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Artificial Hype

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Artificial hype

Radiologists, more than any other medical specialty, feel the professional and emotional 'whiplash' that began five or so years ago. Vanishing jobs (transforming radiologists into production units) for cost over quality for our patients, to the current shortage and need for more radiologists. AI introduced the threat that automation would take what few positions remained; now we know it can be a powerful tool.

Of the most aggressive debates in medicine is AI vs. physician vs. job. AI, VR, AR, deep/machine learning, 3D printing, developed faster than we imagined. Nevertheless, they are here. While for the most part, massive clinical implementation is still another five or more years away, it is coming. This month, the U.S. launched the American Artificial Intelligence Initiative and other countries will have to follow, sooner or later.

Will AI automatically extract information and present it without the presence of a physician? Yes, this may be quite threatening. Radiologists must justify every examination we perform. Imagine a department, like ours, reaches 400.000 examinations per year- it is impossible! Add to this, we know that about 20 to 30% of examinations we perform are useless. We need to diminish this waste in our healthcare systems and the harm it causes our patients.

This is the renaissance of radiology. AI can empower, raise and place the radiologist in the centre of healthcare. All physicians must take an active role, radiologists especially, to seize this unique opportunity to lead innovation and drive the changes in our field. We can actively be part of the inception and development of new tools, and help shape them to fulfill our needs and expectations rather than be forced to adapt.

AI implementation, however, is no simple matter. Ultimately it needs infrastructure, significant financial commitments, extensive research and clinical trials to replace the tangible practice we're called upon to provide every day.

In this issue, HealthManagement.org ventures beyond the AI 'hype.' We discuss digital ethics, can machines be moral, and how AI may impact imaging. Experts in the field analyse AI - the 4th healthcare revolution, how to become an AI-powered radiologist, and present state of the art applications in breast imaging. Furthermore, we look into using gamification and VR for ultrasound training and clinical ultrasound in the age of AI. How far are we really from the vast power of AI to act in conjunction with- or instead of- the medical professional?

In our Management and Winning Practices we highlight how trust in teams leads to better healthcare, innovations in paediatric rehabilitation, cardioprotection and lifespan extension by caloric restriction. We host a critical review of muscle injuries in professional FCB players, and present the 'one stick standard' for vascular access. We talk about value-based healthcare and the doctor-patient relationship and the role of social media in healthcare.

If you are a radiologist in a dark reading room, dealing with hundreds of exams, images, creating reports, with limited exposure to your clinical colleagues, you may feel the pressure that AI equals 'danger.' My impression is to embrace the vast potential of AI to open medical departments, go out into the clinical wards, be active in multi-disciplinary teams and be more 'clinical.'

So will AI replace physicians? Absolutely not. ■

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What Do You Think?

Artificial Intelligence capabilities and applications are growing exponentially but how far are we really from the vast power of AI to act in conjunction with- or instead of- the medical professional? In this issue, we try to separate AI fantasy from reality. As a leading digital and print publication on healthcare management and leadership, there are many ways to share your expertise and join our faculty of highly-esteemed contributors. To contribute, contact us on **edito@healthmanagement.org**

EXEC

GUEST AUTHORS

Mahmoud Abdellatif, Simon Sedej
Revitalising the aged heart through spermidine-rich diet, p. 173

Tracy Accardi
Why embracing Artificial Intelligence is beneficial for all, p. 112

Chelsea Beecher
NYC Go Red for Women movement: STEM Goes Red, p. 90

Maurit Beeri, Eliezer Be'eri
Innovation in paediatric rehabilitation, p. 193

María Jesús Díaz Candamio
The AI-powered radiologist, p. 148

Margaretta Colangelo, Dmitry Kaminskiy
AI in medical imaging may make the biggest impact in healthcare, p. 121

Richard Corbridge
Artificial Intelligence: a next way forward for healthcare, p. 118

Lluís Donoso-Bach
Artificial hype, p. 81

Catherine Estrampes
Unleashing the full potential of AI, p. III

Patience Fagbenro
How following steps for quality impact healthcare consumerism, p. 167

Luciano Floridi
AI opportunities for healthcare must not be wasted, p. 110

Jürgen Fortin
State-of-the-art syncope assessment, p. 176

Marina Gafanovich
Value-based healthcare and the doctor-patient relationship, p. 162

Mathias Goyen
Can machines behave morally enough for healthcare?, p. 116

Rowland Illing
Operationalising AI in radiology, p. 126

Jaime Isern-Kebschull, Sandra Mechó, Ricard Pruna, Xavier Yanguas, Xavier Valle, Xavier Alomar, Jaume Pomes, Javier Martinez, Gil Rodas
Critical analysis of MRI-based classification systems for sport muscle injuries, p. 180

Marianna Keen
Understanding bad communication, p. 96

Werner Leodolter
AI-based prediction in clinical settings: can we trust it?, p. 114

Daniel A. Lichtenstein
Clinical ultrasound in the age of artificial intelligence, p. 154

Christian Lovis, Luciano Floridi, Rafael Vidal-Perez, María Jesús Díaz Candamio
Will AI lead to job cuts or will the tech improve working lives?, p. 108

Kevin McQueen
Achieving zero avoidable patient deaths by 2020, p. 188

Iris Meyenburg-Altwarg
Nursing on the move: cross border hiring, p. 164

Nidhi Nikhani
The "One Stick Standard" for vascular access, p. 170

Robert Pearl
Artificial Intelligence in healthcare: What is versus what will be, p. 104

Paul Sidhu
Future of ultrasound: where are we going?, p. 128

Erin E. Sullivan
Trust-abundant team principles, p. 94

Jonas Teuwen, Nikita Moriakov, Ritse Mann
AI applications in breast imaging, p. 157

Vass Vassiliou
The role of social media in cardiology, p. 178

Ian A. Weissman
AI is the new reality: the 4th healthcare revolution in medicine, p. 100

TABLE OF CONTENTS

HealthManagement • Volume 19 • Issue 2 • 2019

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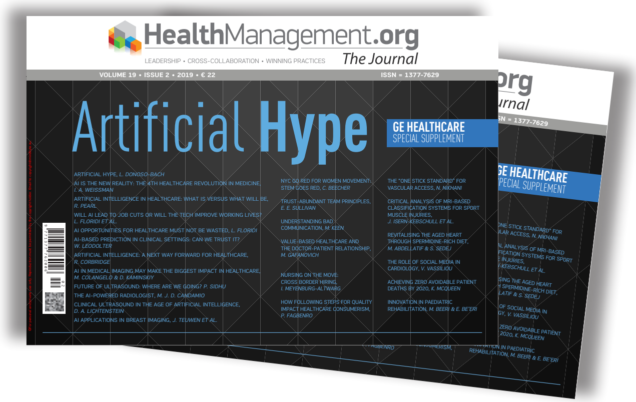

TABLE OF CONTENTS

HealthManagement • Volume 19 • Issue 2 • 2019

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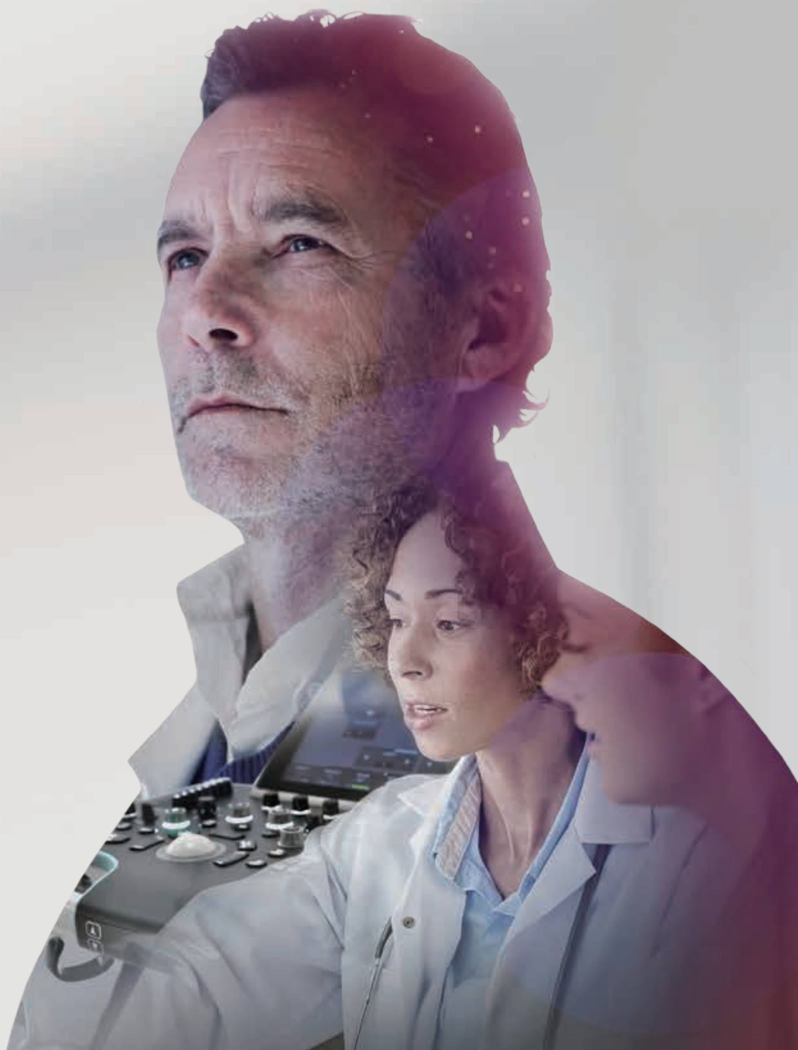

NYC Go Red for Women movement: STEM Goes Red

Chelsea Beecher, Director of Development for the American Heart Association spoke to HealthManagement.org about the STEM Goes Red Movement, highlighting its goals, impact and future outlook.

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Chelsea Beecher serves as the Director of Development for the American Heart & Stroke Association in New York City. Chelsea passionately works to develop partner focused relationships that engage employees, clients, and consumers, and the community, ultimately powering AHA's mission: to be a relentless force for a world of longer, healthier lives.

Chelsea led the launch of STEM Goes Red in New York City and received the Innovator of the Year Award in 2018 for this initiative. STEM Goes Red aims to empower young women to pursue science, technology, engineering, and math (STEM) careers, and arm them with tools and resources to experience good health and wellbeing. The initiative is successfully inspiring high school girls to pursue STEM degrees in higher education, and closing the gender gap in STEM careers.

As the No. 1 killer of women - claiming the lives of 1 in 3 women - cardiovascular disease forces us to consider that a woman we know and love may be affected at any age. Beating heart disease and stroke means more time for women to be change makers, business leaders and innovators, and more time to be moms, sisters, partners, and friends.

Chelsea Beecher spoke to HealthManagement.org about the NYC Go Red for Women Movement: STEM Goes Red, providing more insight into the primary goals, impact and future outlook of this initiative.

You recently received the Innovator of the Year Award for launching STEM Goes Red in NYC. Could you tell us something about the NYC Go Red for Women Movement: STEM Goes Red?

Heart disease is the number 1 killer of women, killing more women than all forms of cancer combined, but nearly 80% of cardiac events can be prevented. The American Heart Association rallies women to become aware of their risks and provides simple, actionable steps for improving their overall health and wellbeing through the Go Red for Women movement.

STEM Goes Red is a new initiative of the Go Red for Women movement to empower high school girls to pursue science, technology, engineering, and math careers and become driving forces for health in their communities.

"STEM GOES RED IS A NEW INITIATIVE THAT AIMS TO EMPOWER YOUNG WOMEN TO PURSUE SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM) CAREERS"

What are the primary goals of the STEM Goes Red movement?

There are 3 primary goals of the STEM Goes Red movement:

1. Empowering the next generation of future female STEM leaders – Millions of STEM jobs are becoming available, but there are not enough skilled workers to fill them. Moreover, women are highly underrepresented, occupying only 24% of jobs in STEM-related fields. It's predicted that by 2030, half of all vacant STEM jobs will be in the healthcare sector. We want to ensure that the brightest minds are working to help us find cures for heart disease and stroke and helping us to live healthy.

2. Breaking down barriers to better health – Wealth and education are key social determinants of health, and we want to ensure that healthy living is not a luxury. For example, there are 1.2 million people in New York who are affected by food deserts with no access to fresh foods. We need to change that! While we work towards health equity, making the healthy choice the easy choice no matter where you live, work, learn, play, or pray, we want to enlighten young women to the potential that a job in STEM will provide them. Women with STEM jobs earn up to 35% more than comparable women in non-STEM jobs, and 40% more than men with non-STEM jobs. This type of salary will allow them to live in a safe environment with walking paths that provide the opportunity to be more physically active, and the ability to shop for the fresh food and produce at the local store.

3. Inspiring a commitment to be healthy for good

The high school years are a pivotal time in life, an exciting, but also a stressful time, when young women are becoming more independent, taking standardised tests, applying to college, moving away from home, starting relationships, and so on and so forth. We want to be there to support them! Through STEM Goes Red we provide tools and resources for eating smart, moving more, and being well. We want to prevent bad habits from forming because bad habits are hard to break.

What role do you think the STEM Goes Red movement can play in tackling heart disease?

Through our health messaging and prevention efforts, we are saving lives by stopping heart disease before it starts.

By providing young women with the chance to come together to connect with established female leaders, we believe that they will walk away with the support system and confidence to pursue their dreams. The American

Heart Association has funded 13 Nobel Prize winners (none women). We hope we will have inspired a future female Nobel Prize winner, a scientist, researcher, cardiologist, neurologist, or anyone who will diagnose, treat, or prevent or cure heart disease or stroke.

Can you give us any specific examples as to how this movement has made an impact on the management/prevention of heart disease?

Go Red for Women (GRFW) is celebrating its 15 year anniversary. Today, more women than ever recognise that a woman's leading cause of death is heart disease.

- 6 out of 10 women have either heard of the GRFW initiative or have seen the GRFW logo
- 91% of GRFW supporters reported having made healthy lifestyle changes
- $482M raised by GRFW luncheons to support research, education, advocacy, prevention, and awareness programmes
- 3.6M+ women digitally interact with GRFW across all its platforms

Currently, the STEM Goes Red Movement is only active in the US. Do you have any plans on expanding it or taking on a more global approach?

Go Red for Women launched in 2004 as an awareness campaign and quickly grew into an international movement and has become a platform for real change. The inaugural full-day STEM Goes Red event in NYC impacted 100 high school girls, and over 2,000 female students participated in events across the country. Our goal in NYC, and I imagine in STEM markets across the country, is to provide more year-round engagement and reach more local students. I expect that STEM Goes Red will reach a global scale much like Go Red for Women, which is now in 42 countries.

The gender gap in the field of cardiology has been highlighted quite a bit in the recent months. What do you think needs to be done to reduce this gap?

What's interesting is that emerging research suggests female heart attack patients have better outcomes when treated by female physicians. We need to increase the number of women who are treating women in healthcare, researching conditions that affect women differently than men, and creating products and resources for women that help them live better. By uniting women of all generations around our mission to be a relentless force for a world of longer, healthier lives; by enlightening young women to the need and possibilities that exist in healthcare; and by igniting the potential that lives within these girls, we can close the gender gap and reduce the mortality rates from cardiovascular disease in women.

You are also actively involved with the Heart & Stroke Innovation Forum organised by the American Heart Association? Could you tell us something about that?

Prior to leading STEM Goes Red, I helped launch the Heart & Stroke Innovation Forum, which was an annual event in NYC that brought together world-renown experts and leaders in academia, industry, and investment for a collaborative discussion on the innovations and issues impacting cardiovascular care. The objective of the Heart & Stroke Innovation Forum was to spark ideas that would benefit the healthcare ecosystem and, ultimately, advance the mission of the American Heart Association. While the NYC event no longer exists, the AHA has since launched the Center for Health Technology and Innovation and a conference of its own, the AHA Health Tech & Innovation Forum, which is an invite-only event from Nancy Brown, CEO of the American Heart Association.

For anyone, men or women, interested in joining these efforts in NYC, Chelsea Beecher can be reached at Chelsea.Beecher@heart.org. For more information on the Go Red for Women movement, please visit **goredforwomen.org**. ■

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Trust-abundant team principles

Effective models of trust

How can you incorporate the all-important ingredient of trust within your healthcare team?

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Once upon a time, it was possible for a doctor to hold most of what she needed to know to practice medicine within her own brain. This was long before Google and before medicine was carved up into specialties and sub-specialties. The advances brought on by the information age and technology mean that no individual can know all there is to know anymore. And this isn't just in medicine. It has happened in most other industries. In fact, in the 1990s, teams became the new corporate structure to deal with complexity. And, today in healthcare, we need teams to deliver care and solve complex health problems.

Now when I say complex, I don't necessarily mean hard. Let me explain what I mean.

Not long ago, I had an endocrinologist explain that she wanted to convince primary care physicians to keep non-compliant diabetics in primary care. In terms of influencing patients who are not compliant with medication, her training and the training of a primary care doctor is the same. The endocrinologist wants to see the diabetics who have failed three different types of insulin. That is the type of problem she is trained to solve.

That's a hard problem, but it's a simple problem. And simple problems don't require teams.

Specialists are great for simple problems that are hard.

On the other hand, non-compliance is actually an easy problem. The patient needs to take their medication every day. Easy, but complex. Consider that the possible reasons for a patient's non-compliance may stretch beyond simply forgetting to take the medication, maybe the patient cannot afford the medication, or afford the food the patient needs to take the medication with or maybe the patient doesn't have a stable home with a refrigerator to store the medication.

"BUILDING TRUST IN TEAMS INVOLVES CHANGING THE DOCTOR'S ROLE FROM COMMANDER TO TEAM LEADER, AND GIVING SKILLS TO LEAD"

That's a problem that doesn't need a specialist. It needs a team. A team that patients trust. A team that trusts its processes. Most importantly, a team that trusts each other. There is no team- whether it is a sports team or a healthcare team- that will thrive when trust is scarce. Scarcity of trust will kill a team. However, successful trust-abundant teams are possible. Most of my research has focused on exemplar primary care organisations, and as part of that research I've had the ability to observe and interview many bright spot teams. On these teams, trust is actively grown in as many ways as possible; and here is what I've learned:

Put the patient on the care team, and at the centre of the care team

All of the organisations I've studied were highly patient-centred, emphasising individual patient preferences and ensuring patient values guided clinical decisions. Sites articulated sincere deference to the patient and their articulated needs, which often translated to patients defining their own goals, often in personal, or social terms as opposed to disease-centric terminology. Most organisations were also aggressive in actively soliciting, responding to, and incorporating patient feedback in order to keep their practice patient-centred; one site collected patient feedback using eight different methods (eg iPad surveys in the clinic, email, customer service phone numbers).

Make the physician a team leader, when possible/practical

It is possible to break away from a trust-scarce model where the doctors supervise every aspect of a patient's care. Building more trust in teams involves changing the doctor's role from commander to team leader, and giving the doctor the skills to lead (which are generally not taught in medical school). One organisation spends six months "untraining" each physician they hire, which means changing the hierarchical mindset physicians typically learn in medical school and residency. This site teaches physicians to rely on each team member's expertise, effectively sharing the ownership for patient care amongst the team, so that the physician has time to lead the team and manage the most complex patients.

Not all trusting teams must be physician led

While it is great to make physicians team leaders, not all healthcare teams must be led by physicians. One organisation cared for the most complicated and complex patients within their catchment area, and operated without a physician as part of their team structure. The multi-disciplinary care teams were led by social workers and staffed by health coaches, community health workers and licensed practical nurses. The only physician within this organisation was the CEO who fully trusted his teams' ability to effectively care for patients.

Trust forms the basis for all the relationships within the system

A number of organisations were explicit about making trust a core value of their system; trust mattered not only between the patients and physician/healthcare team, but also between all employees. Employees used daily check-ins, team huddles, and larger meetings as opportunities to connect with others and build trust on their team or within their organisation. In a few of our bright spots, we learned that the metrics of trust looked different from most healthcare metrics. Highly functioning, trust-abundant teams meant that physicians had more time at home with their families, as they were not coming in early, staying late, or working at home. Further, most sites realised that they had to work in partnership with other specialties and partners outside the four walls of their practice, so they had to build trust (and relationships) at multiple levels within the system.

Support top-of-license work through technology and training

The organisations I studied had fully empowered individuals to work at the top of their license through technology and well-designed onboarding and ongoing training. At one site, customer service representatives, who typically had a high school level education, were initially trained for six months in the practice's technology and processes. (The practice's improvement coach also provided ongoing training and process updates on a regular basis for the entire team). The customer service representatives, when fully trained and operating at the highest level, were using the practice's technology to queue prescription refills for provider approval. They were also triaging patients using the practice's decision-support technology. The customer support team, as a result, was highly engaged, enthusiastic about their work and felt as if they had an integral role in caring for the practice's patients. The physicians heavily trusted this team to take on many routine and administrative tasks which allowed them to spend more time on patient care.

The absence of fear is trust

I visited one organisation at a time that was particularly challenging. As a result, the practice held a "team morale meeting" one morning to address staff feeling overstretched. This morale meeting demonstrated that the practice had developed important organisational habits. Despite some high-stress issues, everyone was speaking equally and contributing to the conversation as well as sharing opinions and ideas. This meant that the front desk administrator and physician contributed equally to the conversation about morale, and maybe more importantly, to the list of action-based solutions the team was going to try to make improvements. In this room, the absence of fear built trust and allowed the team to move forward.

So, what will you build? What type of team would you rather join? A trust-scarce team or a trust-abundant team? ■

KEY POINTS

- ✓ Some problems require a specialist; others require a team
- ✓ Teams cannot operate well without trust
- ✓ Patient-centred teams develop trust
- ✓ Teams don't always need a hierarchy to function successfully

Understanding bad communication

Deter defensiveness, solve problems

Chris Argyris' insights on bad communication and defensiveness are the building blocks for organisational communication.

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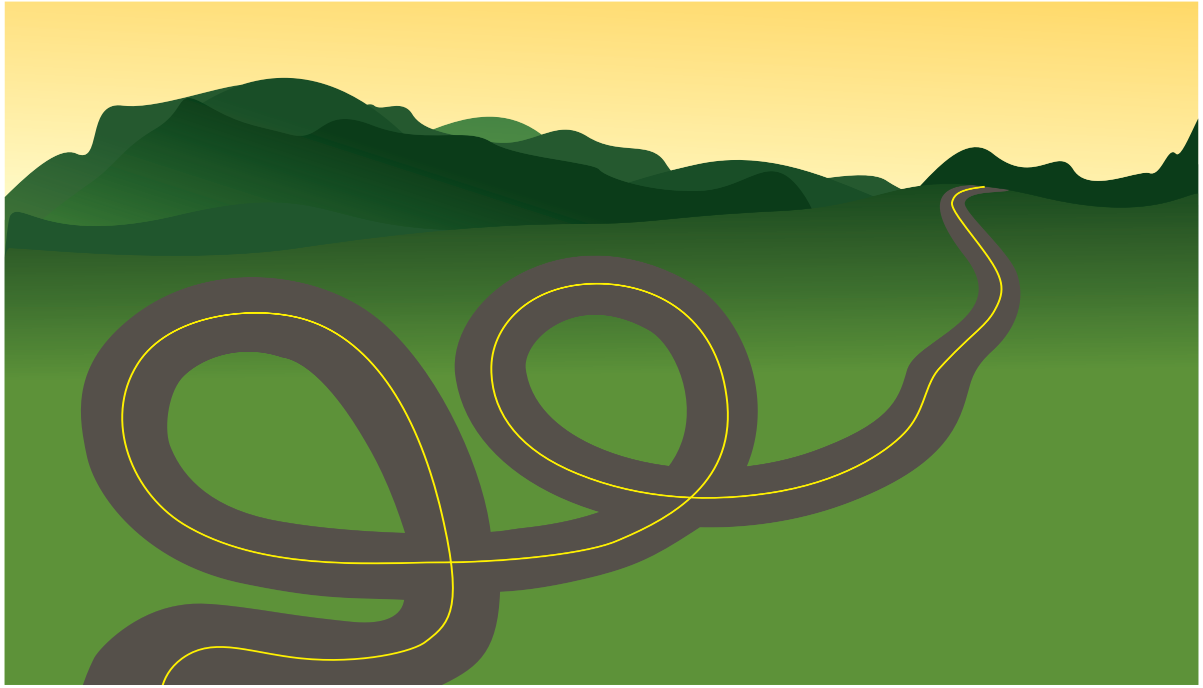

A celebrated business theorist, Chris Argyris (1923-2013) was James Conant Professor of Education and Organizational Behavior Emeritus at Harvard Business School. His concepts form a large part of modern organisational development and organisational learning theory. An iconic and well-known part of his philosophy is the idea that double-loop learning, which questions underlying assumptions and behaviours, is far more effective than superficial single-loop learning. Argyris and Schön (1978; 1996) asserted that open communication, usually considered a good thing, could in fact block learning and hinder progress. You can get communication all wrong, which is a worrying concept for all leaders, and many falter when it comes to tracking good and bad communication. Others have not even differentiated between beneficial and detrimental interaction. Recognising the differences is the first step towards orchestrating change; many of Argyris' theories can guide acknowledgment and action.

Recognise bad communication

In an era where organisations need to be flexible and respond well to change, bad communication can suppress successful adaptation. Modern organisations recognise individual accountability as important, but unhealthy communication can stifle this. Leaders should identify negative types and patterns of communication. According to Argyris (1985; 1990), those that impede learning and progress include those based on:

- Defensiveness
- Denial of real problems
- Inability to face tough issues
- Refusal to examine one's own attitudes and contributions to the problem.

Monitor communication

Managers and leaders who spend time on the front line, engage in group discussions and form focus groups will significantly increase their chances of identifying unhealthy and damaging communication within the organisation, but only if done in the right way, asking the right questions, expressed Argyris (1990, 1994). They will also set the landscape on which staff can build positive relationships. Argyris observed that the methods many executives use to tackle relatively simple problems actually prevent them from getting the kind of deep information, insightful behaviour and productive change they need to cope with the much more complex problem of organisational renewal. Discussing failure, learning from disaster, confronting disappointment and pointing out sub-standard performance are crucial. Also important are questioning procedures in place and recognising the need for change. Leaders should encourage and participate in all of these, with the emphasis on learning and praise rather than blame and punishment.

Enrich relationships

What we learned from Argyris is that relationships and communication need to be developed to incorporate truth, compassion and realistic insights. It's not all about regular contact between staff members and departments, but about deep, constructive and courageous communication with continual feedback that minimises defensiveness or fear. Start by making your staff comfortable, accentuating that there will be no negative consequences to honest remarks; then ask them where they feel there are problems in company culture, staff attitudes, and even leadership. Show a personal interest in their opinions, motivation and attitude. Delving into psychology and sociology will help you to better understand your organisation.

The type of communication managers encourage should reflect on all staff's work and behaviour and encourage individual accountability. By initiating discussions that incorporate double-loop learning, core issues will begin to surface—problems that are the root of bullying, blame, fear, defensiveness, complacence, low morale and low quality healthcare.

Lead in the right direction

A willingness and openness to take on whatever issues might surface is key to this step in organisational management—a step that can take you away from disorganisation and towards a more manageable company. It will bring to surface the kinds of deep and potentially embarrassing information that threatens the current status quo but can motivate learning and produce real change.

Argyris (1994) noted that, in his experience, executives often know in advance where the worst inefficiencies might be found, and often complain that the problems need to be sorted. The problem usually goes far deeper. An important—and difficult—thing to consider is how you, as a leader, are helping to inhibit progress. What problems are you ignoring, whitewashing or perpetuating? Putting "reflection into action" is key according to Argyris. This involves not only making improvements but questioning behaviour and beliefs.

Argyris noted that executives cited the blindness and timidity of management as barriers to the much needed change to clear problems. They also blamed interdepartmental competitiveness verging on warfare and a company culture that made it unacceptable to get others into trouble for the sake of rectifying an issue. Here, loyalty means turning a blind eye, denying responsibility and passively watching inefficiencies develop and persist—not a beneficial form of loyalty. Argyris identified cost reduction as a second problem. Alongside striving to meet budget requirements, leaders need to encourage accountability and constructive discussion that acknowledge and resolve problems of all kinds.

Scrutinise mixed messages

Remember that understanding employees' feelings can be confusing. Argyris (1994) found that staff were often proud to work for a company despite finding managers inconsistent and ineffective. He established that employees were satisfied because they were not made to take responsibility for the bad state of affairs. They were not committed to the company in the way managers had in mind; they were merely relieved they could rely on executives to sort out the mess and pay their salaries. Giving staff higher responsibilities can achieve motivation that involves commitment to high performance.

Recognise defensiveness

Defensive reasoning

Are you aware of defensive reasoning taking place when there is a threat of embarrassment or damage to somebody's ego or to the department? This sort of reasoning is often what prevents resolutions to problems, Argyris (1985; 1990) found. Even when people believe they are protecting themselves and others, they are actually causing damage in the grander scheme of things, and preventing learning. Perhaps you yourself are performing such reasoning; Argyris (1980) explained that this mental model is formed early in life to deal with emotional and threatening issues, so some people may not be fully conscious of their defensive reasoning. This is why questioning one's own thought processes and behaviour is important.

Organisational defensive routines

Argyris (1990; 1993) found that organisational learning is inhibited by defensive routines. These various policies, practices, and actions are put in place to prevent people from having to experience embarrassment or threat. Simultaneously, they prevent staff members and leaders from examining the nature and causes of that embarrassment or threat. To successfully apply double-loop learning, it's important to keep asking yourself: am I only hearing what I want to hear, or sending mixed messages? Ensure that you carry this philosophy across to the implementation stage.

Break the status quo

A change in a leader's attitude will trickle down to others in the organisation and present an adaptable and effective working environment from which growth can occur. Argyris and Schön (1978) found that executives had good intentions in terms of candour, forthrightness, and commitment building in the face of changes; however, when it came to it, they dealt with the resistance they expected from subordinates by easing in, covering up, and avoiding candour and plain speaking. Many did not acknowledge that if the approach didn't work, they could look at alternatives, so employees would not be forced to adopt change that didn't work for them—something which would again be detrimental. Argyris and Schön (1978) suggest that to achieve what they call Organizational II learning, an interventionist strategy needs to be formed and implemented which involves staff to map and solve problems, and which embeds learning agents, discoveries and evaluations into not just individuals' but organisational memory.

Double-loop learning in modern hospitals

Modern clinics that incorporate a value-based healthcare system are now exploiting big data and producing algorithms, using technology to bring learning into the double-loop concept. Wearable devices and big data are helping to share all kinds of patient data, but sharing staff data is also important. Successes, failures, experiences and all kinds of information are shared between staff and they are able to learn from one another. At first, some employees may be nervous about sharing their data and may be untrusting of the technology, but with positive communication and time to adapt they can start to use the information without fear. Staff can be educated with the help of outcome data and comparison tables without the inference of competition. Applying Argyris' ideas, change management should involve regularly challenging behaviours and assumptions so that areas can be identified where positive change can be achieved.

