachelor of Arts Nursing).

Outcomes

Over the entire period of the project, the rate of absenteeism fell to 7.5%. In addition to these measurable results, the following content-related and non-measurable results, which were also perceived as very positive by the nursing staff, could be derived:

- Meeting individual development needs.
- Improving individual resources.
- Improving resources in the work area.
- Improvement of the analysis capability of the management team.
- Improvement of the nursing staff's self-reflection competence.
- Increased transparency.
- Increase of the perceived esteem from colleagues.
- Intensified relationship between employees and superiors.
- Meeting of training needs.

Conclusions and Outlook

These results make it possible for the responsible managers to work on the processes and structures at different levels in order to reduce the stress-related experiences of the carers. Ward 42 is currently working on the most urgent issues requiring change.

Furthermore, it was possible to detect general development needs in the context of stress-related behaviour and the handling of pressure. As there is no further training on offer for these topics, this need was passed on to the Nursing Education Academy in January 2019 by the nursing management. Training courses are currently being prepared on the following topics:

- Resilience, resistance and inner strength.
- Stress-reduction.
- Anti-stress and anger management.
- Change of position of patients to a more central role in their healthcare.

The competence development of the nursing staff through the amended processes of the MVG, combined with personal development through participation in further training courses with the focus on health promotion, has a positive effect on the experience and handling of stress as well as the stress-related behaviour of nursing staff. Both elements make a significant contribution to supporting and strengthening the health of caregivers. With this practical project, we, the responsible nursing managers at MHH, are fulfilling our duties, countering an ever-increasing burden resulting from increased capacity and maintaining our most important resource – our nursing staff.

In this context, in addition to our efforts, it is more than imperative that policymakers also assume their responsibilities and improve the framework conditions for carers. Only in this way can healthy carers continue to enjoy their challenging work – because healthy carers are indispensable for our society. ■

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Key Points

- The average length of stay in German hospitals has fallen, but the number of nurses has decreased.
- The resulting heavy workload of nursing staff has led to increased sick-day absenteeism.
- Individual interviews between management and nursing staff on stress factors and needs improved presence.
- Training focused on mental and physical health of nursing staff improved performance.

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Must-Attend Healthcare Events

Several important healthcare events are taking place around the world in February and March 2020, providing insight into the latest advancements and technologies in healthcare, and highlighting current trends and future opportunities. Medlab Middle East, World Patient Safety, Science & Technology Summit and HIMSS Global Health Conference & Exhibition are perfect destinations for networking, learning and practice.

Medlab Middle East

3–6 February 2020, Dubai World Trade Centre, Dubai, UAE

This upcoming world-class exhibition themed 'Transforming Diagnostic Innovations,' is a live experience for business combined with the only CME accredited multidisciplinary congress.

During the exhibition, 600+ manufacturers from 35+ countries will present products in 80+ categories. In total, 11,500+ attendees and 4,550+ delegates from 135+ countries are expected to take part in this year's Medlab events.

The congress participants will be able to visit 12 CME accredited multidisciplinary conferences dedicated to laboratory management, immunology, clinical chemistry, microbiology, histopathology, blood transfusion medicine, molecular diagnostics and genetics, haematology and points of care testing.

There will be two new fields as well. Those attending the Laboratory Innovation conference will focus on enhanced diagnostic efficacy, explore the latest updates in mass spectro-

metry and assess the potential for the use of stem cells in therapeutic treatment. The second new conference, Digital Pathology, will provide information on the benefits associated with digital pathology and its role in workflow issues, among others.

A novel conference format is the focused scientific group discussions on selected topics in the medical laboratory.

Live Health Connect, a free-of-charge online portal, is open to both visitors and exhibitors, allowing them to network and mingle during the event.

An all-new dedicated Transformation Hub will showcase advanced clinical laboratory products by SMEs.

Transformation Talks is another special feature aimed at engaging potential buyers in educational sessions where manufacturers discuss products and in-demand solutions.

In the Education Zone participants will be able to discover clinical researches and projects in laboratory medicine through poster display and oral presentations.

More information: medlabme.com

2020 World Patient Safety, Science & Technology Summit

6–7 March 2020, Waterfront Beach Resort, Huntington Beach, California, USA

Patient Safety Movement Foundation (PSMF) invites hospital leaders, medical and information technology innovators, government officials, patients, families and advocates to explore solutions for eliminating hospital errors around the world. The Summit is organised in partnership with the International Society for Quality in Health Care (ISQua), the American Society of Anesthesiologists (ASA) and the European Society of Anaesthesiology (ESA).