Avoid falseness, overcome delusions

The emphasis on being positive condescendingly assumes that employees can only function in a cheerful world, even if the cheer is false, expressed Argyris (1994). But his theory recognises that problems will inevitably arise in all organisations, and all staff need to accept this and be ready to respond accordingly. You're not expected to wade through the muck with a smile on your face, but to at least keep your eyes open so you can navigate towards the clearer water ahead. Surely that's better than prancing through the muck with a smile, only because you're pretending it's a field of daisies. You can only keep up the delusion for so long. ■

KEY POINTS

- ✓ The wrong type of communication can inhibit learning and hinder progress
- ✓ Defensive staff in defensive organisations will impede problem solving
- ✓ Double-loop learning, questioning your own assumptions and behaviours, is key
- ✓ This can help leaders to recognise social, psychological and organisational issues in the company
- ✓ Leaders should acknowledge any defensive reasoning of their own and lead the way

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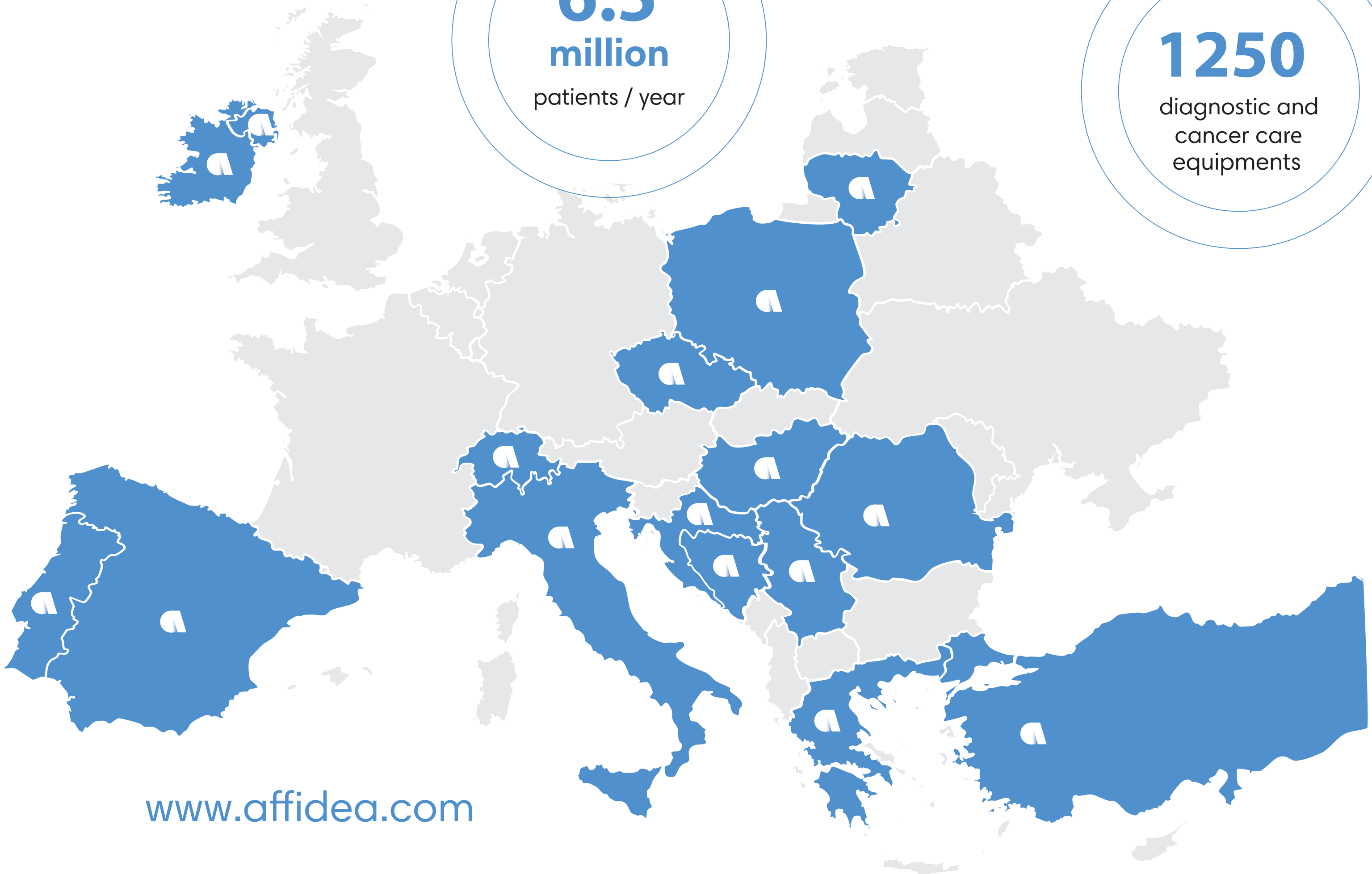

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AI is the new reality: the 4th healthcare revolution in medicine

AI: Hype? Rather, augmented intelligence is the fourth healthcare revolution in medicine and will lead to improved patient care.

The future is bright, if we continue to develop creative solutions to improve patient care, in collaboration with deep learning algorithms, then we'll again have succeeded in advancing medicine into a new healthcare revolution, more evolved and sophisticated, to benefit clinicians and patients.

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When George Hinton PhD, noted computer scientist and godfather of neural networks, stood in front of a large crowd at the Creative Destruction Lab in Toronto in late 2016 and proclaimed that, "Radiologists would be out of a job in 5–10 years," his statement was the modern "shot that was heard around the world"(Mukherjee 2017).

Since then, Dr. Hinton has toned down his rhetoric a bit with statements like,"The role or radiologists will evolve from doing perceptual things, that could probably be done by a highly trained pigeon, to doing far more cognitive things."

Faced with the modern-day challenges of healthcare, the pigeon may rue the day that it entered the medical profession. The reality is that it's becoming increasingly more difficult to practice value-based medicine in today's climate of volume-based medicine. The days of having time to be able to review the patients' chart, compare old films, speak to the referring physician when necessary, communicate critical findings to the patient in timely fashion, and be available to answer questions is falling away with the increasing complexity of imaging, and the multifactorial workload challenges.

Since it is unlikely, in the near future, that administrators will tell radiologists to forget about metrics and relative value units (RVUs), and instead focus on providing a value-based interpretation for the patient, new solutions are needed to deal with the increasing workload challenges while continuing to provide value for the patient and referring clinician.

Fortunately, we now live in an exciting time of deep learning, and solutions are on the horizon. Artificial Intelligence has in fact been around since the 1950's. Isaac Asimov published his "three laws of robotics" in 1950, and the first AI conference was convened at Dartmouth College in 1956. Robby the Robot appeared in the 1956 classic science fiction film, Forbidden Planet, and since then our collective imagination has taken off with dreams of what robots and artificial intelligence can do for human kind.

Machine learning evolved in the 1980's, but it wasn't until high performance computing hardware: graphics processing unit (GPU)/tensor processing unit (TPU)/Quantum-based gaming technology became available to run sophisticated video games like Xbox that deep learning became a reality in 2010. Deep learning (using convolutional neural networks) is now driving advances in medicine in areas of research such as drugs and vaccines, medical devices, medical imaging, and radiogenomics.

Image-omics (radiogenomics or deep learning applied to radiological images) will be a very powerful tool since tissue-based genomics isn't able to sample other parts of the tumour, the phenotype, gene-gene interactions, or the host response. The days of just describing a mass on a study will evolve into a more sophisticated approach, using radiogenomics to detect the molecular and phenotypic properties of the entire tumour, which will improve the patient's treatment.

The number of AI-related publications has increased from less than 500 between 1952-1992 to over 6000 in 2017 (**ncbi.nlm.nih.gov/pubmed**). The increasing number of research publications in AI is being driven by much more available computational power, improved techniques, critical theoretical advances, large capital investments in technology, and large amounts of available data (cloud and open source). The advantage of deep learning is that it identifies features and connections, versus just connections, that leads to rapid improvements in its performance.

"THE IMPORTANT THING NOW IS FOR RADIOLOGISTS TO GET INVOLVED, BECOME FAMILIAR WITH AI, AND STAY ENGAGED"

The clinical applications are intriguing. Some examples. Fei Fei Li PhD and her colleagues at Stanford University are focusing on endowing healthcare space with ambient intelligence to assist clinicians and patients. This ambient intelligence will sense the physical space, recognise all activities, while integrating the data into a clinical ecosystem. This application has the potential to decrease and prevent medical errors such as immobility-induced ulcers, retained surgical sponges, hygiene-related infections, bloodstream infections and patient falls (Yeung et al. 2018).

Luciano Prevedello, MD, MPH and colleagues at Ohio State University are focusing on augmenting components of the imaging lifecycle. They're working on optimising imaging workflows through triage prioritisation of imaging studies, and on improving image interpretation through lesion detection, characterisation, quantification and comparison.

AI research is moving quickly on a multiplicative logarithmic trajectory. Applications that didn't exist two years ago are now available. Prior challenges are becoming strengths, which are leading to advances in radiology and medicine.

Current challenges of deep learning in medical imaging include data availability and privacy concerns, data annotation and curation, data/algorithm validation and testing (early validation methodologies have not been robust), and length of process (idea to publication to clinical application), which can take many years.

One of the economic challenges will be in overcoming the Gartner Hype cycle as we move into the trench of disillusionment. If vendors can't identify ways to monetise AI in a timely fashion, venture capitalist's investment in AI technology may start to diminish.

The future strategy in convincing the C-Suite to sign on to AI technology is not to sell AI, but to sell the benefits that AI will bring such as workflow optimisation.

Dr. Li's optimism stresses the importance of human-centered AI. "AI technology should be inspired by human intelligence. The development of AI should be guided by its human impact, and the goal of AI should be in enhancing humanity, not by replacing it" (Fei-Fei 2018).

The future lies in the combined and collaborative efforts of humans plus AI. To date, the best AI-powered systems have required humans to play an active role in their creation, tending and operation (Mims 2017). Therefore, the term I prefer is augmented intelligence.

"THE FUTURE LIES IN THE COMBINED AND COLLABORATIVE EFFORTS OF HUMANS PLUS AI"

Augmented intelligence, powered by deep learning, will optimise our workflow leading to improved patient care. Deep learning will learn to automate certain time-consuming perceptual functions like detecting multiple pulmonary nodules or new multiple sclerosis plaques in the brain while comparing these lesions to prior studies, and generating a value-based qualitative and quantitative representation for the treating referring clinician.

Time saved, will allow the radiologist more latitude to review the chart, consult with the clinician, and speak with the patient. This increased collaboration with the patient will result in improved patient outcomes since patients will be able to ask questions, understand their disease process, and they will become more invested in improving their care.

The important thing now is for radiologists to get involved, become familiar with AI, and stay engaged. It falls upon radiologists to understand AI so that they can inspire future generations of radiologists and clinicians. Fortunately, resources are now available to help radiologists become more comfortable with AI through the American College of Radiology (ACR Data Science Institute). An excellent AI lecture series/journal club was developed by the resident and fellow section (RFS) of the ACR that is helpful for all radiologists. The ACR RFS AI Journal Club now has its own YouTube channel which includes all prior AI Journal Club recordings. The Radiological Society of North America (RSNA) has begun a new series of AI webinars, and the RSNA has just begun to publish a new journal called *Radiology*: Artificial Intelligence to support the growing and exciting work in this area.

The future is bright, and if we can continue to develop creative solutions to improve the care of patients, in collaboration with deep learning algorithms, then we'll again have succeeded in advancing medicine into a new healthcare revolution, more evolved and sophisticated, that will continue to benefit both clinicians and patients. ■

KEY POINTS

- ✓ It's becoming increasingly more difficult to practice value-based medicine in today's climate of volume-based medicine.
- ✓ AI research is moving quickly on a multiplicative logarithmic trajectory; prior challenges are becoming strengths leading to advances in radiology and medicine.
- ✓ The future strategy in convincing the C-Suite to sign on to AI technology is not to sell AI, but to sell the benefits that AI will bring such as workflow optimisation.
- ✓ It falls upon radiologists to understand AI so that they can inspire future generations of radiologists and clinicians.

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DISRUPTING THE PRESENT | BUILDING THE FUTURE

Embracing Innovation to Deliver Results

As more governments pledge to deliver Universal Healthcare to their citizens, many developing countries are experiencing a dramatic overhaul in how their healthcare systems function. Major trends include the growth of health insurance (social and private), a sharper focus on value, and a renewed emphasis on access, affordability, and quality. There is increasing opportunity for the private sector to pioneer disruptive innovations that challenge historical norms. Whatever the future holds, one thing is clear: it cannot be business as usual!

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Creating Markets, Creating Opportunities

Artificial Intelligence in healthcare: What is versus what will be

Artificial intelligence will alter healthcare as we know it, augmenting some jobs and outright replacing others. Though we can't be sure when this will happen, what's most important for now is understanding what AI is and what it isn't.

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At medical conferences and in hospital cafeterias, few topics come up more frequently, or cause more confusion and speculation, than artificial intelligence (AI).

Proponents of AI promise that machine learning will reduce the administrative burden of medical practice and dramatically improve patient health. Critics warn that AI will depersonalise medicine and put physicians out of work, perhaps someday soon.

Neither assertion is likely in the short-run; both speak to a need for greater understanding within the medical community about the promises, pitfalls and practical applications of artificial intelligence.

What is and what isn't Artificial Intelligence?

Today's healthcare technology firms and digital device manufacturers hype their latest innovations as "AI." However, most applications powering medical practice and research today rely solely on human-generated algorithms and data analytic tools. Of course, the computers on which they are housed can perform impressive calculations at breakneck speeds, but the science behind them doesn't involve true machine learning.

Artificial intelligence and its newer, more powerful design, "deep learning," rely on neural networks, which are almost exactly what they sound like. These complex analytic tools use webs of analytic software that are layered on top of each other to simulate (and even expand upon) the functions of the human brain. Using multilevel or "meta" analysis, a computer's neural networks find patterns that even the designers of the application were not aware existed.

AI applications already demonstrate advanced comparison capabilities, which today carry the promise of ever-more sophisticated pattern recognition and visual diagnostics in the future. Deep learning tools can quickly process images of varying levels or layers, separating aspects such as colour, size, and shape before integrating the totality of information. Using huge volumes of data, AI systems identify hundreds of minute differences, which are then combined to provide new insights and more accurate conclusions. Although these specific functions are only now beginning to surpass the speed and ability of humans, the conceivable applications in healthcare are endless.

AI might someday radically transform diagnostic medicine to the point it can identify cancer at the single-cell level. Exciting projections like these have led many entrepreneurs and futurists to declare that machines will someday take over complex diagnoses entirely. Today, however, the most commonly used computer applications do not feature deep learning as with AI.

By segmenting the three most promising applications – human-generated algorithms, data analysis and true "artificial intelligence" – we can better understand the potential of each to improve healthcare and the obstacles standing in the way of their broader implementation.

1. Data analytics: Not AI, but lifesaving nonetheless

Combining statistical analysis and powerful computers capable of retrieving huge amounts of data in a matter of seconds, data analytics help doctors extract and act on massive quantities of clinical information in real-time. This enables faster and more successful responses in clinical settings.

Think of data analytics in healthcare as a team of physician assistants, racing around the hospital at lightning speeds to assess the status of patients, review their laboratory work and examine the data streams coming from their beside monitors. These assistants would also be tasked with simultaneously comparing this information against a pre-established set of criteria to predict which patients were at greatest risk of having an unrecognised, life-threatening medical problem or experiencing a serious clinical decline in health status in the near future. Of course, even if humans were capable of this task, the costs would be enormous. Instead, computers have taken on this task to the benefit of thousands of hospitalised patients.

"MOST TECHNOLOGIES LABELLED “AI” TODAY AREN’T ACTUALLY ARTIFICIAL INTELLIGENCE"

The division of research inside the nation’s largest physician organisation, The Permanente Medical Group, created an algorithm that possesses this incredible utility. Using all pertinent data generated through patient monitoring, laboratory studies and physician input, the algorithm is able to determine which Kaiser Permanente patients currently in a medical or surgical unit will most likely experience a deterioration in health and need to be transferred to the ICU within 24 hours (Hu et al. 2016).

Traditionally, clinicians have made these kinds of determinations twice a day, during morning and evening rounds. The computer performs this same function 24/7 and uses data from 650,000 hospitalised patients, 20,000 of whom previously required this type of ICU transfer, to do so. All this information proves superior to human intuition or individual experience, making the machine much more accurate than its physician counterparts.

The researchers who developed this predictive analytic model did so with incredible precision. They were able to identify the 1-2% of all hospitalised patients whose medical condition will deteriorate that night or the next day and require admission to the ICU.

When the computerised application finds an individual who fits these criteria, a text alert is sent to the responsible physician who immediately checks on the patient and intervenes before any serious clinical deterioration can occur. Thanks to data analytics, patients in these situations are 75% less likely to die.

Of course, there are occasional false alarms just as there are patients who may experience complications without warning. But the solution has proven far more accurate and reliable than the old way of doing things. As a result, hundreds of lives have been saved each year since its introduction.

2. Algorithmic computerised applications: Providing consistent, evidence-based care

A second solution, also commonly mistaken with “AI” is an algorithmic approach to care. Using clinical experts from each medical specialty with evidenced-based solutions, algorithmic approaches define specific pathways that lead to superior outcomes for patients. Applying the algorithms consistently has been shown to improve medical outcomes compared to doctors who rely on intuition and personal experience alone. Although computer-driven and physician-determined approaches seem unrelated, they share similar characteristics.

The process of becoming a doctor requires memorising thousands of “algorithms,” perhaps better thought of as little forks in the road (or nodes) along the journey toward a diagnosis or clinical decision. The subsequent path taken is the result of a “yes-no” conclusion.

Imagine, for example, treating a patient who is having trouble breathing. The first question on the algorithmic-tree might be whether the person has a fever. If yes, the algorithm takes you in one direction, toward a series of infectious aetiologies. If not, it takes you in a different direction towards even more branch points, these ones separating heart failure from a blood clot in the lung from an allergic reaction and so on until all possibilities have been exhausted and the proper conclusion reached.

And this is where computers excel. The longer the algorithm, the easier it is for the human mind to overlook or skip important questions (branch points) or omit potential diagnoses, leading to the wrong conclusions. But a computer algorithm never forgets.

It's easy to see why many people confuse these high-tech pathways with artificial intelligence. In algorithmic-based applications, the computer appears to be taking in data and providing recommendations, similar to AI, but there is a difference. Rather than the analytic pathway being generated through computerised neural networks, they're created by humans, similar to data analytics. As such, they can't be better or smarter than the physicians who develop them. But having been created by clinical experts, they're proving to be far superior to the judgment and abilities of most clinicians.

Many of the nation's highest-performing medical groups are now using these advanced information technologies to achieve superior clinical outcomes, outperforming their health-system peers and competitors.

Look, for instance, at the difference among medical groups and physicians in the effective control of elevated blood pressure (hypertension), the leading cause of strokes. Based on data from the National Committee for Quality Assurance (NCQA), the highest-performing medical groups help patients achieve normal readings 90% of the time. Doctors without these types of computerised solutions achieve normal readings only 55% of the time (Jaffe et al. 2013).

Though computers have helped many healthcare-delivery systems achieve nation-leading quality outcomes, not all doctors embrace them. Physicians don't like it when anyone (or anything) tells them how to practice. For years, doctors have dismissed algorithmic applications as "cookie cutter" medicine. It takes strong physician leadership within medical groups to help fellow doctors get over this hurdle and realise that following evidenced-based recommendations leads to improved medical outcomes. Helping doctors recognise this is a crucial role for physician leaders.

Individual physicians and healthcare systems that have yet to embrace algorithmic care (and whose quality outcomes lag) have been able to get away with it for some time. But as patient expectations grow and transparency in healthcare becomes paramount, it's unlikely doctors who underperform today will be able to get away with it for much longer.

3. This is Artificial Intelligence in healthcare today

The pathologist examines a tissue slide to determine if a patient has cancer. The radiologist confronts a similar decision when looking at a mammogram. The dermatologist inspects a lesion and must determine whether it is melanoma. The ophthalmologist looks for signs of diabetes in a scan of blood vessels taken from the retina.

These are all important decisions that impact whether a patient will live or die. And yet, contrary to what most people believe, the diagnostic accuracy of today's clinicians is far from perfect. And because people and machines use fundamentally different approaches to reach diagnostic conclusions, AI is currently outperforming humans on a statistical basis in each of these diagnostic fields.

In general, doctors rely on heuristic principles to reach their conclusions. Since our brains can't retain the full details of tens or hundreds of thousands of images, we apply a few shortcuts to make our determinations and diagnoses. Pathologists, for example, diagnose cancer when the cells from the specimen are primitive in form, demonstrating excessive mitotic division and invading the surrounding tissue. Similarly, dermatologists worry about melanoma when a pigmented skin lesion has multiple colours and irregular edges. These alterations in form and structure do correlate with malignancy, but can be seen in benign lesions, as well. Furthermore, not all cancers demonstrate each of these abnormalities, and some fail to display any of them. As such, diagnoses in medicine remains inexact when seen through the eyes of humans.

> "AS SUCH, DIAGNOSES IN MEDICINE REMAINS INEXACT WHEN SEEN THROUGH THE EYES OF HUMANS"

Visual pattern recognition software using AI's analytic tools, however, applies a different methodology to making the correct diagnosis. Rather than using these "rules of thumb," high-speed computers compare each new specimen to the thousands scanned before. And unlike the human mind, the machines are capable of including hundreds of factors and assigning a relative mathematical weight to each. As a result, they are already proving to be 5% to 10% more accurate than physicians in a growing number of areas, such as in the diagnosis of pneumonia (Rajpurkar 2017; Stanford News 2017; Standford Medicine News 2018).

With AI becoming more sophisticated, advancements are forthcoming in a growing number of diagnostic fields, including:

radiology (CT, MRI and mammography interpretation), pathology (microscopic and cytological diagnoses), dermatology (rash identification and pigmented lesion evaluation for potential melanoma), and ophthalmology (retinal vessel examination to predict the risk for diabetic retinopathy and cardiovascular disease).

Despite the success of these AI applications, it may take a decade or more for them to replace physicians in clinical practice. Trust remains a big barrier in the adaption and implementation of AI approaches. Patients have believed in the diagnostic acumen of doctors for centuries. But when it comes to a doctor's ability to interpret certain studies, such as mammograms and pap smears, the results can be far from trustworthy. Overall, humans fail to find approximately 1 in 5 breast cancers. Similarly, the current sensitivity of a Pap test is only about 70 to 80%.

As a result, doctors often hedge their findings with phrases like, "most consistent with," "can't rule out," or "follow-up studies recommended." Substitute an AI application for a doctor and patients become less trusting and less forgiving, even if the computerised interpretations are more consistently correct.

Unlike applications that use AI to diagnose visual images, technology alone is currently unable to make the kinds of diagnoses doctors reach in their offices, based on a patient's history and physical exam. The reason is not technical since the AI applications could use the same methodology for clinical diagnosis as in visual pattern recognition. Instead, it's the lack of accurate and comprehensive data upon which to make its determinations. AI can't be any better than the information it's provided. Unlike slides, photographs, and X-rays, which are exact, medical records, including electronic ones, are not.

Most electronic records are designed for billing purposes, not medical care. And as doctors get increasingly busy, they tend to copy and paste their own notes or those of their colleagues, rather than taking the time to document the history and physical findings with 100% completeness and accuracy. Unfortunately, this paucity of time is unlikely to improve soon.

Conclusion

Those in the technology space are familiar with Moore's Law, an observation made by Intel co-founder Gordon Moore that the number of transistors on a chip doubles every one to two years Applying this insight more broadly, we might expect that computer speeds will double at least another five times over the next 10 years. Computers 30 times more powerful than those of today will support machine-learning tools and inexpensive diagnostic software that far outpace what any human alone can accomplish and dwarf what currently exists.

Whether doctors will celebrate or rue these advances remains to be seen. But regardless of their enthusiasm or resistance, the future is coming. As deep-learning software further establishes the best medical approaches, diagnoses, and treatments for hundreds of medical problems, patients will become the beneficiaries. Over time, they will be able to use a variety of computerised, algorithm-based tools to care for themselves, just as they manage so many other aspects of their lives today. And when such possibilities become realities, be it one, two or three decades from now, AI and the other associated technologies will permanently disrupt healthcare as we know it. ■

KEY POINTS

- ✓ Both proponents and critics of AI are overly confident in their predictions and conclusions about the specific impact AI will have on healthcare
- ✓ Most technologies labelled "AI" today aren't actually artificial intelligence
- ✓ In contrast to AI, applications that fall in the categories of data analytics and human-generated algorithms are already improving medical outcomes
- ✓ In some medical specialties, artificial intelligence is already 5 to 10% more accurate than humans at making diagnoses
- ✓ Adoption and implementation of AI are inhibited by the lack of trust patients, and doctors have in these sophisticated technologies. At some point, this too will change

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Will AI lead to job cuts or will the tech improve working lives?

Can Artificial Intelligence (AI) be trusted to better working conditions and create more jobs or, as the technology becomes more widespread in healthcare, will it be a threat to employment in the sector? HealthManagement.org spoke to four Artificial Intelligence (AI) experts for their views.

We are certainly witnessing a huge reshaping of the healthcare profession and our expectations about it. I suspect many jobs will become digitally-intense, in terms of interaction with and supervision of technological solutions. New jobs will be made possible by the lowering of the bar of the economically viable (think of the budget airlines equivalent). I also suspect there may be a growth in health management and prevention jobs. The whole industry of personalised medicine will create investments and create jobs.

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AI is changing the world. Now, machines can recognise images, they can tell a story about a picture such as 'this image represents a blue train in the desert.' Machines can compose music, paint and mimic human speech in real-time. However, machines haven't yet won our trust. Few would trust flying in a plane without a pilot, even though planes can fly without human intervention. Likewise, who would let a computer do a diagnosis or a therapy, without any human supervision? So building trust in machines requires taking a giant step forward. It is not about understanding how it works, it is not about opening the black-box of machine learning. It is about reliability and reproducibility, with, well, something very human called trust. Trust takes time to build and takes no time to lose.

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In the initial phase I would not be worried about healthcare job cuts. AI implementation will constitute a great opportunity for healthcare specialists to improve the way we perform our duties and collaborate in the development of a new technology. As a cardiac imaging specialist, one of the great advances could be the automatisation of routine and time-consuming tasks that, with the help of AI, could become more efficient and consistently accurate. At the end of the day, this will save a lot of time that could be used on other activities by the healthcare workers. In the first phase, the healthcare worker will confirm the work of the machine, but from my point of view, probably, in a second phase, the results will be accepted without human intervention. Therefore, this second period will be a time when healthcare specialists will need to reinvent their function to maintain their jobs or transform the way we treat patients as an interface between patients and machines guided by AI.

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There are no worries about artificial intelligence implementation eliminating radiologists' jobs. But it is interesting to imagine how our work could change. There is a special interest in the AI automation of interpretation of medical imaging, since radiologists' costs is one of the biggest expenses in radiology. But AI implementation in radiology faces many challenges, the standardisation of AI algorithms being the main one. It is envisioned that radiologists, working as data scientists, could play a central role in so-called precision medicine with a kind of "precision radiology" to which radiomics could add important information. But there is a lot of work to be done, especially in demonstrating that the implementation of AI and Big Data in Radiology is capable of improving the outcome for our patients and the efficiency of healthcare systems. Technical advances in imaging acquisition and big data envision a bright future for diagnostic imaging, which should continue to be led by the AI-powered radiologist.

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AI opportunities for healthcare must not be wasted

The reality about the potential and limitations of AI

One of the world's leading authorities on the ethics of Artificial Intelligence provides an overview on how the technology could impact healthcare and warns of opportunities not to be missed.

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I am reasonably optimistic about the opportunities that Artificial Intelligence (AI) presents. But I am not so optimistic about our ability to seize those opportunities. If only we could do the right thing, the outlook could be amazing. But are we going to do the right thing? I am not so sure. The fact is, presently, we are misusing and under-using AI.

I come from decades of experience in the field of philosophy of AI and people who are waking up to the issues it poses, such as ethical challenges, right now are frustrated at what appears to be slow progress in the field. However, people like me, who have been in this field for a very long time, are actually delighted that governments and society are finally paying serious attention to the situation. At least, this is a good step forward. After all, publications on the ethical impact of AI date from the 60s. Or, to take another example, the car industry has been automated for decades. A lot of our problems have been brewing for some time. The difference is that now they affect and are felt by many people.

Nowadays, we can see serious engagement from medical industries such as pharma and healthcare wearables, all the way to governments, research agencies and international institutions. The mushrooming of initiatives is a good sign. But, while this is wonderful to see, in the excitement about AI, what is somewhat missing is the acknowledgement of the presence of a wealth of research and investigation which is already there. We don't need to reinvent the wheel.

Yes, caution is essential, because the impact of AI in healthcare could be deep both in a good and in a bad sense. Some people like to use the word "careful." I like to use the world "mindful." We should not be timid and afraid. Let's look at what can be done safely and in a socially acceptable way, and let's be ready to redress and change direction as soon as a mistake appears. We need to pursue innovation in tandem as well to balance this out. But let us not miss great opportunities just because we have been sold some scaremongering stories and sci-fi scenarios.

The shift from careful to mindful underlies the belief that AI is a powerful force for good. A lot in this technology is being developed by humans for humans to improve our lives. I am sceptical about 'better-safe-than-sorry' being the only approach. We need to find ways of testing new ideas and solutions safely but also innovatively because there is so much more that we can and should do to improve the lives of billions (yes with a 'b' not an 'm') of people.

Governance of AI lagging

When people talk about the 'threats' that AI could bring, they seem to underestimate what economists call the opportunity costs. This is essentially the cost of things we didn't do because we chose something else. The cost of not applying AI could start to accumulate.

Not enough attention is being paid to governance, and, if you have some inside understanding, it is not difficult to see where things are going. It seems to me that one of the problems we have is that we don't have enough clarity on ethical guidelines. There is insufficient push about this from healthcare stakeholders. I try to convince people that the main problem is not what kind of innovation we are going to have but what solutions we want to put in place when using any kind of innovation. The governance of the digital is the real difficulty, not just digital innovation per se. What incentives are we establishing for social understanding, acceptability, corporate responsibility and good governance to develop socially preferable solutions, and hinder the worst shortcomings? This all comes in waves though. In the same way academia anticipated digital ethics issues and today we finally have some real engagement, we are now anticipating issues in academia that will affect the governance of digital in the near future. I expect this to hit the social spectrum engagement a bit later. We could compare it to developing a cure in the lab and getting the pills from your GP. It takes years.

"CAUTION IS ESSENTIAL BECAUSE THE IMPACT OF AI IN HEALTHCARE COULD BE DEEP BUT I WOULD USE THE WORLD “MINDFUL” RATHER THAN “CAREFUL”

AI impact on employment

There is a risk of talking too much about risks. In the job context, it is very interesting because the statistics can be confusing. In almost any story about jobs being automated, created, transformed or made obsolete, there appears to be no consistency in a comparative analysis. The bottom line is that nobody quite knows what the impact of AI on the healthcare job market will be. But when some people talk about their being no jobs in the future, my response is that this is just not plausible. There will always be a surplus of demand for care, at all stages and in all contexts. For example, we know, in the UK at least, that healthcare and elderly care are in desperate need of staff.

Imagine we go back to the past and someone has just invented vending machines. They should have killed off every coffee shop in the world. But what has happened? Coffee shops are blooming. Vending machines have not killed the barista job. We have more diversity, more choices. Do not get me wrong. This is not as reassuring as it may sound because, on the other hand, bank ATMs did kill some banking jobs. I'm only stressing the difficulty in making predictions. In this case, common sense is not the best guide, because there are complex feedback loops linking many transformations. On this note, I want to point out that the country where there is the highest number of robots per person is Japan but that is also where there is very low unemployment. In fact, Japan has a crisis of unfilled jobs to the point that they're considering opening the market up to foreigners.

There is a lot of uncertainty. It means we have to be ready for what could be a curve ball. The point is, it's not all good or bad. AI will eliminate some jobs but create others. It is the painful transition that needs a social safety net. Not all those who will get the new jobs are those who will lose the old ones. We must ensure that our society takes care of the generation that is going to pay the highest price in this radical transformation, even if this means borrowing a bit from the future to smooth the significant impact of AI on the job market.

Back to the future

Imagine looking back at this century from 100 years in the future and they are talking about us now. They tell a story about the 21st century and AI from the 22nd century perspective. Will they be saying ‘They had so many opportunities and what a mess they made. What were they thinking?’ or ‘They had so many opportunities and they managed them quite well, thank you!?’

We can compare this to the environmental crisis. We are not pleased with our parents and grandparents for what they have allowed to happen to our planet; and the next generation will probably not be grateful to us for the poor job we are currently doing.

When it comes to AI, I would like to avoid this. Whatever it takes in my little corner, I want to make sure that the story written by the 22nd century about the 21st will be a good one.

That's why I am so engaged and enthused about working hard to make sure that whatever good could be done will actually be done rather than leaving a legacy of a ‘should have, would have, could have’ scenarios. ■

KEY POINTS

- ✓ AI is being misused and underused
- ✓ AI has decades of history but ethics discussions are only now hitting society
- ✓ Governance of AI needs more attention
- ✓ We don't know how AI will impact the employment market; dystopic projections are unfounded
- ✓ Healthcare is facing severe understaffing and AI could fill a shortfall
- ✓ A mindful rather than a paralysing careful approach to AI is more fitting to ensure innovation and pursuit of opportunities

Why embracing Artificial Intelligence is beneficial for all

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In many ways Artificial Intelligence (AI) may seem like a new concept in healthcare, mainly due in part to the recent traction the topic has made in the news in the last few years. It has even been falsely sensationalized, to further elevate buzz, as a tool that will one day replace clinicians altogether. The truth, though, is that companies like Hologic, Inc. have been working for many years to evolve processing capabilities in AI to benefit both patients and healthcare professionals alike. And, there are many advantages to using AI today, all of which are only optimal when such technology functions in tandem with clinicians—not in place of them. This can especially be seen in the radiology field and when looking at the role risk stratification plays in radiology.

Like with many cancers, knowing the risk factors for breast cancer is an important part of the breast screening and diagnostic process. Separating out patients who are at high risk of getting breast cancer, or whose mammograms reveal suspicious tissue that looks like breast cancer—a form of risk stratification in radiology—is of the utmost importance to get patients who are in need of clinical treatment on their therapy as soon as possible. AI allows radiologists to do just that, opening up opportunities for more personalized screening pathways as technology advances to be able to predict what a patient is in need of based on their "profile." In fact, data collected by Hologic from a global collection of clinicians at the Radiologic Society of North America (RSNA) Annual Meeting showed that AI will have the greatest impact in the long-term on personalized screening pathways through the creation of new risk models. In some ways, this has already begun.

Consider the growing importance of breast density assessment and the current process for it. Women with very dense breasts are four to five times more likely to develop breast cancer than women with less dense breasts, which means that having very dense breasts is an important risk factor for patients to be aware of.[1,2] Today, the only way a woman can know how dense her breasts are is to get a mammogram. From there, radiologists will look at her images to categorize her into one of four categories according to the Breast Imaging Reporting and Data System (BI-RADS), which includes fatty, scattered fibroglandular, heterogeneously dense, and extremely dense. While this visual assessment process can certainly work for some patients, classifications are open to interpretation since other radiologists may look at the same images and categorize the patient differently based on their own subjective view. This can create inconsistencies in breast density assessment, leading to confusion about what a woman's breast cancer risk actually is.

However, with the integration of AI technology, radiologists can work more consistently to assess breast density. The next-generation Quantra™ breast density assessment software from Hologic, for example, is powered by machine learning thanks to years of breast image case collection and identifying each image's breast density category according to the BI-RADS. Having this AI technology in place enables quick and accurate breast density assessments across the entire patient population, elevating the standard of care and standardizing reporting across an entire radiology practice.

As a result of implementing breast density assessment consistency, women can know whether or not their breast density puts them at high-risk for breast cancer, which can potentially help those with very dense breasts maintain screening compliance. Additionally, since different screening modalities can be used to detect breast cancer, by integrating AI into breast density assessment, clinicians can advise women with more confidence on how they should be screened for breast cancer in the future to have the most effective results. Tomosynthesis, for example, should be recommended for women with dense breasts. This is because only the Hologic 3D Mammography™ exam is proven to be superior for women with dense breasts compared to 2D alone, which only further demonstrates the need for consistent, accurate breast density assessment.[3] Thus, with AI analytics, patients can be assigned a screening pathway that makes most sense for them, hopefully improving patient outcomes.

Although at first glance AI breast density assessment may seem like work is being taken away from radiologists, in reality it is more so simply being redistributed. Clinicians are still in tune with each patient's unique profile, such as their body habitus and positioning during screening, which can be necessary context in some cases to supplement AI analysis. Similarly, in order for AI algorithms to be effective, the deep learning machines must be asked the right questions. This, too, comes from clinicians. Thus, while AI can help standardize an important part of radiology, it is most effective when it works alongside radiologists who can insert clinical expertise in cases that are necessary, while they can then focus the duration of their time on other high priorities for their patients.

Aside from breast density assessment, AI is making a positive impact on radiology in other ways, especially workflow efficiency in tomosynthesis. In an era when streamlining workflow must be balanced with improving patient outcomes, capitalizing on methods that allow clinicians to work more quickly while also providing high quality care is crucial. AI now makes this possible. On Hologic's 3Dimensions™ mammography system, for example, clinicians can expedite 3D™ exam read times with the Intelligent 2D™ imaging technology's built-in mapping capability. The Intelligent 2D imaging technology uses advanced machine-learning algorithms and high-resolution 3D data, and it creates 2D images that are well-correlated to the 3DTM data, which may not be seen in conventional 2D images. The smart mapping enables radiologists to instantly move from suspicious areas detected on the 2D image, to the point of interest on the 3DTM slice, saving valuable read time.[4] In this case, AI is once again not replacing radiologists but rather giving them the information necessary to be able to move on to more high priority areas of work while still providing the confidence required to make informed clinical decision for patients.

Looking to the future, Hologic is continuing to collect as many tomosynthesis images as possible to train AI to target only the tissue that seems suspicious, or high-risk, for radiologists to hone in on and address.

It's clear from analyzing current breast density assessment and image reading processes that AI can have a very positive role in radiology, especially for separating out high-risk cases and tailoring screening pathway options. Radiologists should embrace AI as a supplemental tool to their expertise, making them more efficient and confident at their jobs and allowing them to focus on high-risk cases, to truly benefit from the next generation of AI technology that is undoubtedly on the horizon. Those who do will find that they are best equipped to make a real positive impact on breast screening and patient outcomes as risk models and personal screening pathways become the standard of patient care. ■

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AI-based prediction in clinical settings: can we trust it?

AI is proving its worth in delirium prediction

An AI model used for prediction and prevention of delirium in elderly patients is reaping results and gaining the confidence of users.

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The challenge

Users in healthcare are facing the situation that it is becoming increasingly difficult for them to incorporate information available for their decisions in a limited amount of time.

Therefore it is necessary to provide relevant information for the respective decision situation – a context-sensitive presentation of a medical history. In a further step, then clinical decision support can be given.

Appropriate algorithms collect and link available information, they derive indications and recommendations for decision-makers (doctors, nursing staff, therapists, patients) and make it available at the point of care in real time.

But scepticism and mistrust of users have to be adressed: They must be enabled to gain confidence in such systems and trust their information by evident benefits (especially for the patients) and intuitive integration in their user interface.

An AI case already in clinical practice

In this case, a prediction for delirium is offered as decision support, based on statistical and machine learning models ("controlled" and "qualitatively evaluated"). These models are derived from extensive data from the hospital operating company KAGes with approximately 2.1 million longitudinal medical histories from the Austrian province of Styria with approximately 1.2 million inhabitants. In this area about 90% of the acute care beds are operated by KAGes.

Delirium is a highly relevant syndrome with elderly patients. Delirium means an acute, organically induced impairment of the brain. Affected patients respond inappropriately to environmental stimuli, seem "confused" and unable to orient themselves.

In up to 44% of cases, delirium is considered preventable. If left untreated, however, it will lead to a significantly higher risk of complications during hospitalisation or even death. According to studies, the hospital stay is considerably prolonged by a delirium suffered (Dowal 2015).

In a supervised learning process, models were generated with several algorithms. In order to avoid overfitting, a training (75%) and a test dataset (25%) were used. The models were optimised exclusively on the training data set. The performance was validated with the test data set. The different algorithms yielded very similar results. The Random Forest as the best algorithm in this use case achieved an AUROC of 0.90 (“area under the curve“ as statistical performance indicator).

> "USER SCEPTICISM AND MISTRUST HAVE TO BE ADRESSED AND THEY MUST BE ENABLED TO GAIN CONFIDENCE IN SUCH SYSTEMS"

Based on this model, the probability of suffering from delirium is calculated for each newly-admitted patient with data extracted from his medical history. In case a warning is displayed at the clinical work station, the explanatory component can then be activated by clicking on the warning symbol. This then shows the data of the patient which led to the calculated probability, eg the patient has a certain elevated laboratory value, a certain prediagnosis, an accumulation of disease events in the recent past, difficult social conditions, etc.

"IN UP TO 44% OF CASES, DELIRIUM IS CONSIDERED PREVENTABLE BUT, IF UNTREATED, WILL LEAD TO COMPLICATIONS"

The attending physician or nurse can then take preventive measures to prevent the impending delirium if possible.

Benefits

The benefit for a hospital group such as KAGes can be seen in the case of widespread use as follows (estimated conservatively):

- Approx. 100,000 inpatients in the risk population (60+) per year
- With an assumed (low) incidence of 3%: 3,000 patients with delirium per year (assuming some potentially preventable delirium would have been detected early enough to prevent delirium)
- Average 7 days longer stay for preventable delirium, assumed €500 per day: additional costs of €10,500,000
- Predictive approach detects > 80% of delirium patients early and 25% (low estimate) are considered preventable.
- Cost savings potential per year: € 2,100,000

Further use cases are in development, eg prediction of avoidable readmissions, prediction of the intensive care necessity of surgical patients to improve the disposition of expensive intensive care beds, etc.

Trust in AI

The prediction of delirium was compared with the estimation of the delirium risk by staff members in a nine-month evaluation project proving the high predictive quality of the model in practice. The acceptance of the users was evaluated as well. This approach has allowed users to gain confidence in using this form of artificial intelligence. This very context-sensitive support in the explanatory component makes work easier for the users and increases patient safety. As a result, the senior physicians and nursing staff of the pilot departments have adopted the solution and have recommended it for wide use in KAGes.

Outlook

Further application modules are being developed and there is also interest of other hospital providers to use these models, which are based on an extensive body of data from longitudinal medical histories. There are numerous publications, which show good statistical metrics of their prediction models. But the trust of doctors and care staff proved by real clinical use is hardly found. The "last mile" to clinical use has obviously not been made yet. KAGes has already succeeded and is optimistic it will add more use cases.

KEY POINTS

- ✓ Healthcare users are experiencing information overload
- ✓ Algorithms provide point-of-care information on indications and reccomendations
- ✓ Machine learning is predicting and preventing delirium in an Austrian hospital
- ✓ The potential annual cost savings are €2,100,000
- ✓ Success has enabled user trust in AI

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Can machines behave morally enough for healthcare?

Machine ethics: A case for human-centric Artificial Intelligence

With the development of AI comes the question of ethics, especially in the human-centric healthcare setting.

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Artificial Intelligence (AI) is one of the most transformative forces of our time and presents a great opportunity to increase prosperity and growth. Over the last decade, major advances have been realised due to the availability of vast amounts of digital data, powerful computing architecture, and advances in AI techniques such as machine learning and deep learning. Major AI-enabled developments in autonomous vehicles, healthcare, home/service robots, education and cybersecurity are improving the quality of our lives every day. Furthermore, AI is key for addressing many challenges facing the world, such as global health and well-being, climate change, reliable legal and democratic systems and others. Having the capability to generate tremendous benefits for individuals and society, AI also gives rise to certain risks that should be properly managed. Given that, on the whole, AI's benefits outweigh its risks. We must ensure that we follow the road that maximises the benefits of AI while minimising its risks. To ensure that we stay on the right track, a human-centric approach to AI is needed, forcing us to keep in mind that the development and use of AI should not be seen as a means in itself, but as having the goal to increase human well-being.

Human-centric AI or machine ethics is a new field of research at the interface of computer science and philosophy that aims to develop moral machines. It's all about creating machines that can make moral decisions based on computer technology.

Existing paradigms

Let us take a look at the example of autonomous driving. Even fully-automated vehicles face moral choices. In unavoidably dangerous situations, the protection of human life should take precedence over harm to property and animals. Of particular difficulty are the moral dilemmas that may be encountered in this area of application, such as the need to decide whether to sacrifice a small number of lives to save a larger number, if unavoidable.

In self-driving cars the algorithm decides in an emergency whether the vehicle is driving, eg in a group of pedestrians, into a mother with a child or against a wall. There are heated philosophical and legal debates about this "algorithm of death," for it is certain that the autonomous car is coming, ahead of autonomous weapons and mechanical pets. The development is politically intentional, as it is rightly assumed that autonomously-driving cars will not only drastically reduce travel costs and energy consumption, but also the number of accidents. The computer processes much more information much faster than the human being, never gets tired, never drives drunk and does not text SMS messages behind the steering wheel.

Since, at the same time, it is certain that there will continue to be accidents in which fatalities are unavoidable but can, at most, be selected, the question arises with which decision ethics one equips the corresponding algorithms? Philosophy thus becomes an important element in the production chain of an automobile.

As big as the ethical dilemma of the death algorithms is, not giving a direction at all would be no solution. Even more immoral than to coolly and quickly weigh the life of a child against that of a senior citizen would be to block a technology that prevents tens of thousands of deaths per year. Statistics provide the killer argument in favour of the new technologies, no matter what ethical dilemmas they bring with them. Even the use of military drones is justified as they cause less collateral damage.

"HAVING THE CAPABILITY TO GENERATE TREMENDOUS BENEFITS FOR SOCIETY, AI ALSO GIVES RISE TO RISKS THAT SHOULD BE PROPERLY MANAGED"

If the algorithms of autonomous cars were really programmed according to survey results, the ethical dilemma would be dealt with quantitatively. If one considers that these algorithms are ultimately nothing more than complex arithmetic operations, one suspects that here, across systems, a bizarre feedback of the mathematical comes about. The ethical problems that result from the success of the mathematics system become even more mathematical.

An international standard of values

Of course, it would also be strange to programme the algorithms differently, so that, depending on the ethical self-understanding and majority decision, certain countries prescribe self-sacrifice, others act in a strictly coherent way, and others give priority to rescue operations, no matter what the risks. Of course, one could easily recode the algorithms via GPS to the locally-applicable ethical norms in order to enforce the different values internationally. At the same time, however, the question arises whether and how it would be possible to give technology an ethical standard that is globally binding. Can a transcultural understanding be reached, beyond different values?

One healthcare application for moral machines is the care of the elderly. Due to demographic change, the proportion of people in need of care will increase sharply in the coming decades. Artificial systems are repeatedly brought into play as a means to counteract the nursing calamity. However, systems to be used in this context face moral choices such as how often and insistently does a care system remind people to eat and drink and to take medication? When should a care system inform the relatives or call the medical service if someone does not move for a while? Should the system monitor the user around the clock and what should be done with the data collected?

The way ahead

Can artificial systems act morally? The development of increasingly intelligent and autonomous technologies inevitably leads them to confront morally-problematic situations. Therefore, it is necessary to develop machines that have a degree of autonomous moral decision-making. It is unclear on what ethical basis artificial systems should make decisions. This also depends on the field of application and should be the subject of a social discourse, especially in those areas of application that require generally-binding rules. It's timely that there are plenty of research groups and initiatives, both in academia and in the healthcare industry, that are starting to think about the relevance of ethics and safety in AI. ■

KEY POINTS

- ✓ AI benefits are already demonstrating value to society
- ✓ It is worth overcoming ethical risks AI presents
- Machine ethics aim to develop moral machines
- ✓ Philosophy is a key element in AI algorithms
- ✓ A code of global ethical values may be necessary
- ✓ We need to develop machines that comprise autonomous, moral decision-making

Artificial Intelligence: a next way forward for healthcare

The promise and the reality and how to combine the two for efficient and patient-centred hospital care

By harnessing new insights and benefits offered by AOI and Machine Learning, Leeds Teaching Hospital is upgrading the precision of its healthcare information to enable a new world of prediction and analysis that sees the delivery of a new citizen focus in the care that is delivered

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Digital technology constantly changes, grows and delivers, but some of the promises of digital technology are ethereal when it comes to healthcare. Since 2010 IBM has had the promise of Artificial Intelligence (AI) in healthcare through the Watson initiative. IBM would describe Watson as a solution to the big healthcare problems, but which healthcare problems? Sometimes Watson has felt just out of the grasp of the front line digital leadership in all but the richest of healthcare systems, and for so long Watson has been 'code' for AI in healthcare.

In 2018 the UK minister for health talked up the virtues of AI as a solution to the General Practitioner resource issues hitting primary care delivery in the National Health Service (NHS) for the last decade, maybe even more. Almost in complete contrast, the NHS England team asked that digital leaders stopped considering the 'shiny things' like AI and concentrated on the foundations of good technology, like getting information to the centre on time. At the same time the NHS's national digital body added to the confusion by announcing a change in their focus and organisational structure to provide expertise on the same list of shiny things that NHS England has asked the frontline to stop worrying about; all this at a time when the Google CEO says, 'artificial intelligence will be more important than humans learning how to light fire and collect water' (Clifford 2019).

It feels like the time to ask Alexa, Cortana, Siri and their colleagues for help in understanding the landscape.

One thing the digital health system of the NHS has been good at over the last two decades is making the best of a confused landscape. As we head into the earliest part of 2019 I can put my finger on five AI developments, all of which to me seem to be promising or already delivering some real foundations for a new frontier.

A lot has been said about the possibilities for AI in the space of clinical research, and in return for the promise of what the science can achieve. The front line has been clear that this will only work when the quality of data improves, but it is improving - and at a rapid rate. For example more and more trusts are able to declare themselves as 100% digital in Pathology departments. The opportunity of AI in this space is tremendous. Systematised Nomenclature of Medicine coding (SNOMED), even clinical coding delivered by AI and Natural Language Processing in itself will improve the opportunities. In all honesty, it no longer feels like a leap of faith to get to this, just a little more hard and focused work created against a considered (and not excitable) backdrop. Being able to use AI to consider pathology images as a research tool is something that we, in Leeds, can get to in 2019. It feels like the benefits can be huge, but today we can't quite determine what they will be, and therefore that requires us to take a bet. We do know, though, that ensuring that the 'A' in AI stands for augmented and not artificial, will be key to taking the academics and clinical team on the journey with the digital capability and its promise in research.

The work we can deliver today in health, though, is perhaps best described as the UK edition of ITSMF's ServiceTalk magazine. The publication described Artificial Narrow Intelligence (ANI), in the autumn of 2018 as simple(ish) automation of repeatable tasks now often branded as AI (Karu 2018). The reality is, there is very little need for the intelligence to truly be stretched and the focus is on a single domain or task type. When we take the next step and arrive at Artificial General Intelligence (AGI), that's when new benefits and new insights will be possible rather than fostering old ways of doing what we have always done.

Perhaps more exciting though is when we hook the Gartner-esque definition of digital trends of big data, machine learning and Robotic Process Automation (RPA) together. We can overlay them on some of the operational problems rather than the overtly clinical issues we are faced with daily.

Take the 'wicked' problem of Did Not Attend (DNA) for example. Algorithmic work done in a large London trust has been able to create a predictive model that has been shown to be over 70% accurate in identifying the person type, operation type and previous response to healthcare that is most likely to resort to not attending for a clinical event. By adding an RPA reminder to the process of those likely to DNA and with the ability to alter bookings within the automated process, the trust is able to make fundamental changes to its rota and roster system and manage its capacity with a level of efficiency unheard of without this innovation. This is one of the key actions we are all, every healthcare system in the world, trying to achieve. In Ireland, further still, the RPA process has been added to a short video of the consultant or lead clinician being appended to the message welcoming the patient to the clinical setting they will be visiting the next day, putting to bed some of the last-minute jitters and seeing a marked difference in the DNA response. Not quite the full suite to give us AGI but clearly getting there.

Yet again as digital professionals in healthcare we marvel at the difference this makes in frontline healthcare where we have deployed it with two key elements missing from the position statement; firstly, if this is possible and works why is it that there isn't a national solution that can be deployed to achieve this? Secondly, let's face it - this isn't that new or cutting edge. My barber has been doing it for years. Why can't we do this together and at a greater speed so that the patient gets a standard and expected experience, possibly removing some of the dystopian fear that goes with AI in healthcare?

"ONE THING THE DIGITAL HEALTH SYSTEM OF THE NHS HAS BEEN GOOD AT OVER THE LAST TWO DECADES IS MAKING THE BEST OF A CONFUSED LANDSCAPE"

Developing algorithms through a depth of machine learning in the AI space is something that we can not only dream of but now truly begin to deliver. The NHS can gain benefit from its 'crowd' if the way of working that the London trust has instigated can be put into practice. One NHS organisation does the work on DNA problems with AI experimentation whilst another begins to consider something else that can be delivered, aiding in the process of building more and more algorithmic responses to the issues at hand. These experimental solutions can be shared to be proven in different environments, ensuring that the differences we all know exist across the NHS don't skew and fail the algorithm. In theory, as more data is added to the pool, the algorithm gets more and more accurate.

Leeds Teaching Hospitals Trust has taken this way of working on board; the work they have started with machine learning in the AI space will focus on predicting a date and time of discharge at the point of admission. Leeds has a great set of live open data on environmental elements, weather, traffic, air quality, school holidays and festivities going on in the local area. All of these elements have some effect in some way on the ability to make patients well again and the timeliness of this. By mixing these data points with the health records, with performance data, with the daily capacity and capability of the trust we believe we can predict a date that each patient will be 'medically fit for discharge' (MFFD). The 'so what' for this innovation, though, is fascinating; first and foremost the ability for the hospital to work with other healthcare partners across the city to ensure patients can be supported on the day they are medically fit to leave will go some way to removing the concept of the stranded patient. The solution to stranded patients has always been for the system to 'pull' them out of the hospital, but identifying them has often been difficult. With an agreed and working algorithm for MFFD, the patients can be identified and a plan created at the point of admission that is no longer based on guesswork and can be built on to become more and more reliable.

However there is another unintended consequence of this date being available; telling the patient the date and time they should also be striving for has been suggested to impact on their own desire to be well and away from hospital, the data equivalent to 'get up and get dressed' and the 'PJ Paralysis' campaigns seen in many hospitals in 2018.

"DEVELOPING ALGORITHMS THROUGH A DEPTH OF MACHINE LEARNING IN THE AI SPACE IS SOMETHING THAT WE CAN NOT ONLY DREAM OF BUT NOW TRULY BEGIN TO DELIVER"

However in the same way, as the DNA data described earlier, it's important that Leeds now moves to share the algorithm and the data inputs it has applied. The system needs to be provided with better data to reduce the algorithmic bias that will be the first answer of the 'powered by AI production line.' Testing the concept in an AI lab is the next stage for Leeds but, at the same time the trust is looking for partners to bring their learning to the table so that the initial build can truly have the impact everyone wants it to have.

The final example of AI being developed now is the stretch exam question: how to create a machine learning solution that delivers a clinically sound summary based on the records stored in an EHR? It's the panacea for so many clinical systems, to remove the clinical search time. How do we take the structured and unstructured data of a longitudinal record and allow the system to ask the question, 'Show me something interesting?' Once we can do this how do we make sure the data generating bias in the algorithm can be improved, because herein lies the problem. Although AI can learn, it's only really as good as the data we input, and old data has at best old data quality standards applied to it.

However in Leeds we have a wealth of data. We accept a dearth of information in the cancer area in particular. AI, though, allows us to shed a light on how decisions were made and recorded in the past and therefore 'correct the past' and improve the quality. Clear governance needs to be applied to this but in doing this we have targeted the ability to have an AI-generated cancer summary inside the EHR here in Leeds by December 2019. This summary learns and has links to patient and clinician proximity and with elements of suggestive RPA applied. What we think is total AGI.

Having given space to the Google CEO, I believe it only right to enable the next driving force in AI to be quoted to end this piece: "AI will be useful wherever intelligence is useful; helping us to be more productive in nearly every field of human endeavour and leading to economic growth." These were the words of Brad Smith and Harry Shum in the Microsoft publication, The Future Computed: Artificial Intelligence and its role in society (Smith 2018; Shum 2018). ■

KEY POINTS

- ✓ Sometimes AI's potential in healthcare is intangible, leading to stagnation
- ✓ There are big opportunities for AI application in pathology
- ✓ Leeds is using machine learning in the AI to predict date and time of discharge at the point of admission
- ✓ AI is only as good as the inputted data; old data does not offer optimal solutions
- ✓ By the end of 2019, Leeds aims to establish an AI-generated EHR cancer summary

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AI in medical imaging may make the biggest impact in healthcare

An overview of recent advances showing the value of using AI in medical imaging.

Soon every medical imaging machine will be connected to the cloud where AI algorithms will analyse data and help human doctors screen, assess, and diagnose patients. The potential impact of implementing AI to analyse medical images is huge.

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On the entire continent of Africa, if you remove Egypt and South Africa, there are only 6 paediatric radiologists. In Nigeria there are fewer than 60 radiologists for 190 million people. In Mexico there are only about 4,000 radiologists for 130 million people. In Japan there are only 36 radiologists per million people. In the entire country of Liberia there are only 2 radiologists. Fourteen African countries have no radiologists at all. One hospital in Boston, Massachusetts General Hospital, has 126 radiologists.

AI will help increase access to care in places where radiologists are inaccessible. AI has the potential to enable anyone with a smartphone to have access to healthcare. Researchers are working towards extending the reach of care outside of hospitals and clinics. This is especially important for people living in the developing world and for people working in remote environments such as the 4000 researchers from 40 countries working in Antarctica and the crew on the International Space Station in orbit 250 miles above earth.

Using AI will help improve workflow and efficiency. It is estimated that in the UK at any time there are over 300,000 radiographs that wait over 30 days to be read by a radiologist. Using AI will reduce delays in identifying and acting on abnormal medical images. This is especially important in chest and brain imaging where time is critical. According to GE Healthcare, over 90% of healthcare data comes from medical imaging and more than 97% of medical images are not analysed. 40% of all diagnostic imaging performed worldwide are images of the chest (**newsroom.gehealthcare.com**).

Another big advantage with AI is increased levels of accuracy in detecting and diagnosing disease. Breast cancer is the second most common cancer among women and conventional mammogram screening misses 1 in 5 cancers. Although breast cancer is treatable in its early stages, once the disease has advanced and spread it is considered incurable. According to a paper published in The American Journal of Surgical Pathology, Google's AI powered Lymph Node Assistant (LYNA) can detect breast cancer metastasis with 99% accuracy (Liu et al. 2018). Human pathologists miss metastases as much as 62% of the time but AI algorithms evaluate exhaustively resulting in extremely high accuracy.

In studies, assessments by algorithm are more reproducible and less subjective. In study after study, AI algorithms are more effective and efficient at identifying disease than human experts. AI algorithms can read images in less time (minutes vs hours) with higher accuracy (up to 99% in some cases). Soon every medical imaging machine will be connected to the cloud where AI algorithms will analyse data and help human doctors screen, assess, and diagnose patients. The potential impact of implementing AI to analyse medical images is huge.

The world's first AI Precision Health Institute

The world's first AI Precision Health Institute at the University of Hawai'i Cancer Center uses AI to analyse medical images to assess health and predict risk of disease. The AI-PHI is located at the UH Cancer Center in Honolulu in one of the most beautiful settings in the world overlooking the Pacific Ocean. The six story 150,000 square foot UH Cancer Center is one of only 69 NCI designated cancer centers in the United States and the only one in Hawai'i and all of the Pacific Islands. The NCI designation signifies the depth and quality of the research they're doing.

The UH Cancer Center is a state of the art facility that has the ability to attract the best scientists to

The AI Precision Health Institute at the University of Hawai'i Cancer Center. Image property of Margaretta Colangelo.

research cancer. Their research is unique because they research how cancer affects people with different ethnic, cultural and environmental characteristics. UH researchers conduct population based and laboratory based cancer research. Since Hawai'i has one of the most diverse populations in the world, it's an ideal place to study why some ethnic populations are more susceptible to certain cancers and how genetic susceptibility interacts with environmental factors in producing cancer risk.

Research at UH has shown that certain ethnic populations have higher abdominal fat even if they are not obese. This abdominal fat leads to an increased incidence of liver cancer. They are researching ways to treat and prevent the accumulation in abdominal fat in these groups to reduce the risk of liver cancer.

Research in breast cancer at UH has revealed differences in survival rates among women from different ethnic backgrounds. Japanese women have the highest survival probability, followed by Chinese and Caucasian women. Native Hawaiian and Filipino women have lower survival rates. Researchers are studying factors including environment, diet, genetics, weight, and hormonal statuses that could help explain these differences.

John Shepherd, PhD founder and director of the AI-PHI and his colleagues created the first Hawai'i and Pacific Islands Mammography Registry and are designing a study that will analyse mammograms from 5 million women on 5 continents using deep learning. Dr. Shepherd is developing novel biomarkers and conducting research in the following four areas:

"AI ALGORITHMS ARE SOMETIMES MORE EFFECTIVE AND EFFICIENT AT IDENTIFYING DISEASE THAN HUMAN EXPERTS"

1. **Bone density and body composition:** Researching the combination of DXA and bioimpedance measures to describe fat and muscle status in athletes and other individuals where hydration may vary.
2. **Breast Cancer:** Improving the ability of mammography to detect cancer and to offer quantitative risk of cancer, and using deep learning models for reading mammograms to reduce recall rates and unnecessary biopsies for women.
3. **Body Shape:** 3D optical whole body scanning for quantifying body shape as a risk factor for metabolic diseases, and monitoring lifestyle interventions.
4. **Frailty:** Researching the best way to describe frailty and function using quantitative composition measures.