Scheduled panel topics include:

- Educating the Youth
- Safety Policy & Incentives
- Advocacy
- Electronic Health Records
- Health System CEOs.

There will be prominent speakers, such as Joe Kiani, Founder & Chairman, PSMF, and Founder, Chairman & CEO, Masimo; Mary Dale Peterson, President, ASA; Peter Lachman, CEO, ISQua; Marc Gheeraert, CEO, ESA; David B. Mayer, CEO, PSMF, and Executive Director, MedStar Institute for Quality and Safety; Michael A.E. Ramsay, Incoming Chairman, PSMF; Chairman, Department of Anesthesiology and Pain Management, Baylor University Medical Center; President, Baylor Scott & White Research Institute; Jeremy Hunt, Former Secretary of Health and Human Services, United Kingdom; Wilhelmina Jallah, Minister of Health, Republic of Liberia; Kenneth Samet, CEO, MedStar Health; and Jim Hinton, CEO, Baylor Scott & White Health.

For the first time, this year's Summit offers a Pre-Summit Symposium on 5 March, 2020, where attendees will present how their hospitals have achieved improved patient safety outcomes through process improvement, or share the processes they have in place to get there.

At the Summit, PSMF will also recognise the most influential advocates in patient safety and present them

with the Steve Moreau and Beau Biden Humanitarian Awards.

More information: patientsafetymovement.org/summit

2020 HIMSS Global Health Conference & Exhibition

9–13 March 2020, Orange County Convention Center, Orlando, Florida, USA

Nearly 45,000 providers, innovators and market suppliers from 90+ countries are expected to attend this can't-miss health information and technology event of the year.

The event includes 350+ education sessions from industry leaders, renowned keynote addresses and specialty, niche programmes to meet distinct needs. There are 17 topic categories, including, but not limited to:

- Applied Artificial Intelligence and Machine Learning
- Biomedical Informatics or Healthcare Informatics
- Consumerisation and Patient Experience
- Cybersecurity, Privacy, or Security
- Health Information Exchange or Interoperability
- Leadership, Governance, or Strategy
- Population Health or Public Health.

On 9 March 2020, a number of pre-conference events are taking place. There will be forums and symposiums on ageing and tech, revenue cycle optimisation, patient engagement and experience, big data, blockchain, career development, consumerisation, digital health, and nursing informatics, to name a few.

Exhibition and Specialty Exhibit Areas attract 1,300+ diverse participants including 420 first-timers. There are various specialty exhibit areas, of which two, Consumerism/ Patient Engagement Pavilion and Value of Healthcare are new.

During the event, additional specialty education programmes are offered, as well as investment and entrepreneur activities designed for building 1:1 connections and matchmaking with innovators, investors, accelerator programmes and industry analysts among others.

More information: himssconference.org

ECR 2020

11-15 March 2020, Austria Center, Vienna, Austria

The European Congress of Radiology (ECR) is the annual meeting of the European Society of Radiology (ESR). ECR is one of the largest medical meetings in Europe. It is also the second-largest radiological meeting in the world, attracting more than

30,000 participants from more than 130 countries. ECR is not only the annual meeting of ESR, but also the European Federation of Radiographer Societies, and the European Society for Hybrid, Molecular and Translational Imaging. The attendees at the Congress span all areas of the radiology arena including radiology professionals, radiographers, physicists, industry representatives and journalists.

The slogan for ECR 2020 is "A Clear Vision for Radiology." This year, the Congress will once again offer a complete package with keynote lectures, refresher courses, interventional hands-on training, ultrasound workshops, radiographers' programme, custom-made courses for physicists, research sessions and presentations, clinical trials in radiology, case-based diagnosis training, and a look into the fascinating world of artificial intelligence. An important addition this year will be the Children in Focus programme which will explore healthcare and social issues affecting children and young people. New Horizons Sessions, State of the Art Symposia and Special Focus Sessions will enable young radiologists and experts in particular radiological fields to have access to, and choose from, many interesting sessions in all areas of radiology. The Congress will also cover emerging and hot topics such as lung cancer screening, stroke diagnosis and treatment, and many others.