Recently the AI-PHI partnered with QUIBIM a top tier AI company based in Spain. The AI-PHI is using the QUIBIM Precision Platform to centrally manage, store and quantitatively analyse medical images and algorithms. They are creating large scale imaging repositories with automated extraction

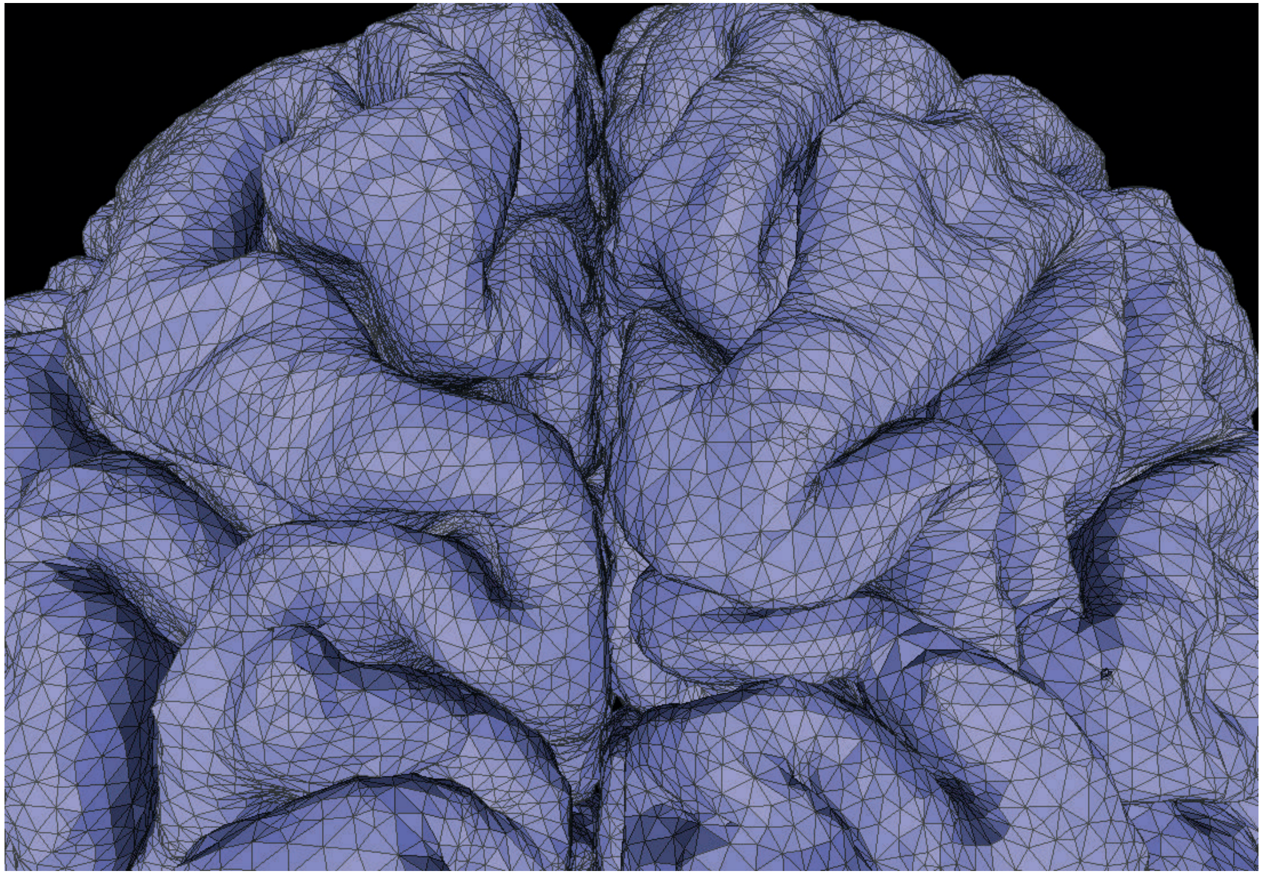

Image property of Quibim

of imaging biomarkers to characterise patients' status. The QUIBIM platform will be the central repository for the AI-PHI's mammography studies, which over time will include mammograms from over 5 million women on 5 continents. The AI-PHI will also use QUIBIM to integrate AI algorithms to detect cancer without the need of radiologists in a first-read. QUIBIM applies AI enhanced methodologies to detect changes produced by diseases and drug treatments and provides accurate quantitative information to doctors, clinicians and researchers. QUIBIM has developed AI algorithms for many types of cancer including brain, breast, and prostate, as well as non-Hodgkin's Lymphoma, and other diseases.

This is a close-up image of human brain sulci, reconstructed in 3D after processing a T1 MRI brain scan with QUIBIM Precision platform. This allows us to extract volumes from different brain regions and calculate the thickness of the gray matter cortex. With the surface extraction of grey matter, we can analyse important aspects such as neuronal density and grey matter thickness which are related to neurodegeneration. Since many neurodegenerative diseases occur as a result of these processes, this analysis can help to diagnose diseases such as Alzheimer's, Multiple Sclerosis, Parkinson's, and Amyotrophic Lateral Sclerosis.

Many lives could be saved worldwide every year if disease is detected and treated early. Using AI to analyze medical images is the most efficient and cost effective way to screen and help diagnose many diseases and the impact would be huge. Efforts have already begun in this direction. This is why AI in medical imaging may make the biggest impact in healthcare worldwide.

"USING AI TO ANALYSE MEDICAL IMAGES IS THE MOST EFFICIENT AND COST EFFECTIVE WAY TO SCREEN AND HELP DIAGNOSE DISEASES"

The following are recent advances showing the value of using AI in medical imaging:

- In a study at Stanford one algorithm named CheXNeXt (**med.stanford.edu**) read chest X-rays for 14 different pathologies. In this study the algorithm matched expert radiologists in accuracy and was much more efficient. The radiologists took an average of 4 hours to read an image; the algorithm read them in less than 2 minutes with the same level of accuracy.
- In China, NovaVision Group used AI (**cnbc.com**) to screen for over 1,000 diseases by analysing one image of the eye. They are able to find disease with 97% accuracy.

- Researchers at University of Warwick have developed an AI algorithm that can reduce the processing time for abnormal chest X-rays from 11 days 3 days. The study "*Automated Triaging of Adult Chest Radiographs with Deep Artificial Neural Networks*," was published in Radiology on Jan 22 2019 (Mauro et al. 2019).

- In a study, published in Radiology (Yiming et al. 2018), AI was able to detect Alzheimer's (**ucsf.edu**) disease in brain scans 6 years prior to diagnosis with 98% accuracy. Radiologists have used brain scans to try to detect Alzheimer's by looking for reduced glucose levels across the brain. However, because the disease is a slow progressive disorder, the changes in glucose are very subtle and difficult to spot with the naked eye.

- In this study on cervical cancer (**cancernetwork.com**) by the *National Cancer Institute's Division of Cancer Epidemiology and Genetics*, AI was more accurate at identifying pre-cancer than a human expert reviewer of PAP tests under the microscope. The AI performed better than all standard screening methods at identifying cases of cervical cancer.

- Researchers at Osaka University used AI to analyse microscopic images to identify cancer cell types (**photonics.com**). Using a convolutional neural network based system they were able to automatically distinguish between different types of cancer cells. Being able to accurately identify cancer cells helps doctors choose the most effective treatment.

- Half a million women die every year from breast cancer. In a study led by researchers at UCSF and Mayo Clinic, computers equalled radiologists in assessing breast cancer risk (Fernandez 2018). This study was published May 1 2018, in the *Annals of Internal Medicine* (Kerlikowske et al. 2018)

- CardioLogs is a Paris-based startup building deep learning algorithms to analyse ECGs. Emergency room doctors used Cardiolog's algorithm and it outperformed the conventional algorithm for emergency department electrocardiogram interpretation (Stephen et al. 2019).

- Google has developed an AI system that can grade prostate cancer cells with 70% accuracy (**venturebeat.com**). This is important because human pathologists who grade prostate cancer cells disagree up to 53% of the time. According to the paper *Development and Validation of a Deep Learning Algorithm for Improving Gleason Scoring of Prostate Cancer*, the AI was 70% accurate whereas human pathologists were only 61% accurate (Kunal et al. 2018).

- Scientists at Stanford have developed a deep learning algorithm (**news.stanford.edu**) that can diagnose 14 types of heart rhythm defects, called arrhythmias, better than cardiologists. The algorithm, detailed in an arXiv paper, performs better than trained cardiologists, and has the added benefit of being able to sort through data from remote locations where people don't have access to cardiologists (Pranav et al. 2017).

- Researchers at USC applied machine learning to measure changes linked to cardiovascular disease (**viterbischool.usc.edu**). Their study was published in *Nature Scientific Reports* (Tavallali et al. 2018).

- In a study published in *Clinical Cancer Research*, deep learning was used to analyse a large set of mammograms to distinguish images with malignant diagnosis from benign lesions (Wu et al. 2018). Deep learning distinguished recalled-benign mammograms from malignant and negative images. This study showed that there are imaging features unique to recalled-benign images that deep learning can identify to help radiologists in decision making to help reduce unnecessary recalls.

- Researchers at the *Lawrence J. Ellison Institute for Transformative Medicine* are developing a platform leveraging machine learning to analyse tissue samples to diagnose breast cancer and assess response to treatment (**ellison.usc.edu**).

- Samsung has applied its AI algorithms to assist diagnosis in each of its imaging modalities increasing the accuracy of diagnosis from 83% to 87% for doctors with four years or less experience (**zdnet.com**).

- A team at Stanford University used deep learning convolutional neural networks to reduce the dosage of gadolinium, a heavy metal used in contrast material for MRI that is often left in the body after an MRI exam (**news-medical.net**).

- In Mexico they are using an AI solution by Lunit INSIGHT for chest radiography and mammography (**itij.com**). It has an accuracy level of 97-99% for chest X-rays and 97% for mammography.
- Zebra Medical Vision AI algorithms help identify patients at risk of osteoporotic fractures and AI algorithms to help identify patients at risk of cardiac events (**itnonline.com**).
- In November 2018, the FDA cleared MaxQ AI Accipio Ix intracranial hemorrhage detection software. This software uses AI to detect brain bleeds (**medgadget.com**).
- In April 2018 the FDA approved marketing of the first medical device to use AI to detect the eye disease in adults who have diabetes. The software uses an AI algorithm to analyse images of the eye (**fda.gov**).
- The NIH and NVIDIA are developing AI tools to support clinical trials. The AI tools will provide precision medicine to patients with brain and liver cancers (**beckershospitalreview.com**).
- A team at Stanford developed an AI algorithm to help radiologists accurately diagnose MRI scans of knee injuries. Doctors diagnosed fewer false positives using the algorithm (**scopeblog.stanford.edu**).
- Bayer and Merck have won a breakthrough device designation from the FDA for software they are jointly developing. The software uses AI to analyse image findings from cardiac, lung perfusion and pulmonary vessels (**pharmaphorum.com**).
- Researchers at Imperial College London and Bayer Pharmaceuticals have formed a partnership to research using machine learning to analyse 3D heart imaging, genetic information, and health data to accelerate drug discovery for heart disease (**imperial.ac.uk**).
- A team at Massachusetts General Hospital in Boston is using AI to diagnose and classify brain haemorrhages using small image data sets. This AI system is as accurate in detecting and classifying intracranial haemorrhages as human radiologists (**economictimes.indiatimes.com**).
- The FDA has cleared IDx-DR, an AI diagnostic system used at the University of Iowa Hospitals and Clinics to AI to analyse images of the retina for signs of diabetic retinopathy. When the AI detects signs of diabetic retinopathy, the AI recommends a follow-up with an ophthalmologist. If it detects no signs of the condition, the system recommends a follow-up screening in one year (**darkdaily.com**). Another AI based diagnostic system for the detection of diabetic retinopathy, detailed in Nature, achieved 87.2% sensitivity and 90.7% specificity in the detection of diabetic retinopathy (Abramoff et al. 2018). ■

KEY POINTS

- ✓ AI algorithms are sometimes more effective and efficient at identifying disease than human experts.
- ✓ AI will help increase access to care in places where radiologists are inaccessible
- ✓ AI will help improve workflow and efficiency
- ✓ Using AI to analyse medical images is the most efficient and cost effective way to screen and help diagnose many diseases and the impact would be huge

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Operationalising AI in radiology

Implementation and integration challenges

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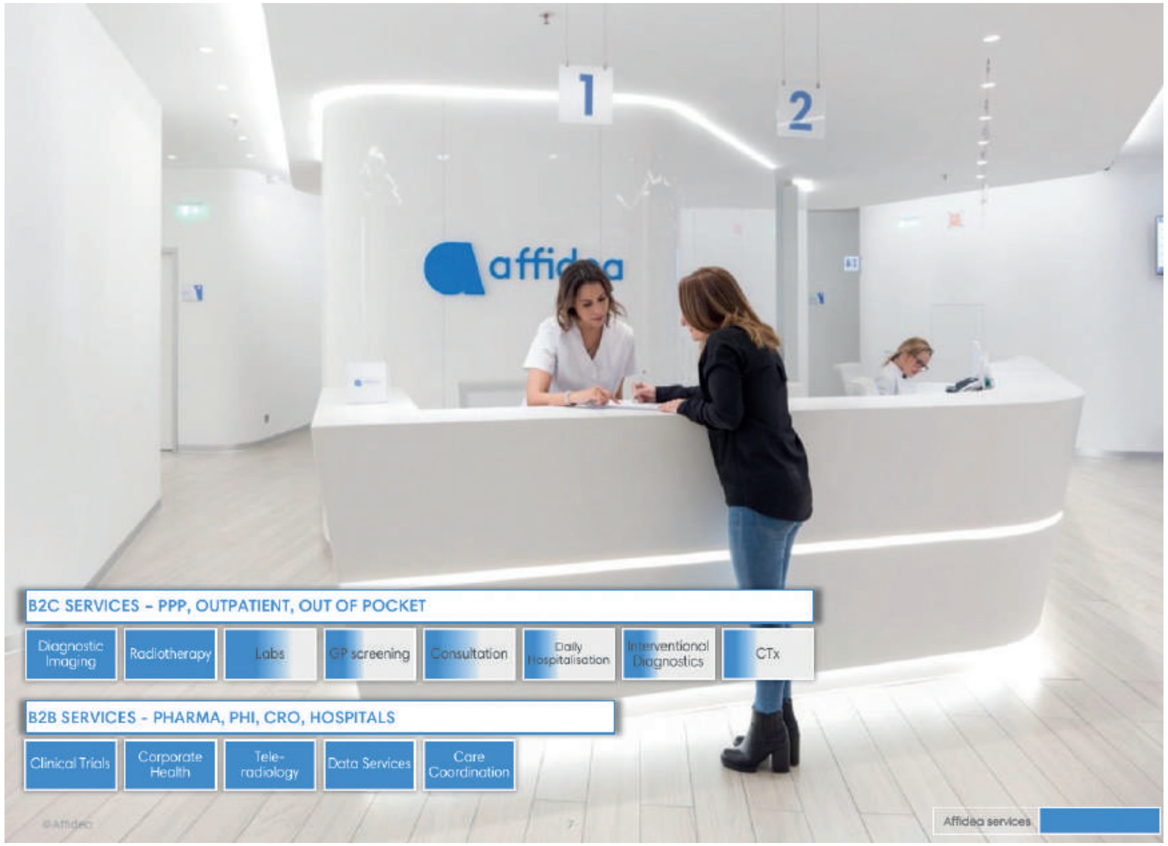

Over the last few years, we have seen a rapid rise in the popularity of Artificial Intelligence (AI). This will be a prime focus for attendees at this year's European Congress of Radiology. As a member of the European Commission's AI Alliance, I am optimistic and excited about the real-world application of AI, but we must first address issues around integration and how best to operationalise this technology.

With access to fast computing and the data sets required to build AI algorithms becoming ubiquitous, we are witnessing an interesting shift from asking if things are possible with AI, to how we can operationalise it. There are two different philosophies in how AI may be implemented – either within a network or by individual centre. On a network level, this allows speed and ease of implementation. However, costs will be greater and data across the network must be consolidated and standardised. If implementing at centre level, there will be no upfront infrastructure costs and piloting AI will be less expensive. The disadvantage of this approach is its difficulty in scaling up should it prove to be of value, and should the wrong centre be chosen an erroneous opinion of the efficacy of the application may be inferred.

"IT WILL BE FASCINATING TO SEE WHETHER THERE WILL BE FIRST MOVER ADVANTAGE IN PLAY, AND HOW COUNTRIES ADAPT TO THE NEW REALITY OF AI POWERED HEALTHCARE"

Demonstrating the value of AI is a challenge in the real world and will be at the top of the healthcare agenda over the next few years. Cost/ benefit analyses need to be undertaken and the results quantified. For example, in a recently published radiology article – a breast AI application improved accuracy but not speed of reporting when compared to a group of expert breast radiologists. In terms of cost, every healthcare system will differ on who pays for AI and how much they are willing to pay. In some countries such as the US, tariffs are already in place for the use of computer aided diagnosis (CAD) systems – this is not so common in Europe and almost unheard of outside a few selected specialties.

At Affidea we have an ideal environment to answer many of these questions that will arise as more and more applications become certified. Firstly we have standardisation of data input with the CT Dose Excellence and MR Excellence programs; these are the largest CT dose and MR sequence optimisation programs running globally (to my knowledge) that unifies both the sequences used (by body part and by indication) and the underlying master data. Secondly, we have a common imaging network across 8 of our countries (to be 10 by the end of 2019) which provides both scale and ease of implementation. Thirdly, our subspecialty groups enable us to leverage the human expertise from across our countries to inform the excellence programs and develop new clinical products that can be rolled out through the Affidea Academy and Centres of Excellence. Ultimately, this combination of process management and clinical excellence can be offered to third parties through teleradiology and will be a vehicle to offer embedded AI tools as they come online.

Geographical coverage of 16 countries in and around Europe provides access to 16 unique healthcare markets. We have learned that one size definitely does not fit all when it comes to what healthcare payors prioritise and accept - be that State, Insurance company or our own patients who pay directly. We are in the process of piloting several different AI solutions to look for answers to these very questions; not if they work, but how to make them work in the real world at scale. It will be fascinating to see whether there will be first mover advantage in play, and how countries adapt to the new reality of AI powered health care. ■

Affidea at a glance:

- Multinational healthcare provider, with presence in 246 centres across 16 countries in Europe, providing high quality affordable care for millions of patients every year.
- Working with over 7,500 professionals, producing 13 million scans every year.
- Affidea is the only healthcare operator in Europe to sit on the Imaging Advisory Board of IBM Watson Health and also sits on Microsoft Cloud's board
- 50% of the European winning centres awarded by the European Society of Radiology belong to Affidea

Future of ultrasound: where are we going?

CEUS for children, ultrasound simulation and gamification models for training and education, EFSUMB initiatives.

Prof. Sidhu, EFSUMB president, talks to Healthmanagement.org about his ECR 2019 presentations: using ultrasound simulation models as tools for training and education, the greatest potential in combining ultrasound with contrast-enhanced ultrasound in examining children and new initiatives in the pipeline leading to EUROSON 2019.

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At ECR 2019 you address the question "where are we going" on the use of ultrasound simulation models as tools in training and education. Which technical procedures do you see applied in a radiology curriculum?

There's a lot of simulation-based scanning at the moment, and it's really the abdominal and pelvic imaging that's becoming quite popular, including trans-intracavity ultrasound, trans-vaginal and trans-rectal procedures that can be applied to teach people using these simulation-based models. The country that's doing most of this work, at the moment, is Denmark and in his presentation during this session, Prof. Michael Bachmann Nielsen, who leads on this project, is presenting their findings. It's quite exciting because the studies have shown that simulators work just as well when applied to training as live models do and of course the benefit is that this is not patient-dependent and its uniform, so it's a very good aspect for education particularly early in the learning process.

What are the advantages and challenges of implementing the different types of ultrasound simulators?

The first challenge will be to overcome reactionary attitudes to the application of simulators to teach; patient-based learning has been the bedrock of education for a long time. Traditionalists will not want to use it on models when not using an actual patient. That first success for the introduction of a simulator will be to demonstrate that using these models effectively teaches the very basic aspects of ultrasound to a competent level. The second hurdle will be to acquire these simulators. They will involve an initial forward investment, and people have to put capital costs out there to get the simulators in place, and then use them. Bearing in mind of course once you've got the model you can upgrade all the software etc. over time and you've got a simulator model for a long period. Those are, in my opinion, the two main hurdles.

What do you believe is the potential to using virtual reality and gamification for training and education?

This is a really exciting area. Again, Prof. Bachmann Nielsen is leading on this out of Denmark, and they are investigating the potential of using all of these procedures and techniques to help in the training of ultrasound. It's in the early stages, but the technology and the software is there from all the other aspects that physicians use it for and it's going to inevitably be applied to training for ultrasound. It's coming.

Are other countries also using simulation tools successfully?

Yes. In the UK, the company that manufactures some of these simulation tools is from Wales, and they are using them in some of the training schemes in the UK as well, on a smaller scale. They are also applying these tools in the United States of America. I'm not familiar where else they're using it in Europe but hopefully during the session people from other countries will be sharing their experience.

Do you believe that these new technology techniques will be included in the daily work of the radiologist? Could they improve your work?

Some of this technology is already there in our daily practice in imaging. An example being fusion imaging, which enables you to use new 'gaming' technology. Fusion imaging has been around for a few years, and we are able to use the technique while performing an ultrasound to precisely match findings from CT or MR imaging. When you're trying to detect a lesion, in effect, you are using the gaming technology to find the lesion by setting coordinate points to pinpoint the area precisely for your ultrasound examination, confidently knowing you are looking at the same thing. It is already done in practice, and this will continue to improve with the continued innovation in software and new technologies.

You are presenting the Luigi Oliva Honorary lecture at ECR 2019. You are a pioneer in contrast-enhanced ultrasound and also for the application in children. What do you see as the greatest potential in combining ultrasound with contrast-enhanced ultrasound in examining children?

There are a couple of areas where the combination is most important, particularly when considering the example of children who present with blunt abdominal trauma. It is critically important to look at the right area, getting the right diagnosis and avoiding repeated CT examinations.

In a child with trauma, it is best to have the mother or father in the room which is not possible during an MRI or CT exam, but it can happen very easily with ultrasound. The child can be running around the room, jumping back on the examination couch and proceeding with the ultrasound examination, without disruption to the scanning protocol. Furthermore, the child's parent(s) in the room makes all the difference, and is not problematic for the imaging procedure.

I see this as a very exciting area, but also expansion in other areas in children, is developing particularly following the approval by the FDA for investigating the liver for determining the characteristics of focal lesions in children. This method again eliminates the need for MR and CT examinations that are currently needed to characterise these lesions. Ultrasound can be of better use in these cases as it is child friendly, does not require sedation or anaesthesia and the child has the comfort of a parent during the whole examination.

Combining ultrasound with contrast-enhanced ultrasound can be used in a number of other places when you think outside the box. Consider it a problem-solving tool, for example, when looking at the chest cavity, the lungs may be assessed for areas of consolidation or for the overlying empyema; adequate information to assess the need for a catheter drainage can be scrutinised easily. This essentially helps the clinician to target the right areas safely and adequately to ultimately help the child.

Is contrast-enhanced ultrasound for assessing children ready for clinical practice?

Part of my presentation is focused on proving contrast-enhanced ultrasound is indeed ready for clinical practice. I will be presenting cases and circumstances where contrast-enhanced ultrasound is all that is really needed for the accurate diagnosis for the child. Therefore, I am confident it is ready for clinical use.

I want to highlight that the main reason for using ultrasound for children is that it is the best imaging modality for the child. It is patient-friendly, even in cases when CT or MR exams are required. If you can avoid radiation, or avoid sedation, administering a general anaesthetic, or iodinated gadolinium contrast agents in the child, you are helping in your role as a physician. The ultrasound contrast is safe for and should be used as often as possible to achieve a diagnosis.

What is the legal aspect to clinical applications of CEUS in children?

I will talk about the legal aspect of CEUS, and it is very important to know that nearly 70% of the medication used in children is off-licence, but as a physician, you know how the medicines work, and can take responsibility for this and can proceed to use them in an unlicensed manner. It is only recently become licensed in the United States, and it is used mainly to determine focal liver lesions and in vesico-ureteric reflux studies.

In Europe, there is no licensed intravenous application in children, but it is nevertheless used widely as it presents great benefit. It is safe for the child and helps reach an accurate diagnosis. I will be talking more in depth during the session discussing why it is safe and perfectly acceptable to be applied as a tool of diagnosis for children.

Do you see any potential developments in the next 3-5 years that could be applied to better assessing children?

I know that researchers in the U.S. at the Children's Hospital of Philadelphia (**chop.edu**) are currently looking at the use of contrast-enhanced ultrasound in assessing the neonatal brain, and considering it a tool for determining extent of ischaemia which is very important for prognosis. Neurosurgeons are also looking at perfusion of the brain in children when they are performing tumour resection allowing the assessment of tumour boundaries for adequate resection; often intra-operative MRI is the alternative, which is cumbersome and costly, not widely available. However, we are still at the early stages.

In May, EFSUMB and FESUMB will welcome the imaging and ultrasound community to Granada for EUROSON 2019. What are the highlights physicians can look forward to?

We are very excited about Granada! Granada is a fantastic city in Spain with a very rich cultural history, and I would recommend anyone who is interested in the history of that area of the world to come and visit Granada. The conference centre is excellent with good facilities, and we have up to six parallel sessions each day at the conference, over three days.

There will be discussions on all aspects concerning ultrasound, from gynaecology right through to the newest advances in contrast-enhanced ultrasound (CEUS). Breakthroughs from new scientific evidence will be presented in the scientific sessions. In addition, we will have a Young Investigators section where the cream of the young investigator participants of the European societies will battle it out for the chance to win the large prize we are offering to the best investigator. This is a very popular section of the meeting.

We will also be launching all the new guidelines that have been recently published by EFSUMB. The most important of these will be the guidelines on non-liver elastography which will be very shortly available online. This will be one of the highlights of the meeting, as it will identify where ultrasound is most useful in all aspects of elastography outside the liver.

What are the new initiatives you are working on with EFSUMB?

We are launching a number of new initiatives. In particular, we are working on many new guidelines including specific ones for point-of-care-ultrasound (POCUS), musculoskeletal guidelines and continuing with the renowned gastrointestinal guidelines. Assessment of the gastrointestinal tract will be the fifth and sixth set of new guidelines.

This compliments the most recently published statement on the use of handheld ultrasound devices.

Looking to the future, we are working on restructuring the society itself, hopefully opening up to more membership, not just in Europe, but across the world and making it a very attractive organisation in ultrasound education throughout the world. In addition, we are looking at the EUROSON Congress trying to upgrade it and update it to make it more attractive worldwide to physicians and people interested in ultrasound.

Exciting times! With even more improvement planned for the future, we are very excited about the potential to opening up the society internationally and restructuring the meeting in the future. ■

KEY POINTS

- ✓ Simulators work just as well when applied to training as using live models with guaranteed uniformity, which is a very good aspect for early education.
- ✓ Ultrasound can be better than CT or MRI in selected paediatric cases being non-invasive, pain-free, real time and the child does not have to experience the examination without a parent beside them; ultrasound is child friendly.
- ✓ Ultrasound is ultimately the best imaging modality for the child, with high resolution when applied to the correct situation, avoids radiation and sedation or a general anaesthetic, circumventing iodinated or gadolinium contrast agents assisting the physician to do best for the child.
- ✓ EFSUMB is currently restructuring the society, opening up and making it a very attractive organisation in ultrasound education throughout the world and updating the EUROSON Congress to welcome an international audience.

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ELEVATING HEALTHCARE

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Table of contents

Unleashing the full potential of AI

The digital revolution has changed every aspect of our lives – from the way we communicate to the way we live and interact. We are slowly moving towards this transformation in healthcare, where big data, predictive analytics and artificial intelligence (AI) can do for healthare what it has done for other industries.

We have already started to see some of its benefits, from image interpretation to automating workflows and improving operational efficiency. For example, algorithms capable of distinguishing between normal and abnormal pediatric brain MRI scans and NASA-style Command Centers that can provide real-time, predictive and actionable insights, already exist. But this is just the tip of the iceberg.

The explosion of clinical, genomic and imaging data has created a path for precision health –taking the right action at the right time for each individual patient and personalizing the diagnosis, treatment and monitoring based on their unique needs.

By effectively integrating data and analytics across the care pathway, medical professionals and staff can be better supported with insights that enable them to bring care that is more efficient, predictive and individualized.

AI is central to achieving precision health. It can integrate and make sense of the data, helping to improve provider efficiency, increase diagnostic accuracy, personalize treatments, and drive higher quality care.

The promise of AI is exciting but there is still a lot of work to be done, and it's important not to over-promise. Even though these techniques will change the interaction between doctors and patients and change how care is delivered, they should not be overtly noticed. Improving the patient experience, provider productivity, diagnostic accuracy and overall quality of care won't happen overnight or as part of some massive disruption.

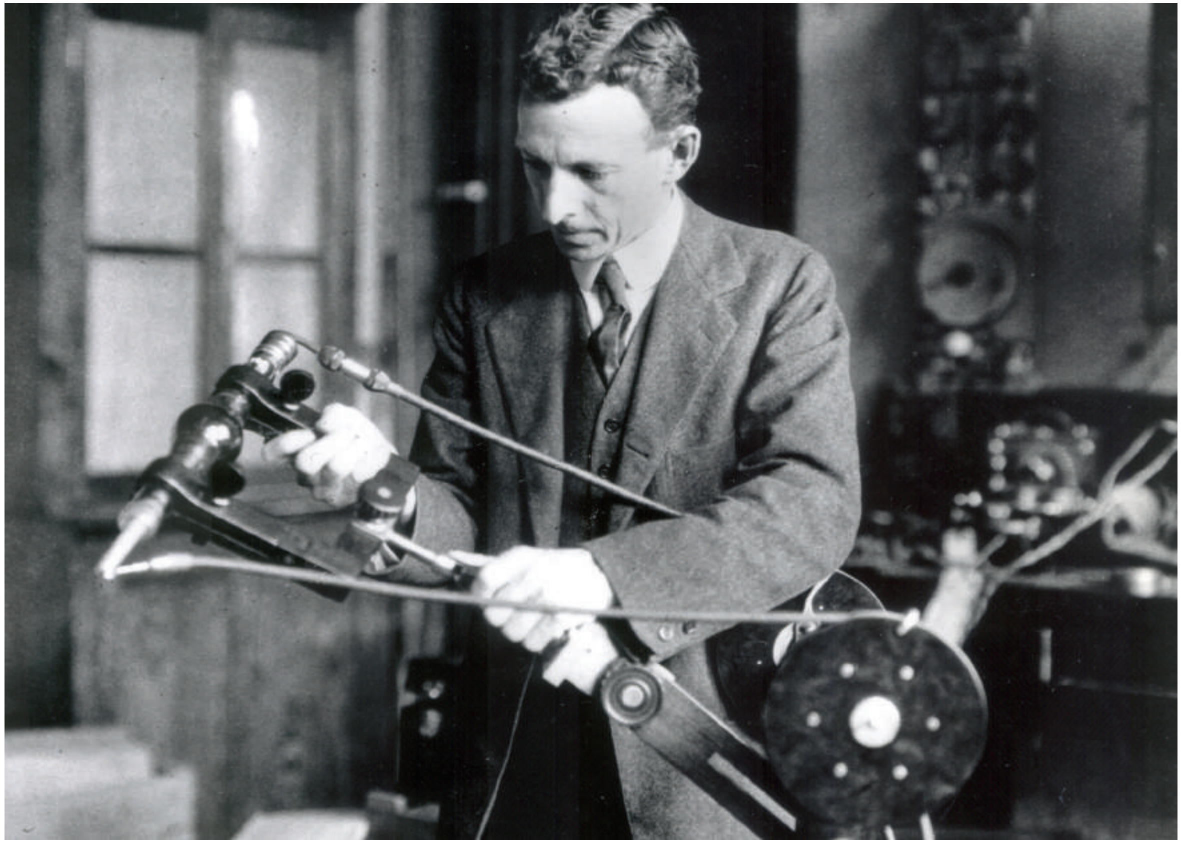
The best AI will evolve invisibly with and into the existing care continuum – embedded into workflows, applications and devices already in use today, making way for a more personal doctor-to-patient experience.

To do AI right, academic institutions, regulatory entities, governments and other industry partners will need to come together – practically, methodically and for the benefit, safety and privacy of the patient. The work to ensure safe, ethical and effective use of AI will never stop – and we are committed to keep at it. ■

Catherine Estrampes
President & CEO, GE Healthcare Europe

One of the largest AI platforms in healthcare is one you've never heard of, until now

Newly announced apps and AI-powered devices built on "Edison" demonstrate why an ability to integrate data from millions of systems and devices may bring real change to the healthcare industry



For years, advocates have hyped Artificial Intelligence's (AI) potential to do for healthcare what it's doing for other industries – personalize recommendations, prioritize searches, and tag pictures. Investments have reflected the excitement, with the healthcare AI market expected to reach $6.6B by 2021.

"People see smart computers all around them – Apple's Siri, Amazon's Alexa, Tesla's self-driving car – and they think healthcare should be the same. Obviously, healthcare is far more complex, requires much higher accuracy, and has less margin for error," said Dr. Michael Blum, Associate Vice Chancellor for Informatics, University of California, San Francisco (UCSF).

However, disparate efforts, different systems, massive amounts of data and layers of complexity have meant the industry remains largely unchanged. Fortunately, most hospitals have at least one thing in common: imaging machines – the technology radiologists use to scan, diagnose and treat patients and the largest generator of healthcare data. A staggering 90 percent of all healthcare data comes from imaging technology, yet 97 percent of it goes

> By alerting the clinicians immediatly, [the algorithm] would allow us to actually speed up the timely diagnosis of a potentially life-threatening condition.
>
> *Dr.Rachael Callcut,*
> Associate Professor of Surgery, UCSF & Director of Data Science, Center of Digital Health Innovation

unanalyzed or unused. Given these statistics, many argue this medical tech is a prime contender for AI.

New information announced today may prove just that. "Edison," a nod to the breakthrough inventor and General Electric's founder, is an intelligence platform built to connect data from millions of imaging devices. It has quietly been spurring apps and AI-powered devices that are showing real results.

In fact, these apps and AI-powered devices are already said to be helping clinicians improve scan consistency, detect and prioritize acute cases, and extend the lifecycle of devices. The platform's ability to add value to hospitals' existing infrastructure, so technology that was installed previously can now be upgraded to have new analytics and AI capabilities, may be why it has flown under the radar as it quietly amasses results.

"This isn't about some flashy gadget or moonshot AI," said Keith Bigelow, Senior Vice President of Edison Portfolio Strategy at GE Healthcare. "Edison powers pioneering but practical technologies that improve the workflows and devices of today and target the greatest pain points in the system."

At hospitals like the University of California, San Francisco (UCSF) Medical Center, clinicians were looking for opportunities to read STAT chest X-Rays faster – exams reserved for potentially life-threatening circumstances – so they could diagnose critical patients quicker.

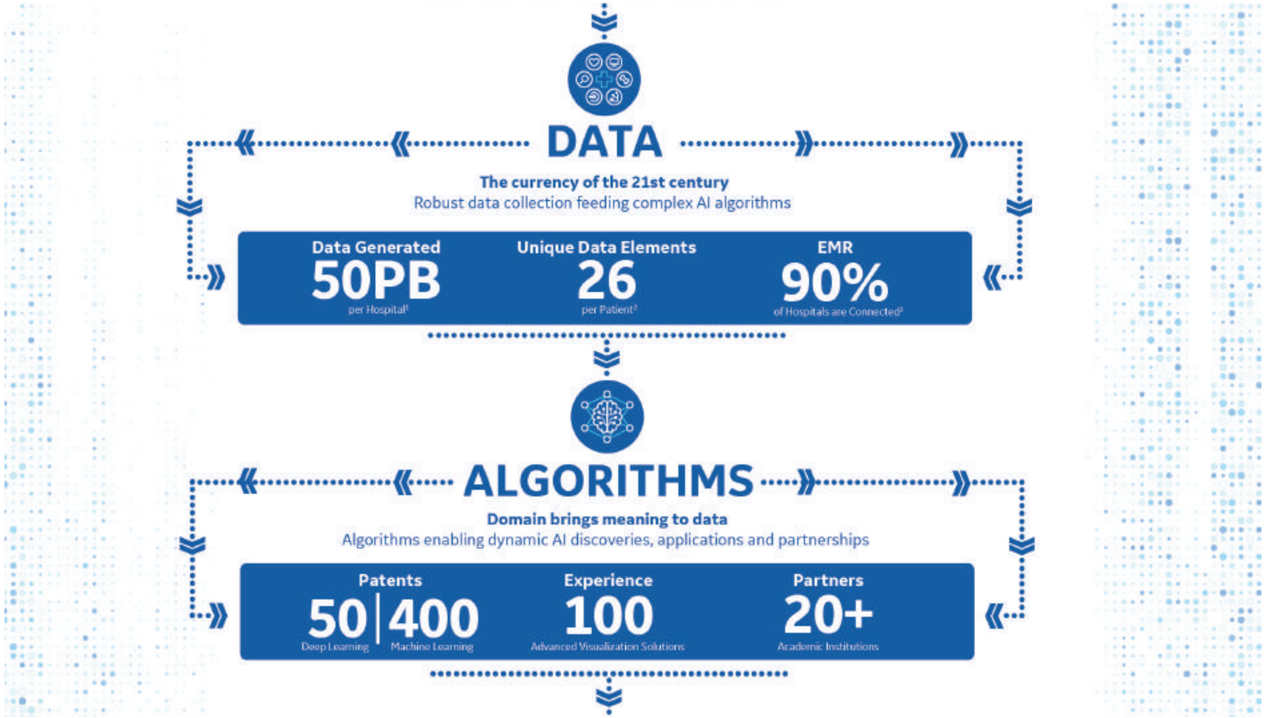
Dr. Rachael Callcut, Associate Professor of Surgery at the University of California, San Francisco (UCSF) Medical Center and Director of Data Science for the Center for Digital Health Innovation, partnered with her radiology colleagues and GE Healthcare to create an initial algorithm that can detect pneumothorax, a condition which strikes nearly 74,000 Americans each year[1] and can be deadly if not diagnosed quickly and accurately.[2] The challenge: a patient with this condition could wait between two to eight hours for his or her X-Ray to be read.[3]

Today, Dr. Callcut and the UCSF team's use case and data science approach has become a suite of algorithms, known as Critical Care Suite* on the mobile Optima XR240amx X-Ray system, powered by the Edison platform, that can alert the clinical team of potential pneumothorax cases as soon as the patients are scanned, so they can prioritize reading them.

"The concept behind this was to develop an algorithm using artificial intelligence (AI) that could actually learn how to find pneumothorax on a chest X-Ray," Dr. Callcut said. "And by alerting the clinicians immediately, it would allow us to actually speed up the timely diagnosis of a potentially life-threatening condition."

To validate the algorithm in different clinical environments, UCSF and healthcare institutions from all over the world, including St. Luke's University Health Network, Humber River Hospital in Toronto, Canada, and Mahajan Imaging in New Delhi, India, worked alongside GE Healthcare to replicate the initial work carried out in acquiring and annotating images.

Elsewhere, Edison's access across multiple MRI systems enabled developers to create a workflow – called AIRx* — that uses deep learning and anatomy recognition to learn from a database of more than 36,000 brain images. And,



from this, they could reduce a manual step that previously plagued radiologists during brain scans. It is also designed to increase consistency between scans and between techs, which can help lower the chances of patient needing to be recalled due to incorrect slice placement. Consistency is particularly important when doing longitudinal assessments for neurological disease.

Bigelow emphasized Edison's ability to upgrade existing infrastructure like CT machines to the latest software, rather than replacing these large, critical pieces of hospital infrastructure.

"With access to the latest applications and services, an older version of a mobile phone becomes just as valuable as the newer version," Bigelow said. "In a way, this is what Edison brings to healthcare technology."

Edison's makers say its goal is to continue quietly, humbly but effectively unleashing value for a wide variety of professionals across the healthcare system. Hospital executives can benefit from upgrading existing devices, and clinicians who use Edison apps can be assured by the fact that algorithms were developed with and validated by a best-in-class ecosystem of clinical and technology partners. Developers who use Edison will benefit from a common integrated platform that brings together globally diverse data from across modalities, vendors and care settings.

GE Healthcare says it ultimately plans to open the platform and 100+ services to more developers and partners, which could accelerate both the development and adoption of AI technology.

It was Thomas Edison, the inventor after whom the platform is named, who famously said, "I have not failed. I've just found 10,000 ways that won't work."

The healthcare industry needs this perseverance, but it also needs progress – fast. Embodying this mindset, Edison powered devices and applications are accelerating innovation and improving patient care.

"Thanks to advances in computing power and data science, we have entered a new era of medicine," Dr. Blum said. "We now have a tremendous opportunity to improve the quality and efficiency of care, and prevention and prediction for an individual are finally going to be possible." ■

[1] https://www.bmj.com/content/348/bmj.g2928

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How do you serve more patients without adding staff or beds? Here's one hospital's answer

UK hospital announces first-of-its-kind hospital Command Center in Europe to improve efficiency and patient care

Every day, up to 400 people come through the Emergency Department (ED) doors at Bradford Royal Infirmary (BRI) in northern England. The hospital serves 500,000 people who live in Bradford and communities across Yorkshire, one of the largest regions in all of England. Over the last decade, ED attendances have grown by more than 40% to 125,000 ED attendances, driving a bed capacity rate that routinely exceeds 96%*.

It all paints a clear picture of the growing demand on the region's healthcare system. That's why BRI, part of Bradford Teaching Hospitals NHS Foundation Trust, is pioneering the first Command Centre of its kind in collaboration with GE Healthcare.

This BRI Command Centre will operate like an air traffic control centre, using advanced technology and Artificial Intelligence (AI) to efficiently move patients coming into the ED into, through and out of BRI. With this advanced functionality, the Centre should help BRI cut waiting times, treat more patients, improve the patient experience, and reduce pressure on staff.

Specifically, the Command Centre aims to decrease patients' length of stay, reduce the need for additional wards and beds – especially during peak winter times – and reduce cancellations for non-emergency surgery.

It should also help the Trust meet national emergency care access standards, which require that 95% of patients are treated, admitted or transferred within 4 hours. What's more, it will shine a light on increasing demand, pressure and risk that may affect the quality of care that patients receive – prompting interventions and proactive action.

"Demand for services is growing at Bradford Teaching Hospitals every year" said Professor Clive Kay, Chief Executive of Bradford Teaching Hospitals NHS Foundation Trust. "The Command Centre will enable us to optimise our use of resources and improve how we move patients around the hospital for treatment and successful discharge. Around 350-400 patients come through our A&E every day, and relieving pressure on our 6,000 staff means they can spend more time delivering care, and less time organising care."

The BRI Command Centre

One of the secrets to the Command Centre's internal workings is what GE Healthcare calls a Wall of Analytics, a literal wall visible to all who step inside the centre that processes real-time data from multiple source systems across the hospital and triggers cross-functional staff co-located in the Command Centre to take action.

This constantly pulls in streams of data from multiple systems at the hospital. Advanced algorithms will help staff to anticipate and resolve bottlenecks in care delivery before they occur, recommending actions to enable faster, more responsive patient care and better allocation of resources. The data will be displayed on multiple high-definition screens in the Command Centre, as well as on tablets and mobile devices, providing 24/7 support to busy medical teams across the hospital.

> "Relieving pressure on our staff means they can spend more time delivering care and less time organizing care. The Command Center will enable us to maximize the use of recources and improve how we move patients around the hospital to successful discharge.
>
> *Professor Clive Kay,*
> CEO of Brandord Teaching Hospitals NHS Foundation Trust.

A combination of historical Trust data and real-time data will be fed through the system. Using GE's proprietary Hospital of the Future simulation, algorithms and AI, the system will generate predictive analytics that will help staff recognise patterns in real-time and predict what will happen in the next 24 to 48 hours.

With the data they need at their fingertips, staff will spend less time navigating through different IT systems to get the information they need to make quick decisions. The Command Centre also provides a single, agreed view of the status of the hospital and helps staff to prioritise tasks.

The future of healthcare

Industry experts say that this type of digitisation is not only inevitable but is only the beginning. Deloitte's Center for Health Solutions report cites centralised digital centres to enable decision-making as one of the major changes the hospital of the future will need to implement in order to function in a world of evolving technologies, demographic shifts and economic changes.

In 2017, Humber River Hospital (HRH) in Canada implemented a Command Centre to address similar patient flow problems as BRI. Despite an 8% increase in patient visits to the Emergency Department, the Centre helped HRH reduce the time a patient in the Emergency Department waited for an inpatient bed by 33%.

Johns Hopkins Hospital was an early adopter of the Command Centre, which helped them transfer patients to other hospitals 60% faster, reduce wait times in the ED by 25%, and time spent waiting in the operating room for a post-surgical bed decreased by 70%.

Oregon Health & Science University (OHSU) was first to leverage GE Healthcare's Command Centre to support better management of sepsis care. Each patient within OHSU's electronic medical systems gets a sepsis risk score. If the score is higher than a given level, it will display on the sepsis tile, indicating that the patient may have sepsis or is at risk, at which time the "mission controller" actively monitors if the appropriate actions are being taken by the bedside nurse and provider teams to asses for sepsis and treat sepsis if present.

The Command Centre at BRI is scheduled to open in spring 2019 and expand services over a four-year period.

cqc.org.uk/sites/default/files/new_reports/AAAH1903.pdf. ■

Analytics in the real world: How one radiology practice is helping patients get an MR exam, faster

Combining applied intelligence, analytics and technologies enabled a radiology center in Germany to reduce patient wait times for an MR exam from 6-8 weeks to just 1-2 weeks

Radiomed, a private practice with nine locations across west-central Germany, recently led a pioneering project combining digital tools with MR technology to increase productivity and quality in imaging.

The program brings together two of the top trends in MR imaging: applied Intelligence, helping doctors find and consolidate relevant data that has the potential to improve patient care and boost workflow, and data-fueled analytics, to dig deeper into that data to make business decisions for improved efficiency and patient care.

"We entered the project to improve MR performance, and what happened since then is beyond my expectations," says Dr. Christopher Ahlers, in Wiesbaden, Germany. "We've been able to increase productivity while maintaining quality, and in some points improving quality because we now spend time on things we feel are most important."

Radiomed sees approximately 150,000 patients and conducts 35,000 MR exams every year. In February 2016, Dr. Ahlers partnered with GE Healthcare to develop the MR Excellence Program.

> We entered the project to improve MR performance, and what happened since then is beyond my expectations
>
> *Dr. Christofer Ahlers, MD,*
> Radiologist and Managing Partner at Radiomed

Now radiomed has analyzed data from its seven MR systems to improve workflows and protocols, significantly reducing waiting time while reducing stress among the clinic's staff.

The program started by defining several key performance indicators that would give radiomed insight into productivity and quality of care. GE then built an IT-based solution that brings together machine data from the MR system during the scan, image data from the PACS, and patient data from the RIS. It then aggregates this data and displays it in a dashboard, where management can analyze workflows, machine utilization, protocols and referral patterns to draw conclusions about productivity and workflow.

As a result, the practice saw up to 30% increase in productivity and increased MR scans from about 120 per week to about 170 per week. What's more, patient wait times for an exam dropped from 6-8 weeks to just 1-2 weeks.

"It doesn't help if you're scanning faster when you don't adapt your scheduling," says Dr. Ahlers. "The paradigm change is to actually real-time monitor what you're doing, and to iteratively look at where you lose your time to make this a sequential adaption process. This makes the whole process much more dynamic."

Although streamlining the patient experience was the key goal, radiology techs at radiomed reported benefits too.

"Due to better scheduling, we don't have to take so many overtime hours. Through this simplification, we have less stress and it is more pleasant working," says Julia Köhler, radiographer at radiomed.

"I must admit, I am deeply impressed by what has been achieved," Dr. Ahlers says. "It opens insights into our workflows and productivity that I couldn´t imagine one year ago. This project will have a tremendous impact on how we work in the near future and will make us rethink what we do in MR."

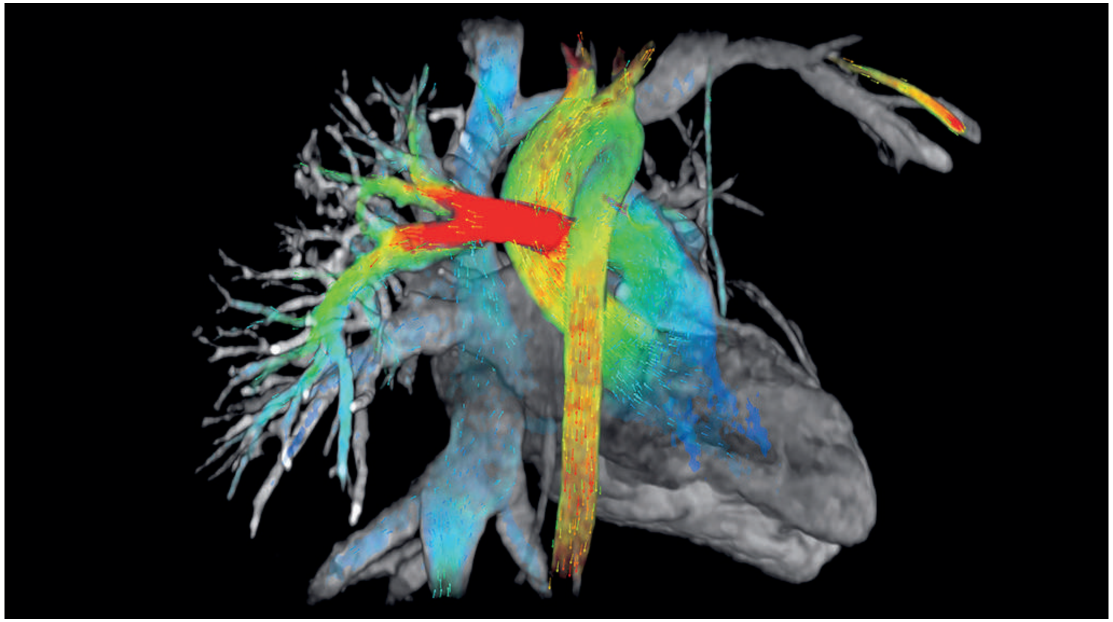
This actionable data is critical to keeping up with faster imaging technology and is part of the larger shift to dynamic, analytics-based business decisions.

Dr. Ahlers will pilot a similar CT excellence program later this year, and he expects to have actionable data by the end of 2018.

"Doing this together with GE opens the door to implement these ideas into an IT-based solution," he says. "Besides selling equipment, GE continues to improve the spectrum of services they offer that really make all of this a holistic approach to radiology, and we really appreciate that. We don't buy only a machine anymore, but we also have a partner onboard that helps us to optimally use our systems and to deliver the best possible care to our patients." ■

This cardiac software originating from a Stanford basement is now one of the top of Artificial Intelligence solutions available

Dr. Albert Hsiao aco-developed the new ViosWorks MR software package to help speed up cardiac MRI exams



t all started with a simple request made in the depths of one of the nation's best hospitals

"Hey, I want to show you something."

Anja Brau was finishing up a meeting in the basement of Stanford Hospital with Dr. Albert Hsiao, MD, PhD, then a radiology resident at Stanford. Hsiao, who has an undergraduate degree in Computer Science and PhD in Bioengineering, wanted to show her the cardiac software he wrote to visualize 4D blood flow data acquired from an MRI sequence developed at Stanford to capture cardiovascular flow and anatomy in a single scan. He'd been playing around with the code in his free time for years, but he thought he finally had something to share.

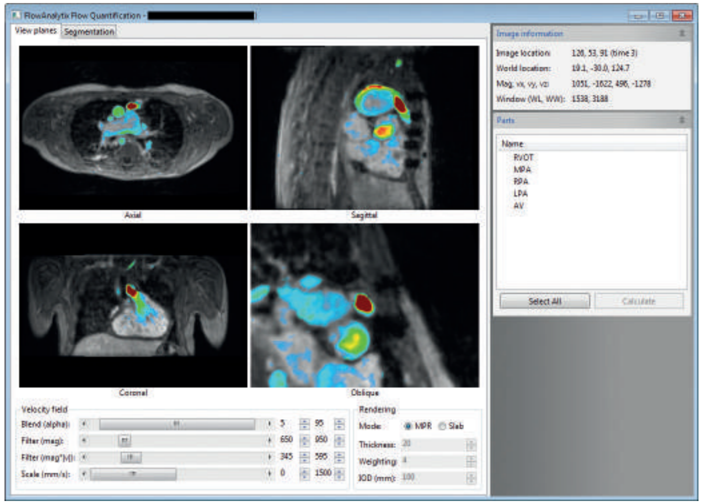
Brau worked for GE Healthcare, a longstanding partner of Stanford and doctors like Dr. Hsiao in developing new MR technologies to help diagnose heart disease. When she looked at Dr. Hsiao's computer screen, she immediately knew they were looking at something special.

"I remember he showed me these color flow 3D renderings of beating hearts. I said, 'Where did you get this?' and Albert said, 'I wrote this.' It was amazing – it was already much better than what we were looking at with other software packages."

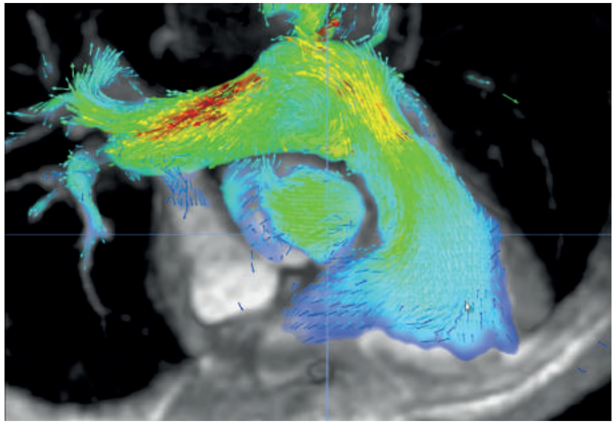
Hsiao, Brau, and others worked together to refine the imaging software for clinical use and now it forms the foundation of ViosWorks, a groundbreaking new MR software solution that can complete a scan of cardiovascular anatomy, function and flow in 10 minutes or less – significantly streamlining cardiac MRI exams that historically took an hour or two to perform.

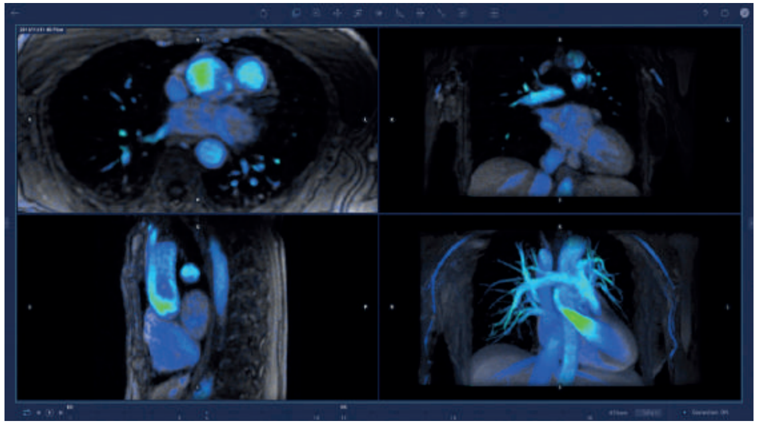
ViosWorks helps physicians see the heart like never before by displaying results in 7 dimensions: 3 in space, 1 in time, and 3 directions of velocity. It shows the blood

Hsiao working on the code for what would become ViosWorks



Screenshot of the prototype interface that Albert wrote in the basement at Stanford





Screenshot of the ViosWorks interface measuring cardiac anatomy, function and flow

flow in the heart as a moving image, much like a 3D animated movie, and allows clinicians to rotate and view the image from any angle.

Offering quantitative measurement of blood flow, ViosWorks can help clinicians tell whether blood is flowing through the heart the way it should be or whether there are cardiovascular anomalies that may require surgical intervention. Conventional MR techniques to measure flow are limited to 2D cross-sectional views of the anatomy rather than a full 3D volume and are very time-consuming to acquire and analyze.

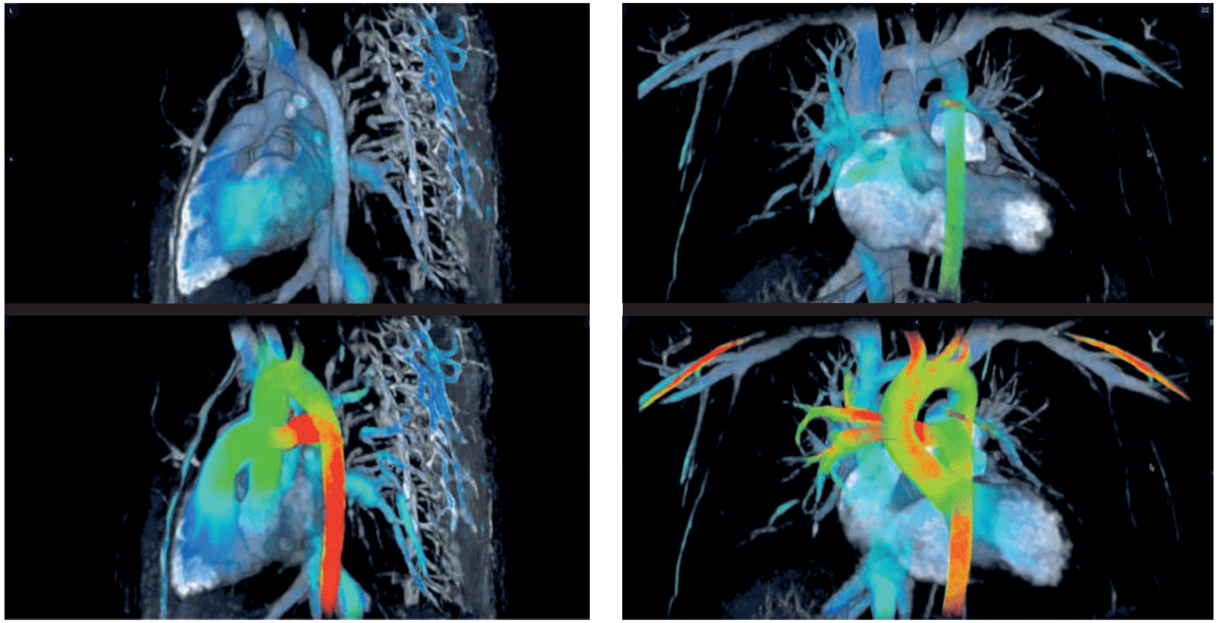
"There's a bit of a learning curve to how to use it since it is such a paradigm shift from 2D flow imaging, but once physicians learn it, they love it due to its speed, simplicity, and intuitive 3D representation of cardiovascular health," says Brau.

Dr. Hsiao uses his technology in clinical settings nearly every day. "It's a little bit anticlimactic because it's so routine now. I hardly even think about it," he says. "The exams are really simple. We can typically get the clinical exam done in under a half an hour and have time to spare for developing the next great technology. And it's all because of ViosWorks."

The software and algorithms in ViosWorks not only help speed up the cardiac imaging process, it provides high quality images. Plus, patients don't have to hold their breath, and the faster exams mean that facilities can serve up more patients in the same time.

Dr. Hsiao says the relationship between GE and Stanford was the first step in making ViosWorks a reality.

"The whole concept of collaboration between GE and Stanford [and now GE and UC San Diego School of Medicine, where Hsiao is currently assistant professor and associate



director of cardiovascular imaging for the Center for Translational Imaging and Precision Medicine] is really core to why this was even possible. It proves how long-term academic-industry partnerships can be really fruitful," he says.

AI and the future of MR

ViosWorks is powered by Arterys, the company Dr. Hsiao co-founded in 2012 to specialize in web-based medical imaging analytics powered by Artificial Intelligence (AI). It offers innovative cloud supercomputing and AI assistance to accelerate physicians' day-to-day workflow.

When Dr. Hsiao first started adjusting Stanford's MR scanners to capture information for his software, they captured so much raw data that hospital computers couldn't efficiently process it all into images that doctors could interpret.

To address this hurdle, Dr. Hsiao and Arterys looked to the technologies behind modern 3D video games to distribute large amounts of 3D data across many graphics processing unit (GPU) cores. Along with this approach, Arterys was able to develop a cloud-based system to manage and rapidly process the gigabytes of MR data behind each cardiac image.

"In many ways, Arterys broke the mold on how image analysis is done and what the infrastructure is to support it. We're just beginning to scratch the surface of what is possible for that infrastructure, and Arterys continues to add analytics," says Brau.

Arterys was the first company to receive FDA-clearance for an AI algorithm on the cloud, which they developed to measure the size and function of the heart. In the past, to measure the function of the heart, Dr. Hsiao drew circles on the images to measure the size of the heart's chambers.

"We were basically a bunch of highly paid kindergarteners using the equivalent of Microsoft Paint," he says. "Now we've trained an AI algorithm to calculate the heart volumes and function, which is a lot more efficient use of time."

"There is a lot of data that is inaccessible to us in the images. Since we only have so much time to render a diagnosis or analysis, we are only able to use a fraction of that information clinically. AI can help us get to that, to potentially be a tool that can automatically gather quantitative data, better predict prognosis and help us sustain our patients longer before resorting to heart transplantation," says Dr. Hsiao.

"We can apply AI to take on the world's most extreme kindergarten circling exercise on the thousands of images that we collect in a single exam," he says. "Piece by piece, we're taking down these mind-numbing tasks, giving them to AI, and making the physician more useful so more time can be focused on the patient."

Soon, he believes these advancements in AI will be applied to many other diseases, such as cancer.