As far as the 'ESR meets' component is concerned, ESR 2020 will feature Canada and Israel as well as a single session with Slovakia, Slovenia, and Croatia. There will be presentations from both Canada and Israel that will talk about innovations, technology, and artificial intelligence. Slovenia, Slovakia, and Croatia are quite similar in terms of their medical systems and their practice of radiology and presentations from their end will focus on cardiovascular and interventional radiology and interventional neuroradiology.

As always, it is expected that ECR 2020 will once again be a dynamic, innovative, and service-oriented congress.

More information: myesr.org/congress

Last but not least, the 2020 edition of Arab Health, the MENA region's largest professional healthcare event is taking place on 27–30 January 2020 in Dubai, UAE. This year it is hosting 55,000+ attendees and 4,250+ exhibiting companies from 159 countries, and the 45th Arab Health Congress is attended by 5,200+ peers. We are looking forward to meeting you there!

Upcoming Issue

Cover Story: The Future is Digital

We have both a data gold mine and a data problem. How can we utilise data for best treatments? Where do we have to change our perspective and investment policies to follow new paradigms? What short and long-term strategies should hospitals adapt to stay ahead? What are the best examples already implemented and what is still lacking?

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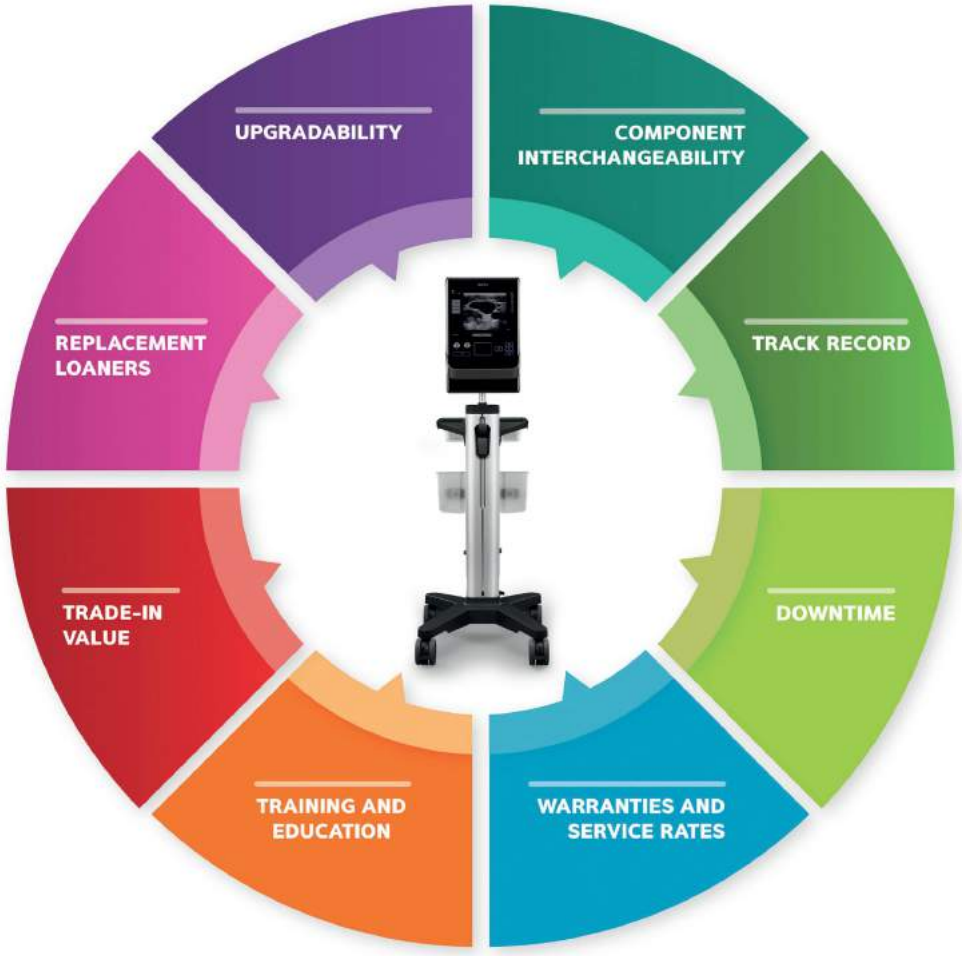

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1. Data on file and from public sources, 2017. **2.** Results from Friedewald, SM, et al. "Breast cancer screening using tomosynthesis in combination with digital mammography." JAMA 311.24 (2014): 2499-2507; a multi-site (13), non-randomized, historical 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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