"If we could combine imaging and genomic data, it would be powerful," he says. "We simply don't have the ability yet to sort through the massive amounts of individual patient data that comes from the combination of these two sets of technologies. But we are beginning to see the promise of AI to handle this data. That's where we will be able to give patients much more precise treatments that are tailored to them and their specific tumors." ■

The immunotherapy hurdle – and why doctors could soon predict how each patient will respond

A partnership between Vanderbilt University Medical Center and GE Healthcare will create AI-powered apps to enable safer and more precise immunotherapies

> One of the biggest challenges for treating patients with immunotheraby is when I sit in a clinic room, the patients across from me, and I can't necessarily tell them who is going to benefit and who is going to get side effects form that immunotheraby.
>
> *Dr. Travis Osterman,*
> DO Assistant Professor in Biomedical Information
> and Hematology & Oncology, VUMC

When two doctors oceans apart were jointly awarded the Nobel Prize in Physiology or Medicine for their work in immunotherapy – the breakthrough treatment that turns the body's own immune system against the cancer – the world cheered. Their efforts had ushered an entirely new way of treating devastating cancer and new pharmaceutical drugs that helped patients with no other hope achieve remission.

Little doubt exists about the tremendous contributions these scientists made to medicine and patients' lives. They had succeeded where others had frequently failed, grinded through years of trials when others had given up and proved to the world the power of a previously untested therapy.

Today both say they want to continue their work to ultimately treat more patients.

But despite the rapid advancements and excitement surrounding immunotherapies, there is a looming challenge that doctors and researchers are dealing with in trying to treat their patients clinically.

Many of those patients who stand to receive the immunotherapies researchers work so hard to find may not respond to the treatment and could also experience severe side effects, such as inflammation in internal organs, infections, hormone or gland problems and more[1]. No matter how effective a treatment is in the lab or in trials, to date it has been exceedingly difficult to know which patient will respond well or reject a given treatment.

Additionally, it takes an average of 12 years[2] and costs almost two billion dollars[3] to bring a drug to market, where it can be fully administered to patients. In many cases, patients who aren't the right match for specific treatments are recruited to participate in clinical trials, creating unnecessary expenses, severe side effects and slowing down approvals of new therapies.

"We don't want to give a therapy that has a high likelihood of doing more harm than good. This is a big problem in immunotherapies. We're relying on very primitive tools right now," said Dr. Park, M.D., Ph.D., Director of Precision Oncology, Vanderbilt University Medical Center.

Dr. Park's organization, Vanderbilt University Medical Center (VUMC), announced it is forming a partnership with GE Healthcare to address this hurdle to making immunotherapy mainstream. Together, the two institutions will create Artificial Intelligence (AI)-powered apps and positron-emission tomography (PET) imaging tracers to predict how individual patients will respond to immunotherapies – in advance, before treatment.

"The partnership will hopefully allow us to have more precision in who we can treat. It will allow us to predict whether they're going to have a response and equally important, whether they are going to have any side effects," said Dr. Park.

By creating multiple diagnostic tools, VUMC and GE Healthcare seek to enable safer and more precise cancer immunotherapies. This would help physicians to better target immunotherapies to the right patients and avoid potentially damaging, ineffective and costly courses of treatments.

This will be achieved by retrospectively analyzing and correlating the immunotherapy treatment response of thousands of VUMC cancer patients, with their anonymized demographic, genomic, tumor, cellular, proteomic and imaging data. The two organizations will co-develop AI-powered apps drawing on this data to help physicians identify the most suitable treatment for each individual patient.

"We think that there are probably answers in all of the data that we collect, and we're going to work with GE Healthcare to sift through that data and use cutting edge technology to try and find the answers to those questions," said Dr. Osterman.

As part of the partnership, the two institutions will also develop new PET imaging tracers. These apps and tracers will help physicians to stratify cancer patients for clinical trials, with the hope that the PET tracers will also be used to monitor the efficacy of immunotherapies in everyday practice.

The first AI app prototype will be available by the end of 2019 and the PET tracer proof of concept by the end of 2020.

The partnership adds to the increasing list of ventures between academic institutions and health tech creators to accelerate the development of potentially life-saving treatments. In August, a center jointly funded by GE Healthcare and the Swedish government announced it would help cell therapy company BioLamina develop and fine-tune its manufacturing processes so it can scale and more quickly deliver treatments to market. Similarly, inside the Center for Commercialization of Regenerative Medicine's labs in Toronto, funded by $40 million from GE Healthcare and the Ontario government, scientists are paving the way for manufacturing cells that can turn into any kinds of cell needed in therapy – in bioreactors.

"As we become more adept at treating and preventing cancers, the disease will no longer be a life-ending tragedy for so many patients. Rather, cancer will become a chronic condition that can be effectively managed without limiting a person's vitality or lifespan," said Jeff Balser, MD, PhD, President and Chief Executive Officer of Vanderbilt University Medical Center, and Dean of Vanderbilt University School of Medicine. ■

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The AI-powered radiologist

Imaging acquisition advances & big data envision a bright future for diagnostic imaging, which should continue to be led by the AI-powered radiologist.

Technical advances in imaging acquisition and big data envision a bright future for diagnostic imaging. Radiologists working as data scientists can play a central role in precision medicine, leading as AI-powered radiologists.

There is a special interest in the AI automation of interpretation of medical imaging, since radiologists' costs is one of the biggest expenses in radiology. But AI implementation in radiology faces many challenges, being the standardisation of AI algorithms the main one.

It is envisioned that radiologists, working as data scientists, could play a central role in the so called precision medicine, into a kind of "precision radiology" to which radiomics could add important information. But there is a lot of work to be done, especially to demonstrate that the implementation of AI and Big Data in Radiology is capable of improving the outcome of our patients and the efficiency of healthcare systems.

Technical advances in imaging acquisition and big data envision a bright future for diagnostic imaging, which should continue to be led by the AI-powered radiologist.

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As a consequence of artificial intelligence (AI) advances, a revolution is expected in Medicine. There is huge pressure to get the help of AI to deliver more efficient care to the increasingly complex, ageing and demanding patients, in our data-overloaded and many times obsolete healthcare systems. AI appears to be the solution for every problem, reducing costs and increasing efficiency, from primary care to surgery. Of course, diagnostic imaging is being included in this hope: it is said AI implementation would soon imply a radical transformation of radiology.

I'm trying to figure out what radiology will be like in a few years, from the point of view of a radiologist, and how the progressive implementation of AI will affect our daily work.

According to experts, it will take a long time for artificial intelligence to transform our way of performing radiology. Maybe significant changes will start in 10-15 years, after the main AI trials are finished and published, something necessary before clinical real world AI adoption happens. In 25 years a total disruption in medical diagnosis is expected.

There is a special interest in the automation of medical imaging interpretation, but it is considered AI will modify most aspects of the speciality (Dewey 2018).

We will assume the name of our specialty will be maintained, despite the intrusion of the AI, the overlap with/invasion of other specialties (cardiology, vascular surgery...), and the possible fusion with others (pathology, genomics). For decades, radiology has not been only based on X-rays, but this 'classic' name continues to define us. Even after becoming the authentic data scientists of hospitals, the "diagnosticians" par excellence, we will keep our name.

I guess we will continue doing our work mainly in front of computer screens. I imagine myself most of the time in front a workstation. Of course, a futuristic and ergonomic one -music included, please-, with a curved and huge multiscreen with a lot of information, including not only images, but genomic information and other vast data extracted from the electronic health records (EHR), flowing in a way more similar to that of stockbrokers' screens than to that of the current radiologists' ones.

AI will make medical imaging easier, faster and cheaper

By extracting data from EHR patient's relevant clinical, genomic etc, information- AI will help in the entire so called **workflow orchestration:** from patient scheduling and triaging, to making the choice of the most convenient radiology study to be performed, avoiding overuse.

For artificial intelligence to be able to extract information from EHRs, previous input of data is needed. Most of these data, mainly clinical history and physical examination, must be previously inserted by human beings (mostly physicians). Although AI is improving in the extraction of conventional data, to be readable and useful for AI deep learning (DL) natural language processing (NLP), doctors' data must be entered using a standardised terminology. This does not seem to be occurring soon.

AI will also help personalising protocols and imaging acquisition parameters to every patient, as well as detecting technical problems, notifying radiologists when it is necessary to repeat or complete a particular study.

Even the MRI scans will be faster: 3D sequences will soon be the norm and the "less profitable" sequences in terms of diagnosis will be eliminated, reducing costs.

AI is already 'reading' medical imaging

Imaging analysis and interpretation (diagnosis and reporting) is the most appealing opportunity of AI in radiology, since radiologists' work is a well-paid job in most countries.

AI apps, theoretically, succeed in 'diagnosing' in many medical imaging areas, (Topol 2019) mainly in the brain, lung, breast and heart, but also in others such as eyes, liver, bones, joints, prostate and kidneys diseases. Almost all diagnostic modalities are included: ultrasound, CT, MRI, PET, X-ray and mammography. AI can diagnose not only pneumonias; the list of possible automatic diagnoses is large, and includes characterisation of pulmonary nodules, bone diseases, fractures, oncologic diseases, Alzheimer's disease, brain haemorrhages and pulmonary thromboembolisms. Automatic monitoring of the volume of tumours can be carried out. The possibility of AI elaborating the sometimes tedious scoring classifications of lesions will be welcomed.

"THANKS TO THE TOOLS OF ARTIFICIAL INTELLIGENCE THE ROLE OF THE RADIOLOGIST WILL REMAIN FUNDAMENTAL"

One of the first main roles of AI will be the **triage of normal studies**. This is specially relevant in **screening**. A comprehensive multispeciality radiology screening programme could be developed with the help of AI, instead of screening for individual diseases. Triage is also useful in the emergency setting, such as in trauma or neuroradiology studies, prioritising relevant studies.

Furthermore, automated body segmentation of CT and MRI scans could automatically routinely extract information about **body composition** from routine studies, such as bone density, lung volume, muscle mass, fat volume or cortical kidney volume. Diagnosis and control of obesity or sarcopenia, for example, could be automatically done.

Precision radiology and radiomics

As Paul J. Chang said at the RSNA 2018 congress, "machine learning can and should be applied to radiology, not to replace radiologists but to enable us to provide precision medicine."

Precision medicine uses non-invasive medical tools to define the phenotype associated with every patients' individual health, resulting from its genetic risk and environmental exposure. The interpretation of medical imaging findings by radiologists traditionally relied on the contribution of clinical and laboratory data. Currently, and increasingly in the future, much more information will be available from the radiologist to refine the diagnosis, from physiologic metrics from wearable biosensors to genomics.

All that information converges on the radiologists' workstation together with the high resolution advanced imaging pictures, who when working together with pathologists become the main real health care 'diagnosticians.' We always have been, but soon in a much greater capacity. We could talk about the 'empowered' radiologist. As these AI apps are embedded in our workstations, in many cases we will not be aware they are acting. AI will help to delineate the most plausible diagnosis from a list of differential diagnoses giving a percentage of probability of a large list of diseases. AI will also help to decide the most appropriate follow-up, anticipate a prognosis and recommend the best treatment for every patient.

Precision Medicine allows for more accurate and personalised diagnoses, prognosis as well as therapy response prediction. In this regard, radiomics is an exciting radiology field, together with other 'omics' such as genomics, proteomics, metabolomics etc. Radiologists evaluate medical images extracting features describing patterns of pixels, such as signal intensity or attenuation, shape and size. Thanks to AI, radiomics would be able to perform "precision radiology" by mining hundreds, or even thousands of quantitative features from medical imaging (CT, PET and MRI) pixels, including 'texture analysis', features derived from the analysis of pixel-to-pixel relationships, sub-visual to the human eye (Gillies 2016). Radiomics could quantify intra- and intertumoral heterogeneity, differentiate phenotypes of interstitial lung disease, and even predict patient's life expectancy.

A workflow integration between radiology, pathology, (Sorace 2012; Jha 2016) and genomics in the so called "**integrated diagnostics**" or "**diagnostic institute**" (Lundström 2017) has been proposed. Integrated reports including clinical, imaging, pathology and genomic features could provide not only more accurate diagnoses but also prognostic information. There are several fields where pathology-radiology integration is useful, not only in oncology. Also in interstitial lung disease, bone and soft-tissue disease diagnoses, including vascular tumors and malformations.

Radiologists will have a very important role in precision medicine. We can talk about 'precision radiology' in which radiomics, still in development, can play a large role. Given that in the interpretation of the imaging findings a huge amount of other data converges, thanks to the tools of artificial intelligence the role of the radiologist will remain fundamental.

"MRI WILL BE FASTER, 3D SEQUENCES WILL SOON BE THE NORM & 'LESS PROFITABLE' DIAGNOSTIC SEQUENCES WILL BE ELIMINATED, REDUCING COSTS"

The radiologists role in the AI implementation

The radiologists' role in the AI advances in our field is crucial, helping AI developers to know what tools we need to work more efficiently, training algorithms that later will be implemented in the hospital workflow.

For AI apps being developed, big data (in this case, large amounts of images with their respective radiology reports and patient's data) information extraction by training deep learning (DL) models are needed. These AI tools will be only effective if they have been developed with **the right data**. Some see an interest for AI developers in the standardisation of radiology reports, facilitating DL extraction of data by means of structured and contextual reporting.

Is it really necessary for every radiologists to be experts about artificial intelligence? Only those radiologists working with application developers should have a more deep knowledge about AI coding, but it is crucial that radiologists know the expectations and limitations of artificial intelligence in our field.

Paradoxically, many of us are already working with AI, by providing our own reports to artificial intelligence developers. That means we are inadvertently collaborating with those who hypothetically can destroy radiologists' job positions. Radiologists have not yet complained, but others (mainly these app developers) are benefiting from our work. The situation could be similar to what has happened with Sloan Kettering pathologists, who have seen how their contribution to the development of the specialty has been taken advantage of by AI developers- and by some colleagues. Patients are also displaying privacy concerns, as happened at the British NHS, where Google has access to patients' data.

There is a great deal of hope in big data, but positive effects in medicine derived from the use of big data remain to be demonstrated. As in Borges's book, (Borges 1941) an "infinite library" (as big data could be considered) is not capable of solving the mystery. The same goes for big data. The classical work of the radiologist is to separate signal from noise in imaging perception. Now the noise with big data (Taleb 2012) at the theoretically personalised medicine field is huge. No doubt time will clarify what is really relevant in big data, and there is a crucial role for radiologists here.

The future role of radiologists would be to check the diagnostic results produced by algorithms embedded within our imaging reading workflow. As data science specialists, radiologists will maintain the control of diagnosis by integrating the EHR information and accepting, rejecting or tweaking the AI diagnostic work. It will persist for many years, the need to review and validate the diagnoses made by AI so that the role of radiologists will persist for a long time.

Radiologists "stepping out of the dark" thanks to AI

Another theoretical advantage of AI in imaging will be the readiness of diagnosis, being able to simultaneously read innumerable studies. This rapidity should be exploited by radiologists to increase our almost nonexistent relationship with patients. This relationship already exists, for example, in breast imaging and in interventional radiology, maybe because in these cases a 'final' diagnosis is reached, including the pathological diagnosis of the lesions. In fact, we currently make many diagnoses quickly and in front of the patient, ultrasound being the paradigm, and in few occasions we proportionate the diagnosis immediately to the patient. It would be interesting to change this practice, since the patient's work-up would be streamlined, avoiding unnecessary appointments based only on the communication of imaging results.

It has been proposed that this type of consultations could be done by robots/bots, but humans (normally) have the advantage over robots in qualities such as empathy. Nevertheless, there are signs of human-like **intuition**, **creativity and imagination** in AI, creating 'digital humans', robots able to talk to patients face-to-face. Despite these expectations, there is no doubt patients would rather prefer to communicate for long with a human (radiologist) being.

We must offer as often as possible the results of imaging tests directly to the patient. As a matter of fact, patients have increasingly greater access to their web-based/portal electronic medical records, and more and more times that includes not only the radiology reports but images. It makes sense radiologists being organised into "**reporting hubs**", so that every radiological study is carried out and 'read' by the most expert radiologists in every field, many times thanks to teleradiology. Radiology consultations must be the norm in clinical complex cases. Real debates about complicated cases could theoretically be performed.

Some treatments, especially imaging-guided ones, could be provided by the radiologists themselves. Also follow-up consultations of some lesions could be done by radiologists.

So, definitely, the implementation of AI is a great opportunity for radiologists to step out of the dark, making the relevance of our work better known and, allowing better patient outcomes. So it is hard to assume that bad times are approaching for radiologists. On the contrary, these are fascinating times.

Radiology AI challenges

Overdiagnosis: The increasing sensitivity of imaging tests, such as whole body MRI or PET-TC studies, able to detect lesions more and more little, combined with the vast wearable, genomic etc. data suggest that there will soon be an overdiagnosis avalanche. We have to get used to handling the overdiagnosis of indolent lesions, to avoid overtreatment. It would be desirable to see parallel advances in the differentiation of indolent lesions from those that imply a vital risk, something also crucial in screening.

Screening: Advances in genomics imply a shift to personalised screening based on risk profiles. Screened diseases must have an effective treatment. Otherwise, the fact of detecting them early would have little sense, as is already happening for example with Alzheimer's disease. It has been proposed that **genetic risks** results could be communicated to the patient via an AI chatbot, but such a complex information should be delivered by expert genetic counselors.

The association of some DNA variants with certain diseases have led to think that polygenic risk scores could be useful to identify people at high risk of a disease that could benefit from screening, avoiding overdiagnosis and overtreatment. But there is a lot of uncertainty about Genomic Medicine. More experience is needed, since progress in big data and genomics does not mean we know the real impact of genetic variants in our health (Vassy 2017).

Explainability: One of the main challenges in imaging AI is its '**black box**' nature. Users need explainability to determine the reliability of the AI models. For instance, it would be possible for AI to perform automatic diagnoses based on MRI raw data, not identified in the images, and not readable for humans, yet we would not know on what basis the diagnoses was performed. The European Union's General Data Protection Regulation made a public requirement for transparency — deconvolution of an algorithm's black box — before an algorithm can be used for patient care.

Patients are also empowered with AI

The patient is at the centre of the healthcare system, and he/she has access to AI too. Some consider patients will soon be able to control all aspects related to their own health. Quoting Bart De Wittef from IBM: “The idea of algorithms outperforming doctors is growing, so the discussion about automated consumer-based decision-making versus augmented traditional physician based decision-making will intensify.” But this is not close to becoming a reality. As a patient and as a doctor I would like to participate in shared decision making with doctors, supported by AI. But we are very far from a robot or an algorithm to replace doctors in the main medical decisions (Lamanna 2018).

Privacy and security of patients’ data must be assured, avoiding hacking and data breaches.

"THE POSSIBILITY OF AI ELABORATING THE SOMETIMES TEDIOUS SCORING CLASSIFICATIONS OF LESIONS WILL BE WELCOMED"

Radiology uncertainty

Some believe that the AI implementation in the radiologist workflow could potentially end with uncertainty in radiology, improving the consistency and reducing errors in radiology reports. But the fact that more data will be available does not mean the end of discrepancies and uncertainties. The radiologists’ work, even as a data scientist, will continue being subject to nuances for a long time.

Radiology is not anymore only about identifying imaging patterns, but it is increasingly about quantifying. In the same way identifying imaging patterns is subjective, the limit in determining what is pathological or not in numeric terms is not always easy to demarcate. AI apps will be able to calculate individual disease probabilities, but uncertainties remain. Measuring does not constitute an end in itself (Shaywitz 2018). As the historian Jerry Muller said: “Not everything that is important is measurable, and much that is measurable is unimportant” (Muller 2018).

Interoperability

Standardisation of AI algorithms is key, but it will take a long time. Algorithms are not interchangeable among equipments or institutions. It is said AI could reduce radiology biases, but it is not true. Human judgment is biased, but data are not objective either; different AI systems could not interpret the imaging findings in the same way. A patient could be diagnosed using an app, and considered healthy or having one disease instead of another one. Maybe, in the same way we know some radiologists are more judicious than others, there may come a time when you can also choose one AI system or another (a daring one, or a prudent, conservative approach) to a particular clinical presentation or patient.

The AI hype

AI in radiology is promising, but it is necessary to be cautious with the surrounding hype. Algorithms can be accurate and technically be validated but, to be implemented in the real patients’ world, they must demonstrate they improve both patient outcomes and healthcare systems financial outcomes (Topol 2019). It remains to be seen whether receiving an automatic diagnosis performed by AI has better outcomes than one performed by a radiologist.

The potential **iatrogenic risk** for an AI algorithm is vast. That has been verified with the IBM Watson Health oncology algorithm issues; many of its recommendations for treatment were shown to be wrong. AI systems must be subject to scrutiny before being incorporated to clinical practice, and that includes radiology.

Peer-reviewed publishing is indispensable for validating innovative products and technologies in biomedicine, but most healthcare start-ups have a limited or non-existent impact in scientific literature.

We can adapt the Frank Pasquale sentence summarising the AI limits: “AI ignores the irreducibly holistic assessments that are hallmarks of good judgment.” AI can provide useful partial information, but comprehensive holistic aspects (of patient’s imaging care in this case) are better covered by human (radiologist) intelligence.

In spite of the predominant hype, I do not know any fellow radiologist worried about the possibility artificial intelligence taking away her/his job position.

The radiology revolution involves not only AI

Together with the AI implementation, innumerable technical changes are expected in radiology, which are going to change radiologists’ work. For example, a broader use of MRI in emergency settings or even being used in autopsies is expected. Also a much extensive use of ultrasound by other specialists, primary care doctors, physiotherapists and, as it has been suggested, even for patients. This broad ultrasound availability will increase the demand of advanced techniques, that should remain in the hands of radiologists.

Virtual reality (VR), augmented reality (AR) and 3D-printing are fields linked to medical imaging, by using anatomical 3D images from patients. Cardiologists, cardiac surgeons, orthopaedic surgeons and other specialists will need our collaboration, and radiologists have to maintain the control.

Teleradiology also will be upgraded with AI, with "intelligent assistance diagnosis" or "information analysis collaboration." The possibility of fast reporting of millions of studies at the global level is fascinating, but interoperability is key.

Final remarks

In this Brave New World- like radiology's future, an improvement in the ability of artificial intelligence to integrate, process and extract vast information is expected. Explainability, interoperability, privacy, security, and ethical issues must be resolved. In such a new era for diagnostic imaging, AI and technological advances will strengthen radiologists' professionalism.

Even if in the future AI multiplies radiologists' efficiency, given the continuous increase in the demand for imaging tests, the call for radiologists- or for whatever the name of the future data scientist specialised in imaging diagnosis will be- will continue to increase, making it improbable that the radiologists workforce will shrink.

It has been said in many ways, but we all now agree: it's not the robotic vs the human radiologist; it is the more precise and faster AI-powered radiologist.

Radiologists must take a leadership role in the AI tools development, a guarantee that they will be designed for us, contributing to increase the enjoyment of working in this increasingly exciting specialty. But above all, AI must be optimised for our patients' better outcomes, facilitating an appropriate and fast diagnosis, and for our healthcare systems, which should make health solutions available to everyone. ■

KEY POINTS

- ✓ It will take a long time for artificial intelligence to transform radiology.
- ✓ There is a special interest in the AI automation of interpretation of medical imaging.
- ✓ Standardisation of AI algorithms is key, but it does not seem to be easy.
- ✓ AI must be optimised for our patients' better outcomes.
- ✓ Radiologists, as data scientists, could play a very important role in precision medicine.
- ✓ The "AI-powered" radiologists should lead the diagnostic imaging bright future.

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Clinical ultrasound in the age of artificial intelligence

The foremost expert in critical care ultrasound on the value of natural vs artificial intelligence in medicine.

Ultrasound is a tool like no other in medicine. Most importantly, because it is a work of the hand and the eye, combining the art of reasoning, common sense (that is, intelligence), it provides a unique opportunity for the physician to be in direct contact with the patient.

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Ultrasound is a tool like no other in medicine, not only because of its well-known qualities (non irradiating, repeatable etc). Most importantly, this is a work of the hand and the eye, combining the art of reasoning, the common sense (that is, intelligence), and a unique opportunity for the physician to be in direct contact with the patient. As to medicine, this is not a profession like any other. Ultrasound is therefore a genuine summit, a holy providence. The very interest of being an MD is to use one's own intelligence, to put together all we have learned, for making decisions on the correct management of patients. Ultrasound is at the centre of many of these pathways.

So how about artificial intelligence (AI)? What has AI to do here? First note, this is an amusing oxymoron. Intelligence is the most sensitive, emotional expression of mankind. It allows human beings to survive from chaotic situations, also to make life more interesting, to practice art and so many wonderful achievements. Intelligence is fully linked with emotion, a miracle of life. Can such a holy gift be made artificial? I am not an expert in the field of AI, so I risk to go beyond my level of expertise, or to write trite remarks, but was kindly invited to submit my ideas. What I see is that people seem hypnotised by any new technology (not only AI), maybe for wanting to be like the others. Therefore, other people have the duty to be against, to just provide for a balanced world. I did this before as regards the previous trend, Internet, a revolution that brought unbelieavable advantages, allowing us to have everything immediately, but to the detriment of such disagreements that the overall result is only a slight progress of mankind, at the cost of an incredible energy. Now, we have to face all issues of Internet, which from occult, have become patent.

Regarding AI, the new trend in fashion, my two concerns are first to see it failing, generating comicotragical issues (this has begun, already); the second one is to see it not failing, winning over human intelligence. There would be nothing to admire, nothing worth applauding: I guess that a technology able to multiply the octets (mega, giga, tera...) will do things faster than standard human beings. Even if I find an authentic genius able to resist, we would just have to add one layer of technology (peta, exa, zetta if necessary), and the technology will eventually win. If not, we use a yotta level; or billions of yotta, etc. But which number will succeed to generate genuine emotion? The immense strength of emotion is that it does not require any artificial help, is the pure expression of intelligence. Intelligence is life. So what do we really want? To have things fast, or to live in an acceptable world with an acceptable life, with plenty of acceptable defaults?

Once we understand that the new technologies can do everything, their field of possibilities will no longer amaze us. This scenario will of course mean the end of all professions which require intelligence, that is, all interesting professions, all interesting lives. The argument advocating that AI will make the doctor (and other human beings) free of fastidious tasks seems to be a bit empty, and consequently, dangerous. To begin with, young students will cease to be interested in medical studies, and only robots (intelligent) will take care of us, all along our disease. We will not even thank anybody, it will be included in their programme (they can be formatted for recognising the word "thank you," and answer what somebody decided to program, such as "just my duty," or "do not forget to pay," or "I am a simple robot, you know, I was programmed to listen to your emotion, but I have no human brain, sorry, you lose your energy)."

By the way, ultrasound is all the more unique, as it was "recently" rejuvenated, by being extended to

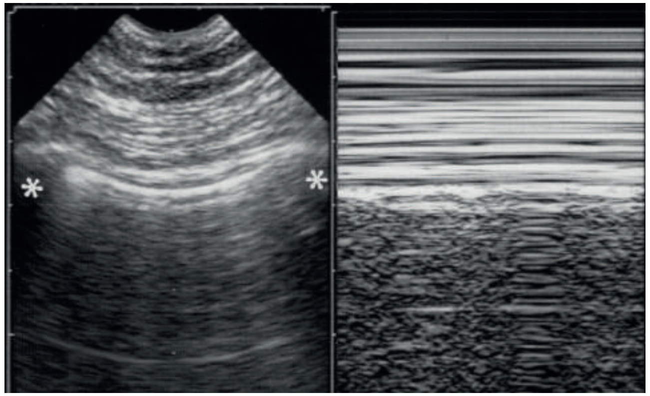

Figure 1.
Lung sliding, a basic sign of normality in lung ultrasound obtained from a simple technology (1992) using a universal microconvex probe. Left, real time shows in this longitudinal view the ribs and rib shadows left and right (stars). In between, half a cm below the rib line in adults, this horizontal bright regular line is the pleural line. Right, M-mode. The dynamic of the visceral pleura against the parietal pleura generates a sparkling on real time, not visible on the left, frozen image. The M-mode shows, from the very pleural line and below, this sandy pattern below a pattern reminiscent of waves : the seashore sign.

critical ultrasound. I highlight the word "recently," although I am proud to have built *critical* ultrasound since 1985 using a gray-scale 1982 technology (the ADR-4000®, visible now in museums). This technology was maybe antique, but the community forgot to exploit it correctly, that is, *at the bedside*. I am currently working on a Hitachi-405®, a gray-scale 1992 technology, slightly better (discontinued 9 years ago, not really replaced). Many doctors are persuaded that the recent revolution of ultrasound was the result of the miniaturisation (modern ultrasound machines look like laptops). While thinking so, these

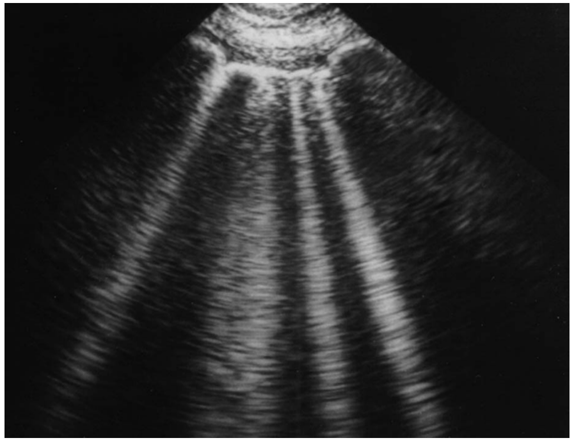

Figure 2
Typical lung rockets, same equipment. This patient suffers from interstitial syndrome, that is mostly, in emergency settings, pulmonary oedema (usually haemodynamic if lung sliding is associated). No need for artificial intelligence for recognising such an elementary item.

doctors avoid to give a medical name to this revolution, which is therefore attributed to the "technology." This common belief is easily invalidated: ironically, our Hitachi-405® is smaller than all laptops in the only interesting dimension, the width. If we use our brain for a few seconds, the vertical dimension (small in laptops) is not a critical advantage in our hospitals, so far as our ceilings are always high enough. The real obstacles are lateral. In addition, laptop machines stay all the time embedded in their carts, and this is an excellent thing: a cart is a mandatory ergonomic part of critical ultrasound, within hospitals, the usual place for saving lives. A simple (natural) intelligence was sufficient for realising this. I, as a simple user, am fascinated by the blindness of the community regarding this detail. Building a new discipline using an old tool was my real pride, because it could generate a simple, elegant "revolution," easy to implement, without destroying anything, without the need of a superhuman, artificial *intelligence*.

Critical ultrasound can be defined as a clinical science based on applications which were accessible but not used in the past. Lung ultrasound is the best example. Lung ultrasound (another oxymoron) was not supposed to exist. We spent however a lifetime (3 decades now) understanding the "ultrasound language" of the main vital organ. We mainly discovered its translational face: any physician dealing with the lung will find interest in lung ultrasound - including the specialists in medical imaging. Of use in its most dramatic application (cardiac arrest) or in routine (up to the family doctor), in seniors as well as babies, in rich or deprived patients, in healthy or scarse-resource countries, in protected settings (university hospitals) or isolated ones (from austere medicine to even spaceships), in any setting lung (and critical) ultrasound is used with no adaptation, this makes no real difference, this is one definition of *holistic ultrasound.*

Why is critical ultrasound a *holistic discipline*? This means, shortly, that its separated elements (the machine, the probe, the targets…) seem apparently unlinked, but their integration makes a homogeneous, synergic whole. As a single example, lung ultrasound allows echocardiography to be simplified (Lichtenstein 2014). As another example, I can perform a whole body critical ultrasound using one single probe. Our wide range microconvex probe has the perfect range and ergonomy for universal use in the critically ill. Most physicians who have learned to use critical ultrasound, especially lung ultrasound, have confided in me that they received a kind of accomplishment in their life. Their "previous" life was exciting but sometimes boring (too much paperwork), or too difficult with challenging settings. Our best acknowledgement is when some ladies (or opposedly) tell us that their husband (wife) comes home after work much more excited once they have discovered the art of critical and lung ultrasound. It sounds like a police investigation, nearly an endless game in many aspects.

And now, we hear about AI in this field, such as automatic recognition of B-lines (among others). We shortly evoke some basis of lung ultrasound. Lung sliding is a parameter of prime importance (for diagnosing pneumothorax and inflammatory lung diseases), accessible to none of the modern technologies (**Figure 1**). The B-line is a comet-tail artifact, strictly defined according to seven criteria (Lichtenstein 2014). A certain concentration of B-lines, called lung rockets, defines interstitial syndrome (**Figure 2**). This sign has a critical relevance for promptly diagnosing numerous conditions: the diagnosis of pneumothorax; the diagnosis of pulmonary oedema (the analysis of lung sliding allowing to distinguish haemodynamic from inflammatory oedema, schematically). The indication for giving and discontinuing fluids in critically ill patients with circulatory failure (the FALLS-protocol), and many others. The search for pneumothorax is the first step of the SESAME-protocol, a focused critical whole body ultrasound approach used during a cardiac arrest. Our unit is always ready for it, so no time is lost (Lichtenstein and Malbrain 2015). When each second counts, we are not sure that AI will be accessible for showing the right way. For managing cardiac arrest, even if the SESAME-protocol can be done in a few seconds, years of exciting understanding are necessary, and this is precisely what keeps us so much attracted.

I want to remind that the (natural) intelligence is not a trait of exceptional people. Any human being is, by definition, intelligent. Many people think they are deprived of this gift, they just forget that the success is done by one third of it, but also one third of work, and... one third of luck. We can favour luck, we can work, even a lot. Intelligence is the only parameter where a direct action is useless. Suppressing the interest of intelligence would tempt people, we imagine, yet if (natural) intelligence is no longer necessary, we also imagine that, in a first step, then people will be happy (because of feeling favoured), and a minority will have to find a profession which does not require intelligence (if they succeed to find a job). Time passing, we don't have the slightest idea of what such a "civilisation" would become. A life without the feeling to be useful, where AI will choose your partner (with perfect technical accuracy of course) scares us to a point that we begin to love the defaults of our life partner!

To conclude, even if ultrasound was long considered a technique in traditional imaging, in our field at least, critical ultrasound appears as a major help to the physician who has taken the best of physical examination for understanding the data appearing on the screen, helping to perform a visual medicine. All this occurs in a normal setting where the doctor remains a doctor (and the patient, a patient). That is, a deal between human beings first. That is a deal where natural intelligence and emotion work in symbiosis, that is, a genuine philosophy. Even in the age of AI, this strength will remain a priceless help. I foresee a bright future for ultrasound, this "sleeping giant" as many say recently, a genuine *stethoscope* according to our knowledge (*Scopein*, to see, and *Stethos*.... the chest wall). ■

KEY POINTS

- ✓ AI, the new trend in fashion; two concerns are first to see it failing, generating comicotragical issues (this has begun, already); the second one is to see it not failing, winning over human intelligence
- ✓ The argument advocating that AI will make the doctor (and other human beings) free of fastidious tasks seems to be a bit empty, and consequently, dangerous
- ✓ I am proud to have built critical ultrasound since 1985 using a gray-scale 1982 technology (the ADR-4000®, visible now in some museums). This technology was maybe antique, but the community forgot to exploit it correctly, that is, at the bedside
- ✓ Building a new discipline using an old tool was my real pride, because it could generate a simple, elegant "revolution", easy to implement, without destroying anything, without the need of a superhuman, artificial intelligence
- ✓ Critical ultrasound can be defined as a clinical science based on applications which were accessible but not used in the past

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AI applications in breast imaging

Review of some state-of-the-art applications of artificial intelligence on mammography and MRI.

Computer aided imaging is not novel, having been around for 50 years. Developments have boosted the accuracy of computer-based analysis and breast imaging is at the forefront, as large databases are available, and radiologists tasks on images are relatively error prone.

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Artificial intelligence is the buzzword of today for radiology. Still computer aid for imaging is not novel, but has been around for approximately 50 years. Recent developments have boosted the accuracy of computer-based analysis in many fields. Among these, breast imaging applications are at the forefront, both because they are very commonly used and therefore large databases are available, and the tasks of radiologists on these images are relatively error prone. In this article we highlight some of the applications of artificial intelligence on mammography and MRI.

Mammography

Reading mammograms in a screening setting is one of the most difficult tasks in radiology. Even in a double reader setting where two radiologists rate the same exam, breast cancer is missed relatively often. To improve upon this, computer-aided detection (CAD) systems were developed. It was assumed that if a CAD system displays suspicious areas, radiologists would not miss them. However, in practice the use of CAD marks to highlight suspicious lesions was far from perfect. The large amount of false positive findings marked by the CAD systems were considered to be a distraction and resulted in a perceived low reliability of the systems, and therefore limited use in clinical practice.

A further difficulty is that a study has shown that radiologists not so much miss suspicious areas, but that a correct classification of observed potential abnormalities is the actual problem. Consequently, a system that supports radiologists with the decision to refer a woman for further examination appears to be more effective than a classical CAD-system, which intends to reduce detection errors (Hupse et al. 2013a). The detection system used in this study was built before deep learning techniques were introduced into medical imaging but already came quantitatively close to the performance of radiologists (Hupse et al. 2013b). In contrast to these classical systems, which use carefully hand-crafted features designed to capture certain characteristics of lesions such as spiculation (Karssmeijer and Te Blake 1996), deep learning-based systems learn these features from the annotated data allowing them to surpass the diagnostic accuracy of the classical systems and achieve performances previously assumed to be only within the human realm.

Current deep learning systems allow determining the probability of a suspicious region to be a carcinoma, whether it is a soft-tissue lesion or calcifications with high accuracy. Several research and commercially available AI-based systems are now available for mammography analysis. These systems have an accuracy that is on par with that of average, but dedicated, breast radiologists on heterogeneous datasets of mammograms (Ribli et al. 2018; Rodríguez-Ruiz et al. 2019).

> "READING MAMMOGRAMS IN A SCREENING SETTING IS ONE OF THE MOST DIFFICULT TASKS IN RADIOLOGY"

However, some radiologists still outperform even these AI-systems. This is likely due to the fact that not all available information is currently being used by these AI-systems. For instance, the temporal information provided by previous studies is not exploited with such systems. It is expected that the performance of AI-systems can be extended beyond the performance of an average breast radiologist by including these factors. In a newly funded project, systems will be designed which also take into account suspicious temporal changes.

It does not end there. In the coming years, and as is already happening in the United States, digital mammography will be replaced by digital breast

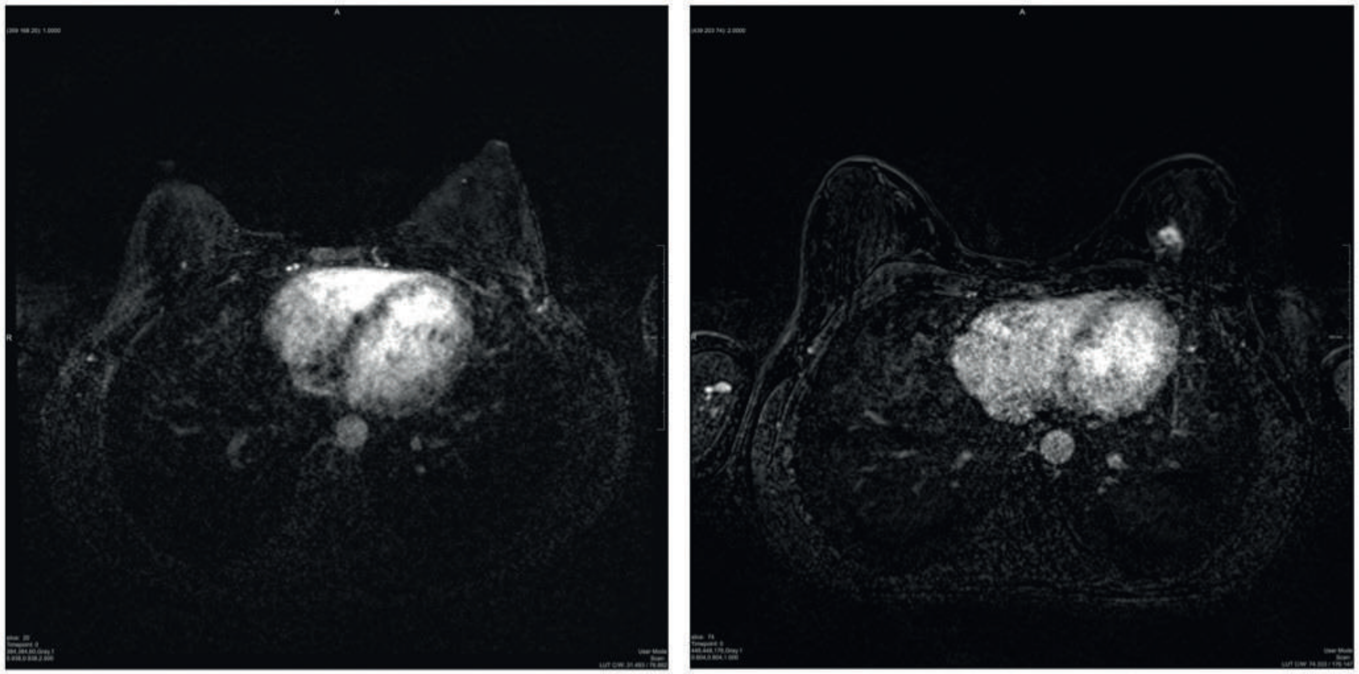

Figure 1. Two MRI acquisitions of suspicious areas which lead to a biopsy. Both images are of young women with a BRCA1 mutation. Left a TWIST acquisition with a BI-RADS 3 lesion centrodorsal in the right breast which was proven to be a small fibroadenoma. To the right a VIBE acquisition of a BI-RADS 4 lesion. The pathology was proven to be an inflamed cyst. Both lesions were declared not suspicious by the CAD system.

tomosynthesis. While this system is more sensitive than mammography, this does not imply that this makes the task of recognition of suspicious areas easier. The larger amount of data and increased reading time further complicate this. Current research therefore also focuses on the applications of deep learning techniques to digital breast tomosynthesis. The main complication is that as the technique is rather new, no large screening datasets with proven malignancies and sufficient follow-up are available. This is certainly a problem for the deep learning algorithms as these derive the discriminative features from the (annotated) data itself, and therefore require large datasets to achieve a satisfactory performance. Because of this, researchers employ "transfer learning" techniques. In this setting the system learns discriminative features on a different dataset such as mammography, and these features are subsequently transferred and fine-tuned for the tomosynthesis deep learning detection system on a tomosynthesis dataset. A recent study showed that an AI-based CAD system for DBT allows for faster reading without decreasing radiologists performance (Chae et al. 2018).

MRI

While mammography has shown to be a cost-effective method to reduce mortality of breast cancer over the past decades, it is known that in certain cases carcinomas tend to be less visible on mammograms. For instance, mammography is proven to be less sensitive for women with high mammography density (Wanders et al. 2017). This is not the case for breast MRI, where carcinomas can be detected with high sensitivity even for breasts with high density. In the DENSE trail (Emaus et al. 2015), which is to be presented at ECR 2019, women in the highest density category (ACR D) are invited for a complementary breast MRI. Next to studying the amount of screen detected carcinomas and the amount of false positives, the effect of breast MRI on the amount of interval cancers is also studied.

A study (Kuhl et al. 2017) has shown that with the addition of a breast MRI scan after a negative screening mammogram, an additional 15.5 carcinomas per 1000 can be detected. Unfortunately MRI is not yet broadly applicable as a screening method for breast cancer due to the large associated costs, and for this reason it is only being used for women with an increased risk of breast cancer (Mann et al. 2008). The significantly increased reading time of a breast MRI exam compared to a mammogram adds to the limited applicability of breast MRI in a screening setting.

While MRI has a high sensitivity for the detection of breast cancer, it also associated with a percentage wise similar increase in the number of false positive findings that further complicates the application of MRI in a screening setting. Next to this, several studies (Yamaguchi et al. 2013; Pages et al. 2012) have shown that between 47 and 58% of the earlier detected carcinomas were already visible in earlier screening rounds. One of our studies shows that in retrospect almost

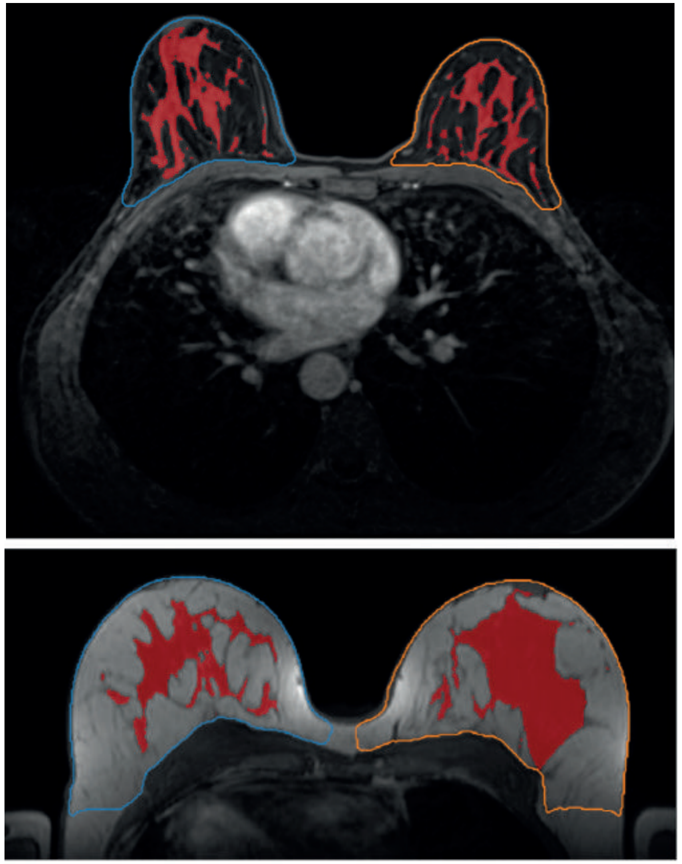

Figure 2. T1w acquisitions. Left is a fat saturated acquisition. The deep learning system is trained to segment the breast shape and the fibroglandular tissue. It is robust to changes in acquisition parameter settings and different sequences.

one third of all cancers was already visible and actionable on an earlier MRI (Vreemann et al. 2018a). However, one should balance this against the positive predictive value (PPV) ranging from 14 to 37% depending on the MRI-screening indication, being higher in patients at higher risk, and the programme based high overall sensitivity of screening with MRI (90%) (Vreemann et al. 2018b).

Our results show that a number of cancers that are missed by the radiologist can be detected by the CAD-system. In this study, we looked at all cancers that were classified as negative in a previous screening round (BI-RADS 1 or 2) but in retrospect were visible when these were detected upon follow up examination one year later. Such a system can therefore support the radiologist by denoting the suspicious areas after a negative classification. Our results show that for these cases 70% sensitivity can be reached with one false-positive finding per scan (Dalmiş et al. 2019; **Figure 1**).

The current state-of-the-art breast MRI protocol consists of multiple sequences and lasts about 15 minutes. To make MRI more available for a screening setting, the costs of the technique should be lowered and therefore a lot of research is going into abbreviated MRI-protocols. In such an abbreviated protocol the pre- and post-contrast T1 acquisitions are acquired in the earlier phases after the administration of the contrast agent but the later T1w, T2w and DWI acquisitions, which often occur in the complete protocol, are left out and the final decision is made on the basis of the available morphological information out of the first post-contrast subtraction.

To decrease the reading time, the Maximal Intensity Projection (MIP) of this volume is studied. In case there is a suspicious area, the complete volume is considered (Kuhl et al. 2014). While this significantly reduces the average reading time, studies have also shown that the use of the MIP can increase the number of reading and interpretation errors (Mango et al. 2015). A CAD deep learning system, which we have developed for this purpose, uses all images of this abbreviated protocol, and alerts the reader when potential findings that are not evident in the MIP images are present.

In a diagnostic setting we want to use a different CAD-system to support clinicians in deciding whether or not to acquire a biopsy. Just as with the previous system, this system can be used with an abbreviated protocol where the CAD-system assigns a malignancy score to a radiologist labelled region. As this system predicts the likelihood of malignant biopsy results, it has the potency to reduce the number of biopsies. Our results show that while maintaining high sensitivity it is possible to reduce at least 20% of all biopsies (Dalmiş et al. 2019).

To be able to use such a system in the clinic, we need to ensure that the model is robust to scanner variations which is quite pronounced for MRI scanners. We are developing methods that are robust against such variations. One typical example is to determine the breast density on breast MRI. To do this properly, we need to have an accurate segmentation of both the breast shape and the fibroglandular tissue. Previous methods would build different models for different sequences, making these models less usable for epidemiological studies. In **Figure 2** we provide an output of such a robust segmentation model.

Based on these positive results, and the success in creating robust deep learning systems, we expect that deep learning will contribute significantly to increase the application areas of MRI and make it an economically viable breast cancer screening method. Not only will this open more ways to detect breast cancer earlier and reduce mortality, but will also decrease the variance in performance between radiologists and improve the screening programme as a whole by supporting less experienced radiologists with their decisions. Still it should be noted that the applications of AI for breast MRI have not yet left the research domain. Implementing these in clinical practice and proving their efficiency will be a major task for the future. Surely, there are exciting times ahead for the applications of AI in breast imaging. ■

KEY POINTS

- ✓ Reading mammograms in a screening setting is one of the most difficult tasks in radiology.
- ✓ A system that supports radiologists with the decision to refer a woman for further examination appears to be more effective than a classical CAD-system.
- ✓ AI systems are now available for mammography analysis with accuracy that is on par with that of average, but dedicated, breast radiologists on heterogeneous datasets of mammograms.
- ✓ Deep learning will contribute significantly to increase the application areas of MRI and make it an economically viable breast cancer screening method.
- ✓ AI will open more ways to detect breast cancer earlier and reduce mortality; decrease the variance in performance between radiologists and improve the screening programme as a whole by supporting less experienced radiologists with their decisions.

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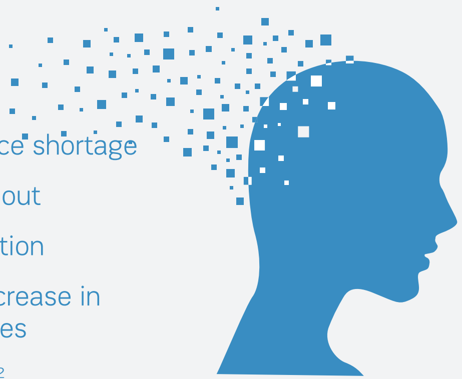
ARTIFICIAL HYPE

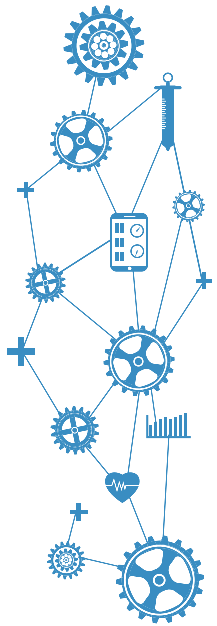
WHY HEALTHCARE NEEDS AI?



- Human resource shortage
- Physician burnout
- Ageing population
- Continuous increase in chronic diseases

Source: https://iii.hm/rj2

AI APPLICATION IN HEALTHCARE



- Automating monotonous tasks
- Modernising treatment designs
- Capitalising on virtual healthcare assistants
- Smart electronic health records
- AI Chatbots
- Improving drug development process
- Better hospital management and inpatient care
- Precision medicine
- Wearables
- Improved patient data and risk analysis
- Dosage error reduction
- Epidemic outbreak prediction

Source: https://iii.hm/rj3, https://iii.hm/rj4

AI IN HEALTHCARE - ECONOMIC IMPACT

$300 billion savings in the US using machine learning tools

£3.3 billion savings in the UK using AI to provide preventive care and reducing hospital admissions

30-50% productivity improvement for nurses with AI tools

2% GDP savings for operational efficiencies in developed countries

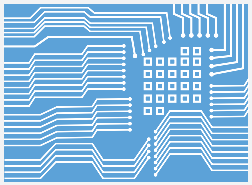
5-9% health expenditure reduction through tailored treatments and engaged patients

$2 trillion **-$10** trillion savings globally by tailoring drugs and treatment

0.2-1.3 additional years of average life expectancy

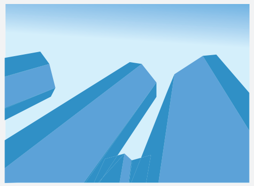
Source: https://iii.hm/rj5

AI IN HEALTHCARE - GLOBAL OUTLOOK



TOP TECHNOLOGIES

- Natural Learning Processing
- Deep Learning
- Context-Aware Processing
- Querying Method



TOP COMPANIES

- Google
- IBM
- Intel
- Microsoft
- GE Healthcare

AI BY REGION

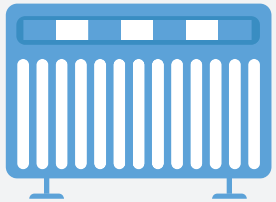
- Market leader - North America
- Fastest growing - North America
- Promising market - Asia Pacific (primarily China, Japan, and India)

"Artificial Intelligence isn't an intruder in our lives, but a multi-talented assistant that can improve our lifestyle if used in the right way."

Think Design

Source: https://iii.hm/rj9

BARRIERS TO AI IMPLEMENTATION IN HEALTHCARE



- Regulatory Implications
- Moral/Ethical Implications
- Data Privacy Concerns
- Absence of Interoperability
- Shortage of talent with AI expertise

Source: https://iii.hm/rj8

CONSUMER WILLINGNESS FOR AI-ENABLED HEALTHCARE

54% Willing Consumers

38% Unwilling Consumers

7% Neither Willing Nor Unwilling

Source: https://iii.hm/rj7

Value-based healthcare and the doctor-patient relationship

The doctor-patient relationship can be considered a gateway to value-based care. Healthcare organisations that want to implement a value-based care model need to see the patient as their most important long-term asset.

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What is value-based care?

Value-based care refers to a care-delivery model that is based on delivering patient care that provides healthcare value. But how do you define this value?

The Institute for Healthcare Improvement IHIP Triple Aim framework helps shed light on what this value could mean (IHI Triple Aim Initiative). The Triple Aim framework outlines a care delivery approach that pursues three dimensions:

- Improving the patient experience of care
- Improving the health of populations
- Reducing the per capita cost of healthcare

The concept of value-based healthcare is based on the achievement of these key elements: improving patient outcomes, reducing the negative impact of chronic diseases, helping patients live healthier lives and ensuring patient satisfaction by providing value. The term value is mainly derived from measuring health outcomes against the cost of delivering those outcomes (NEJM Catalyst 2017).

The doctor-patient relationship

The doctor-patient relationship can be defined as the verbal and non-verbal communication between both the doctor and the patient (Sadati et al. 2018). A distorted doctor-patient relationship has the potential to distort the quality of care. An effective clinical communication that is imperative for providing value-based care should have three primary goals:

- Effective exchange of information
- Right treatment decisions
- Good personal relationship

These goals can only be achieved if there is mutual participation and cooperation between the doctor and the patient and an element of guidance on the part of the healthcare provider. Patient satisfaction is very important when measuring value-based care, and a good doctor-patient relationship can play a key role in not only increasing patient satisfaction but also mutual satisfaction where the doctor feels that their treatment approach is right and the patient feels that their expectations from the consultation were met.

The doctor-patient relationship can thus be considered a gateway to value-based care. Sir William Osler, a famous Canadian physician, once said, "A good physician treats the disease, and a great physician treats the patient who has the disease" (Centor 2007). Without good rapport and good interaction between the two parties, you cannot hope to achieve successful health outcomes.

"RECRUITMENT AND MOBILITY WITHIN AND OUTSIDE THE EU IS OFTEN THE CAUSE OF BLATANT SHORTAGES OF SKILLED STAFF"

A major challenge that we face in healthcare today is the consistent increase in healthcare costs without a simultaneous increase in quality of care and patient satisfaction. Value-based care aims to tackle these issues. Hospitals that are committed to implementing the value-based model are now focusing on the delivery of value that accurately reflects the amount of money they have put in to provide healthcare services. The goal is not just to provide treatment but to improve the overall patient experience which would, in effect, translate into improved outcomes, greater value and greater patient satisfaction (Friedeman 2018).

When we talk about patient experience, we mean more personalised interaction between the patient and the doctor, greater transparency throughout the care journey, and improved customer service. By focusing on improving the doctor-patient relationship, healthcare organisations can provide more value, retain patients and create a competitive edge that sets them apart from other service providers.

Ingredients for value-based care success

When you analyse the key elements that can ensure effective implementation of the value-based care model, you will see that most of them are related to patient satisfaction and patient experience. Greater collaboration between patient and doctor means greater connectivity; increased focus on direct care team means greater attention on patients and prioritising their health; greater alignment between major stakeholders means improved health plans, more effective care teams and shared goals and values; active and more informed patients means more successful outcomes and patients and doctors who are more engaged in care. In simple words, successful implementation and application of the value-based care model is possible if we ensure that patients remain the centre of our focus. Value-based care and patient-centred care go hand in hand, and the doctor-patient relationship is at the core of this philosophy.

Value-based care and patient loyalty

A satisfied patient is a loyal patient. A patient with great care experience is a loyal patient. An engaged patient who is allowed to take an active role in their care plan is a loyal patient. In short, patient loyalty can help meet the demands of value-based care. The only way healthcare organisations can ensure patient loyalty is by becoming their trusted partners and their top-of-the-mind contact in case they fall ill. If providers want patient allegiance, they need to build strong relationships with them, and they need to gain their trust (Heath 2018).

Healthcare organisations that aim to succeed at achieving value-based care need to see their patients as their most important long-term asset. If they can provide value and keep their patients healthy, they will continue to demonstrate a healthy performance as well. It is all connected, with the patient at the centre of it all. ■

KEY POINTS

- ✓ The Triple Aim framework outlines a care delivery approach that pursues three dimensions: improving the patient experience of care; improving the health of populations; and reducing the per capita cost of healthcare.
- ✓ A distorted doctor-patient relationship has the potential to distort the quality of care.
- ✓ An effective clinical communication that is imperative for providing value-based care should have three primary goals: an effective exchange of information; right treatment decisions; and a good personal relationship.

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Nursing on the move: cross border hiring

Addressing obstacles for successful hiring

How to navigate the multiple challenges involved in making a cross-border nursing hire a success.

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People have always moved from their home countries to other countries in order to settle there permanently or for a certain period to work. The reasons for this are manifold.

The main stakeholders are the migrants themselves, the host employers, coordinating agencies as mediators for both sides, but also country initiatives (political objectives and cooperation within framework conditions).

On the one side, very significant differences in living standards and professional conditions promote migration as well as the ever-increasing shortage of skilled workers and increasing demands in the healthcare sector on the other side.

The European picture

The European Union (EU) currently consists of 28 countries and sees its main task as cooperation in foreign and security policy as well as cultural, environmental and educational policy and a common monetary policy. The values on which the EU is founded, along with respect for human dignity, freedom, democracy, equality and the rule of law, is respect for human rights and binding standards. All these factors play a role in addressing the issue of "Cross Border Hiring of Nurses" in Europe.

Increased labour mobility is explicitly promoted and desired by the EU in order to promote, in addition to a balanced and sustainable economic social and balanced development, the competitive global economy and promote EU political integration. Thus, all EU citizens have the right to work and live in every Member State (European Union 2012).

Meanwhile, recruitment and mobility within and outside the EU is often the cause of blatant shortages of skilled staff. However, the greater the need, the more important it is to find out in advance about differences and the comparability of "practiced" professional care in the individual European countries, to develop appropriate assessment tools and to develop a suitable integration strategy.

Main considerations

In the following, some preliminary considerations are formulated for the main stakeholders.

Migrants:

- Which country is suitable and how is the selection process carried out?
- Who is the responsible contact on site?
- How are the transition periods financed and what preparations must be made (language)?

Employer:

- From what country and at what intervals do I want to recruit?
- Maintaining contact and building trust before arrival (Skype, Social Media)
- What additional service providers (agencies, language schools, etc.) do I need?

"RECRUITMENT AND MOBILITY WITHIN AND OUTSIDE THE EU IS OFTEN THE CAUSE OF BLATANT SHORTAGES OF SKILLED STAFF"

- Contract design, particularly repayment obligations in case of difficulties)
- How and by whom should the project be carried out (Integration officer, time and cost)?

Future colleagues on the ward:

- How would the colleagues on the ward be prepared and involved (formation of intercultural competence)?

- How to design the onboarding (plan, patient safety, reflection, coaching for all sides)

Recruiting agencies:

- Agencies specialise according to country and field of nursing and have corresponding references
- What are the fees of the agencies composed of (recruitment, language training in advance, ethical recruitment and commitment agreements with the migrants)?
- What kind of support for employers and the recruited persons are there after arrival (housing, mentoring, all-inclusive package)?
- How flexible are the agencies in the event of problems (time shift, language level not reached, below the agreed number of migrants)?

Language schools:

- Are the specific language schools experienced with training for the healthcare sector?
- How regular is the feedback on the language development of the participants and the reliability of the completion test?

All in all, it is important to build a mutual relationship of trust between the migrants on the one hand, and those who will be working with them. Often, one's own employees get the impression that there is much support offered for the persons being recruited, but the long-standing employees themselves, in addition to the considerable workload, are now also responsible for the additional training of these employees without themselves having any advantages.

When selecting recruiting agencies and language schools, it is important for the outcome to build a mutual relationship of trust in order to be able to respond quickly, reliably and individually when difficulties arise. Since the placement of personnel for the agencies is highly attractive, there are also many substandard providers. Just because an agency has a lot of experience in supplying medical staff does not mean that they also have expertise in recruiting nursing staff. The market, the environment and approach are completely different.

Regulated professions meet special social requirements. They are bound by legal regulations and entry requirements and specific qualifications. The professional title is protected by law. Nursing is one of the regulated professions, so both the recognition and the management of the professional title is a basic condition for the permission to practice the profession within the EU. Besides the protection vis-à-vis patients and the nursing profession, the regulations also guarantee the quality and transparency for the healthcare providers (Prölss et al 2019).

Recognition procedures

As a common standard, EU Member and Contractual States have agreed on certain minimum requirements. These are set out in Directive 2005/36/EG and in its revision 2013/55/EU. In contrast to other countries (third countries), the professional qualifications acquired in the EU can be automatically recognised within the EU on application, without examining the individual training contents. In addition, a certain language level (usually B2) for the host country must be proven. It should be noted that the professional qualifications in the respective countries are only recognised if the country was already a member of the EU at that time. Further details on professional recognition, in particular, on the effects of Brexit, are currently available on the EU websites (Europa 2019).

In the case of migration from so-called third countries, there is no automatic recognition, but the rule is to check individually per applicant as to the extent qualitatively and quantitatively the qualification fulfils requirements. To the extent that something is missing, the deficit must be made up retrospectively in order to enable an equivalent recognition by the host country. This can extend the recognition procedure due to compulsory assignments and examination requirements.

In the past, the applicant submitted the personal proof of professional qualification obtained in the home country and the language certificate to the respective authority of the "host country" and filed an application for equivalence. Tedious procedures and problems through translations and individual interpretations were the result.

Since June 2015, it has been possible to use a European occupational status card (EBA) to allow a significantly simplified, legally valid and more efficient recognition of professional qualifications. This is achieved through an EU-initiated European Internal Market Information System (IMI). The applicant can now submit his documents online via the home country. There it is checked as to whether they are complete, genuine and valid, since the result is placed in IMI as an individual "account." The host country can now establish equivalence directly via the IMI and issue the occupations permit. In the case of revocation of the occupational permit or other occupationally relevant offenses, this will then become immediately apparent at European level. Employers or any other interested parties, if authorised, can check the validity of the EBA online using its reference number (Bundesministerium für Bildung und Forschung nd).

Entry requirements qualification/level of education

The EU directive distinguishes between two options. These allow access to training for 10-year schooling and access to study for 12-year schooling. The duration of the qualification (training or study) must be at least three years and 4,600 hours (theory and practice). The scope of the theoretical training must be at least one-third and that of the clinical-practical training at least half of the minimum training period.

Regardless of whether the professional qualification is training or study, the minimum competencies set out in Directive 2013/55/EU must be achieved.

The educational level of a vocational qualification is based on the country-specific qualifications framework. The basis for this is the learning outcomes associated with the qualifications. Based on technical (knowledge and skills) as well as personal competencies (social competence and independence) these are then evaluated and assigned in the eight designated levels of the respective NQF (European Commission (2019).

The eight-level European Qualifications Framework (EQF) serves as a reference framework. It should make it possible to compare educational qualifications and their qualification levels within the European Union.

It is divided into eight different qualification levels, level eight corresponds to the doctorate, level six a bachelor's degree.

Specialisations are often done as postgraduate training. However, the formats are very different in terms of fields of study, level of qualification, duration and possibilities of use and are therefore only limited for comparison within Europe (and partly also within one's own country) and are only (differently for each country) recognised for specially designated further education.

Despite their comparability at the European level, the real job profiles and competencies of caregivers in the individual countries are very different and must be considered in advance for assignments.

In many European countries, hardly any nursing basic skills or body proximity care activities are carried out, neither in education nor in later professional practice. These are usually the responsibility of nursing assistants. In the eastern European countries, the nursing staff is traditionally still often subordinate to the medical staff and this thus weakens a real professionalisation and encounter at eye level. The delivery of nursing and physical care activities is often perceived by the nurses trained in Eastern Europe as a higher status than others.

Way ahead

Despite all European regulations and adjustments, the actual recruiting procedure requires an attentive and clear assessment and accompanying procedure, which suits both the country and their own institution. Best practice examples can help to provide the best and most secure way of integration for all clients. ■

KEY POINTS

- ✓ There is an increasing shortage of healthcare personnel
- ✓ Mobility within and outside the EU contributes to this shortfall
- ✓ In cross-border nursing, main points for stakeholders to consider include maintaining trust prior to commencement of employment, on boarding, language skills and cultural differences
- ✓ In the EU, job responsibilities in different countries can differ greatly in spite of having similar titles

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How following steps for quality impact healthcare consumerism

Quality Assurance as a function of healthcare business profitability and efficiency

Healthcare needs to invest in quality assurance and improvement to use resources and increase profitability.

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Quality Assurance (QA) is a programme for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met. QA is a wide-ranging concept covering all matters that individually or collectively influence the quality of a product. Simply put, QA involves all activities geared towards the maintenance of a desired level of quality in a service or product (who.int).

QA used to be relevant mainly in the health sector, specifically the pharmaceutical industry, but the term is now applicable to all industry sectors involving any type of service or product such as medical and electronic devices, software and hardware in information technology industry. This expansion of the number of industrial sectors to assure their products and services are of good quality, has also necessitated the development of international regulations to drive and assure compliance to quality claims by these industries. Some of these regulations implemented as norms, standards and guidelines to promote QA are enforced by different regulating bodies such as World Health Organization (WHO), International Standards Organisation (ISO), International Electrotechnical Commission (IEC), different National Regulatory Agencies (NRAs) and the list goes on as more industrial sectors imbibe the quality principles.

The basic principle connecting all these different quality assessments, is the Quality Management System (QMS) principle depicted in **Figure 1** below as the quality management framework components.

"QUALITY ASSURANCE HAS INDICATORS THAT ARE MEASURABLE, OBJECTIVE, QUANTITATIVE MEASURES OF KEY SYSTEM ELEMENTS OF PERFORMANCE, USING A SIMPLE PROCESS"

Some businesses simply divide QA into four major areas: quality control, production, distribution, and inspections. Irrespective of how a company views quality it must be handled in an organisation as a top-down process with the company's management team making it a core part of its mission. If the management's view about QA is that it's bureaucratic, a waste of time and not necessary to meet the financial bottom line, personnel will toe the same line and consequently impact other processes. The core of this article is to emphasise how paying close attention to QA from start to finish of a product's or service's lifecycle can impact an organisation's profitability. QA or quality in general has indicators that are measurable, objective, quantitative measures of key system elements of performance, using this simple process in **Figure 2** to drive compliance.

In healthcare, more time should be invested in planning for quality, followed by implementing the QMS principles, continuous monitoring for improvement and acting on the improvement initiatives in a timely manner to yield needed outcomes including increase financial benefits. The increase in business profitability can better be explained by showing different scenarios using some of the Cost of Quality (COQ) (Accounting for Management no date) elements as shown in **Figures 3** and **4** below. COQ analysis concerns the business expense involved in preventing/controlling, detecting/monitoring and removing/addressing defects or quality incidences that affect a product or service. It is classified into four costing elements of Prevention Cost (planning phase), Appraisal/ Inspections Cost (doing and checking), Internal Cost (correcting defects that happen internally) and External Cost (correcting defects that occur outside the organisation, after a product/service is out of the company). The external cost is the most damaging to a company both financially and reputational.

Figure 1.

Figure 2.

Figure 4 depicts a company that invests more and has a culture of thinking QA at the beginning, middle and end rather than a sudden remembrance to implement QA at the middle or end of a project or process. **Figure 3** is almost the exact opposite, a company that does not put QMS at the core of everything they do with the ultimate price of spending a high percentage of their profit on cleaning up their reputation after the negative effect of a poor quality product gone into the market space. The scenarios above (common in manufacturing and distribution companies) can be applied to any type of company including healthcare companies using their applicable quality indicators. Examples of possible hospital indicators are Inpatient Quality Indicators (IQIs) and Patient Safety Indicators (PSIs).

Application of quality assurance in healthcare industry

The use of QA healthcare is becoming top priority for healthcare providers. Use of quality indicators measures and reports has helped to show that up to 98,000 deaths per year occurred in the United States (US) because of medical errors, thereby being among the top 10 causes of deaths (Jonge et al. 2011). The use of quality indicators to drive patient satisfaction and patronage has been in existence for a while; Health Canada, for example, has been providing health indicators reports since 2002 which contain information on healthcare across the country allowing governments and Canadians to compare data, track changes, see progress and identify areas for improvement within the healthcare system (Government of Canada 2017). This type of practice depicts the plan-do-check-act quality process which ultimately always leads to process improvement and profitability for any institution.

QA can be used to drive patients' satisfaction and patronage in a healthcare setting as only a satisfied patient will be willing to pay for healthcare services. An example of this was well researched in developing communities (Brown et al. 1998). It states that QA promotes confidence, improves communication, and fosters a clearer understanding of community needs and expectations. If providers do not offer quality services, they will fail to earn the population's trust, and clients will turn to the health system only when in dire need of curative care. This scenario is particularly unfortunate in developing countries, where the success of lifesaving preventive care, such as immunisation, growth monitoring, family planning, and antenatal care, depends on the willing participation of communities. Moreover, as primary healthcare programmes adopt cost-recovery strategies, the quality of service must be sufficient to attract the population to the clinic on a fee-for-service basis.

"QUALITY ASSURANCE CAN BE USED TO DRIVE PATIENTS' SATISFACTION AND PATRONAGE IN A HEALTHCARE SETTING AS A SATISFIED PATIENT WILL BE WILLING TO PAY"

Recent trend is the use of Artificial Intelligence (AI) technology in healthcare such as in radiological imaging for the diagnosis of chronic diseases such as in cardiology and tissue perfusion.

Health companies manufacturing medical devices need to put a robust QA process in place that validates the use of these medical devices and addresses any potential risk. The importance of this aspect of the QA process is so urgent that the International Medical Device Regulatory Forum (IMDRF) in their fourth issue, provided a path for global regulators to converge on terminology, a risk-based framework, and an understanding of quality management system principles (U.S. Food and Drug Administration 2018). Hospitals and clinics using these devices must understand them, put their own quality tracking matrix in place to checkmate the manufacturers' claimed device performance and know at what out of specification performance trend stage they

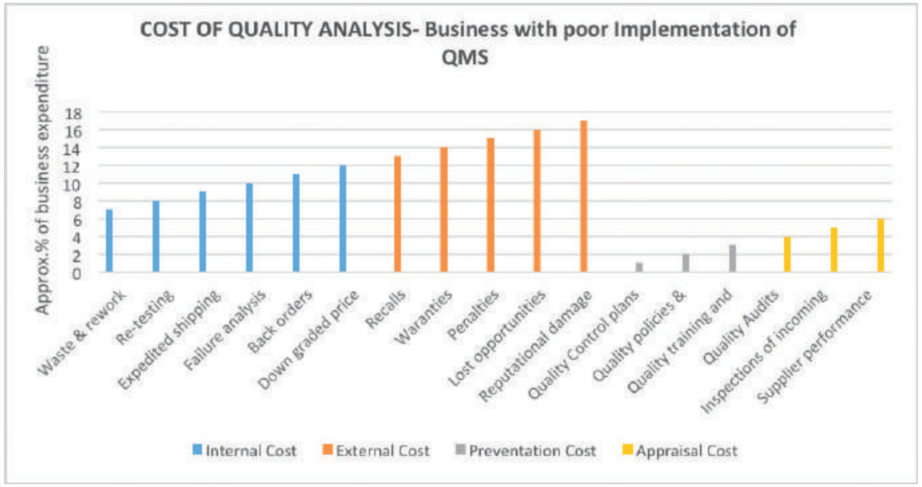

Figure 3.

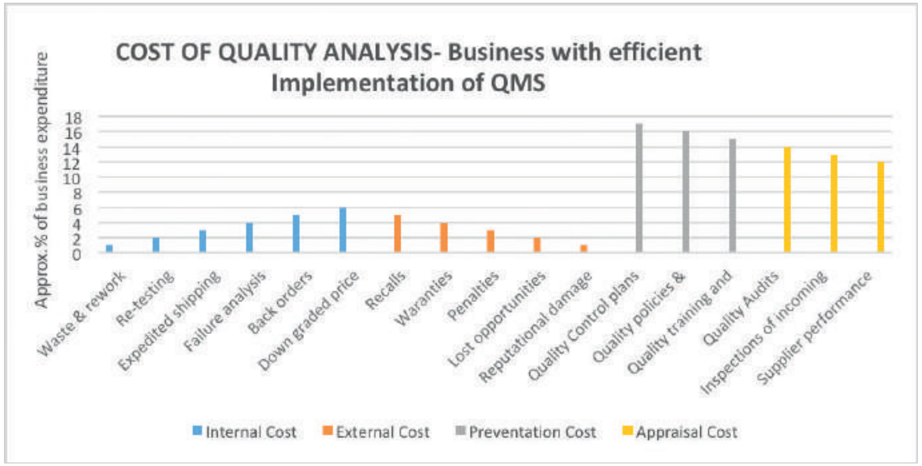

Figure 4.

must raise an alert to the Regulators and manufacturers. This will help protect the patients, health institution's and its healthcare providers' reputation. One of such QA processes to be put in place is a schedule of tracking the medical device maintenance to ensure optimal device output always. For example a simple medical device such as a blood pressure equipment can malfunction due to poor battery life or other internal equipment issues which could have been detected during routine maintenance, may lead to incorrect patient blood pressure readings and ultimately stroke, if true readings are high (200/160) but device shows readings are within acceptable limit (103/76).

Businesses including healthcare companies interested in profiting and driving efficiency in their products, processes and patient satisfaction, must make QA a way of living (culture) and not just a necessity because regulations demand it. ■

KEY POINTS

- ✓ Organisations must put QA at the centre of their operations
- ✓ A culture of QA starts with top management
- ✓ There are internal and external costs, the latter including financial and reputational tolls
- ✓ QA can drive patient satisfaction and loyalty

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The “One Stick Standard” for vascular access

The role of ultrasound guidance in achieving a new safety goal

US visualisation: one-stick standard and how the practice can significantly reduce- or even eliminate- dangerous complications.

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Obtaining vascular access is one of the most common procedures performed in U.S. hospitals, with more than 5 million central venous catheterisations (CVCs) performed annually (Feller-Klopman 2007). Nearly 80% of critical care patients undergo CVC (Gibbs and Murphy 2006) for administration of fluids, blood products, or vasoactive drugs; haemodynamic monitoring; haemodialysis or transvenous pacing (Sisson and Nagdev 2007). However, this invasive procedure can have serious complications, including iatrogenic pneumothorax (the accidental puncture and collapse of the patient’s lung) and central line-associated bloodstream infections (CLABSIs), particularly if CVC is performed blindly, using traditional techniques based on anatomical landmarks.

“Reducing procedural complications is critical to improving patient safety,” reports Tejal K. Gandhi, MD, MPH, CPPS, President and Chief Executive Officer, National Patient Safety Foundation. “Using ultrasound guidance is a highly recommended way to achieve that goal.” A 2016 policy statement from the American College of Emergency Physicians (ACEP) bears that out, stating that the benefits of procedural ultrasound, performed at the bedside, include “improved patient safety, decreased procedural attempts and decreased time to perform many procedures in patients whom the technique would otherwise be difficult” (**annemergmed.com/article/S0196-0644(16)30096-8/abstract**).

Guidelines from numerous government and medical specialty groups recommend ultrasound-guided CVC, with ACEP presenting Class I evidence to support this practice (**annemergmed.com/article/S0196-0644(08)02087-8/fulltext**). The policy statement reported that procedural ultrasound not only allows clinicians to identify the relevant anatomy and pathology before proceeding with invasive procedures, but it also aids accurate execution through direct visualisation as the needle advances towards the target vessel. Quite simply, the effect is similar to turning on a car’s headlights at night to navigate safely to the desired destination.

Adding that procedural ultrasound is helpful for both central and peripheral line placement, ACEP advocates its use to enable a “one stick standard” for faster, safer vascular access to accelerate patient care. Here is a closer look at how to achieve that standard, drawing on recently published data and the author’s experiences as a critical care physician at Banner Health, which operates 29 hospitals and acute-care facilities across seven states.

"USING ULTRASOUND VISUALISATION TO ACHIEVE A ONE-STICK STANDARD HAS BEEN SHOWN TO SIGNIFICANTLY REDUCE- OR EVEN ELIMINATE- DANGEROUS CVC COMPLICATIONS"

Ultrasound guidance helps hospitals reduce a $364 million risk

In fiscal year (FY) 2016, 758 U.S. hospitals incurred an estimated $364 million in penalties under the Hospital Acquired Conditions (HAC) Reduction Program (**cms.gov/Newsroom/**

MediaReleaseDatabase/Fact-sheets/2015-Fact-sheets-items/2015-12-10-2.html). Under this program, the quartile of hospitals with the highest rates of pneumothorax, CLABSI and eight other preventable complications are docked 1% of their annual Medicare reimbursements across all diagnosis-related groups (DRGs), providing a powerful incentive to adopt proven best practices to reduce procedural errors and their associated costs.

About 250,000 CLABSIs occur annually each year in the U.S. with estimated attributable mortality of 12 to 25% and an estimated cost of up to $56,000 per infection (O'Grady et al. 2011a; 2002b). Pneumothorax lengthens hospital stay by 4 to 7 days with an additional cost of up to $45,000 per case (Zhan et al. 2004). The cost can escalate dramatically if the patient sues, with a recent study reporting malpractice payments of up to $6.9 million for central line-related injuries, such as pneumothorax, pulmonary artery rupture, and air embolism (Domino et al. 2004).

Using ultrasound visualisation to achieve a one-stick standard has been shown to significantly reduce- or even eliminate- dangerous CVC complications. For example, in a randomised controlled trial with 900 critical care patients (Karakitsos et al. 2006), ultrasound-guided CVC reduced rates of pneumothorax to 0%, compared to 2.4% for landmark methods. A 35% reduction in CLABSI among those who received ultrasound guidance could be attributed to fewer needle passes and reduced rates of venous thrombosis and haematoma, suggested the investigators, who also reported the following outcomes:

- Superior success with ultrasound-guided CVC placement, compared to the landmark group (100% vs 94%)
- A reduced rate of carotid punctures (1% vs 10.6%)
- Fewer haematomas (0.4% vs 8.4%)
- Significantly reduced blood-vessel access time, higher first-pass success, and a decrease in haemothorax (0% vs 1.7%)

A six-point bundle to reduce central line infections

A recent guideline to reduce CLABSI issued jointly by the Centers for Disease Control (CDC), the Society of Critical Care Medicine and other leading specialty groups recommends "ultrasound guidance to place central venous catheters (if this technology is available) to reduce the number of cannulation attempts and mechanical complications" (O'Grady et al. 2011) (**cid.oxfordjournals.org/content/52/9/1087.full**). The guideline also advises using the subclavian vein as the preferred CVC site, a recommendation also supported by a 2015 systematic review that reported, "subclavian catheterisation is particularly favoured for reported reduction in infectious and thrombotic complications compared with the other sites" (Kim and Koyfman 2015). Newer techniques now allow subclavian catheters to be placed under ultrasound guidance, though Internal Jugular vein access is the most commonly performed due to its ease.

The hospital where I practice- and many others across the U.S.- have seen striking reductions in CLABSI after adopting the following six-point safety bundle, which builds on the Institute for Healthcare Improvement's (IHI) widely used five-point central line insertion checklist by adding ultrasound guidance as a sixth component, as advised by the CDC guidelines. In a recent study, the IHI checklist was associated with a reduction of up to 66% over an 18-month period at 103 participating facilities (Pronovast et al. 2006).

1. Hand hygiene*
2. Maximal barrier precautions*
3. Chlorhexidine skin antisepsis*
4. Optimal catheter site selection*
5. Daily review of CVC line necessity, with prompt removal of unneeded lines*
6. Ultrasound-guided line placement**

*Component of the IHI checklist.

**Recommended by the CDC guideline.

Ultrasound-guided peripheral IV as an alternative to high-risk CVC

Achieving rapid vascular access is particularly critical for providing optimal care for critically and unstable patients. However, failure rates of emergent peripheral intravenous (PIV) access of 10 to 40% have been reported in the literature, with the average time needed for PIV reported at 2.5 to 13 minutes, and difficult PIV access taking up to 30 minutes (Leidel et al. 2009; Crowley et al. 2012). Very often, patients with problematic PIV access due to such factors as obesity, chronic illness, chemotherapy, vascular pathology, or a history of IV drug use end up receiving CVCs.

"QUITE SIMPLY, [US] EFFECT IS SIMILAR TO TURNING ON A CAR'S HEADLIGHTS AT NIGHT TO NAVIGATE SAFELY TO THE DESIRED DESTINATION"

However, ultrasound-guided PIV, which is a standard practice at the hospital where I work, can help such patients avoid unnecessary CVCs and their associated risks. A randomised trial of emergency department patients with difficult vascular access found that ultrasound-guided PIV had a 97% success rate, compared to just 33% for landmark methods. The investigators also reported the following results:

- Faster vascular access in the ultrasound group, compared to the landmark group (13 minutes vs 30 minutes)
- Fewer percutaneous punctures (1.7 vs 3.7)
- High patient satisfaction when ultrasound was used

Since CVCs can have a complication rate of up to 15% (Feller-Kopman 2007), with additional costs estimated at up to $56,000 per case, the outcome of this trial, and others with similar findings (Au et al. 2012), offer a powerful argument for widespread adoption of ultrasound-guided PIV as an evidence-based safety practice to reduce costs and accelerate care for patients who need it the most. And if you or a loved one ever needed a central or peripheral line for emergency treatment, wouldn't you want ultrasound at the bedside- and a medical provider who was firmly committed to achieving the one-stick standard? ■

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Revitalising the aged heart through spermidine-rich diet

Stringent dietary adjustments, albeit effective in delaying ageing, are not attractive to the majority of people. Thus, pharmaceuticals or natural substances that mimic caloric restriction, like spermidine, are emerging as an alternative and feasible strategy to promote healthy ageing.

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Background

We are in an era of artificial intelligence, big data, and machine learning, where humans are living longer than ever before. However, this unprecedented life expectancy is not coinciding with a parallel increase in healthy life years. In fact, age-related chronic diseases, including cardiovascular and metabolic disorders, are on the rise worldwide. As such, an extended life span comes at the expense of disability and poor quality of life. Hence, medicines that specifically counteract the underlying mechanisms of premature health decline in ageing are urgently needed to alleviate the enormous burden of age-related diseases on public health and economies. As a result, geroscientists, ie scientists studying ageing and related diseases, have taken the quest to find effective interventions to reverse ageing. Actually, recent experimental discoveries of compounds that ostensibly mimic a healthy diet and tackle the world's most common ailment - ageing itself - led to a growing belief that healthy ageing is within reach.

Caloric restriction promotes health and prolongs life: is it time to fast?

The impact of food on our health has been long recognised, not only with it being the source of energy and nutrients necessary for growth and development, but also as a remedy to treat diseases or even avoid them altogether. Almost every aspect of our feeding behaviour can profoundly affect both our health and the pace of ageing. This is true for diet composition, the amount of food consumed, the timing of meal intake during the day, and the duration of time between different meals. In this regard, dietary or caloric restriction – reduced food intake without malnutrition – is well known to promote health and extend lifespan in almost every tested organism, ranging from unicellular organisms to flies, mice, and monkeys. The startling benefits of caloric restriction are believed to be due to re-routing energy utilisation from growth towards cellular maintenance and repair processes. One such cell-protecting process is autophagy (the Greek word for 'self-eating'), which is crucial for cellular homeostasis. Besides adaptation to stress, autophagy plays a key role in cellular housekeeping, whereby potentially toxic cellular components, such as damaged organelles and protein aggregates, are degraded, and the end-products serve as new building blocks for cellular recycling or can simply be used as a fuel for energy production (Abdellatif et al. 2018).

As we age, autophagic activity declines, leading to disproportionate accumulation of cellular waste. Furthermore, present-day dietary regimens repress autophagy, which naturally evolved as a cell survival process in ancient history when humans used to undergo prolonged periods of fasting during times of food searching or hunting. In contrast, nowadays we tend to suppress every hunger attack by overindulging in hyper-caloric foods, which inherently block autophagy.

"HUMANS ARE LIVING LONGER THAN EVER, YET SUCH EXTENDED LIFE COMES AT THE EXPENSE OF DISABILITY AND POOR LIFE QUALITY"

Accordingly, caloric restriction can counteract contemporary faulty feeding practices and, at least in part, re-establish normal autophagic activity. Autophagy, by restoring cellular fitness and homeostasis, can, in turn, improve health and possibly prevent age-related disease and may even protect from premature mortality. However, caloric restriction is still far from being a routinely used anti-ageing medical intervention for at least two reasons. Firstly, adhering to strict dietary regimens for extended periods is challenging and practically difficult to reinforce on a population level. Secondly, the efficacy and safety of long-term caloric restriction in the elderly is still to be established clinically amid concerns regarding its effect on aged subjects

Figure 1. Spermidine-rich food

The list of foods rich in spermidine includes whole grains, soy beans, aged cheese, shitake mushrooms, green peas, nuts, apples, pears, and broccoli among others. Image Credit: Dr. Julia Ring

suffering from osteoporosis, infections or injuries, let alone chronic food abstinence in some enthusiastic individuals, which may cause malnutrition. That said, there is a great interest in developing other therapeutic and pharmacological interventions, which could mimic the metabolic effects and bring about many physiological benefits of caloric restriction without having to endure cumbersome dietary adjustments.

Spermidine: a natural caloric restriction mimetic

A promising alternative to caloric restriction is caloric restriction mimetics –compounds that induce autophagy without rigorous fasting periods or cutting down total daily caloric intake. One such caloric restriction mimetic is the polyamine spermidine (Madeo et al. 2018). Spermidine occurs naturally in every cell in our body and regulates some vital cellular functions, including protein synthesis as well as cell proliferation and differentiation. Amounts of spermidine, which decline with age, are affected by its biosynthesis and more importantly by food intake. Therefore, spermidine levels in different body tissues can be increased by a higher intake of spermidine-rich foods, such as wheat germ, soybeans, aged cheese, shitake mushrooms, green peas, nuts, apples, pears, and broccoli (**Figure 1**). Given that spermidine has the ability to activate autophagy in a similar fashion to caloric restriction, it is conceivable that spermidine could be used to treat, delay or maybe even prevent ageing and related disorders.

Cardioprotection and lifespan extension by spermidine

Growing experimental evidence supports the notion that spermidine has a great potential to be used as an effective anti-ageing compound. In fact, dietary supplementation of spermidine to aged mice prolongs their life by at least 10%, which could be increased to 15% or even 25% upon its life-long administration (Yue et al. 2017).

With ageing, both the heart and vasculature show signs of deterioration, including compromised functional reserve as well as myocardial and vascular stiffening. Consequently, ageing, especially when accompanied by other risk factors like obesity and hypertension, substantially increases the likelihood of cardiovascular disease. Given that the leading cause of mortality in humans is cardiovascular disease, spermidine-mediated lifespan extension was tested for possible cardiovascular improvements. Indeed, spermidine was found to turn back the ageing clock and improve cardiac health (Eisenberg et al. 2016). At the organ level, both cardiac structure and function were improved in spermidine-fed aged mice. At the cellular level, spermidine increased metabolic fitness by revitalising the function and restoring the structural integrity of mitochondria – the cellular powerhouse. As for the vasculature, spermidine feeding does not only reduce vascular stiffness in aged mice (LaRocca et al. 2013), but also delays the development of hypertension in salt-sensitive rats, which were protected from hypertensive cardiac and renal disease. Remarkably, activation of autophagy was found to be a prerequisite for such extraordinary cardiovascular benefits of spermidine. Taken together, spermidine seems to mimic caloric restriction and extend lifespan, while protecting the circulatory system, at least, in preclinical testing (**Figure 2**).

Spermidine in humans

The relationship between ageing and spermidine intake in humans has been examined epidemiologically within the BRUNECK Study, in which a total of 829 individuals were recruited in Bruneck (South Tyrol, Italy) and followed up for 20 years (1995-2015). All participants underwent regular clinical evaluation, and their dietary spermidine intake was monitored by means of comprehensive food questionnaires under the guidance of specialised nutritionists (Kiechl et al. 2018). The study revealed that a higher intake of spermidine was associated with lower blood pressure and reduced risk of heart failure and other cardiovascular diseases (a composite

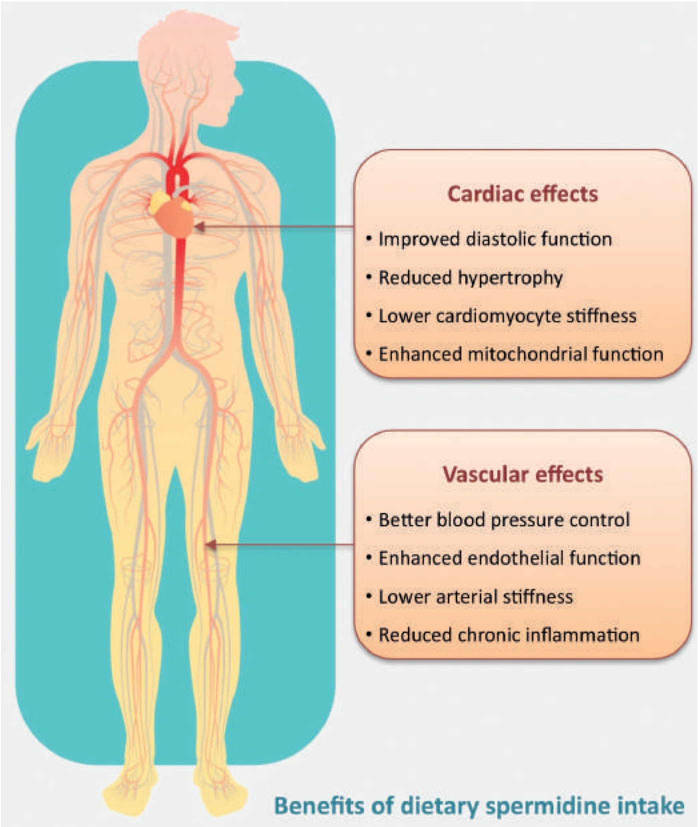

Image Credit: iStock

Figure 2. Cardiovascular effects of spermidine-rich diet.

of acute coronary artery disease, stroke, and vascular death). Furthermore, overall and cardiovascular-related mortality was reduced in those subjects consuming higher amounts of spermidine in their diet, even after correcting for possible confounding factors, such as caloric intake, age, sex, body mass index, diabetes, hypertension, physical activity, smoking, and alcohol consumption. More recently, the safety of spermidine administration to the elderly was examined in a pilot clinical trial recruiting patients with a subjective cognitive decline. Spermidine-rich plant extracts were well-tolerated by the patients and had a positive impact on memory performance (Wirth et al. 2018). Although these findings still await further validation in larger/more rigorous clinical trials, they collectively provide initial evidence for the potential therapeutic application of spermidine in the future.

Conclusion

The medical and socio-economic burden of ageing will continue to stimulate researchers to develop effective strategies that target ageing itself. The possibility that a simple and natural molecule like spermidine, could have profound health-promoting effects and may even promote longevity without the need for radical adjustments of feeding behaviour is quite captivating and extremely encouraging. That being said, the upcoming years will reveal whether spermidine and other caloric restriction mimetics are suitable remedies for clinical use. Until then, eating a few more nuts wouldn't do any harm nonetheless. ■

Acknowledgment

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KEY POINTS

- ✓ Ageing and 'obesogenic' diets are major risk factors for health decline and disease
- ✓ Fasting, without malnutrition, extends health- and life-spans
- ✓ The natural polyamine spermidine reproduces the benefits of fasting without changing feeding behaviour

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State-of-the-art syncope assessment

Aspects & challenges - Approaches & tools

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Head-up-tilt testing (HUTT) and autonomic function testing are essential diagnostic procedures in syncope assessment. With the advent of unique innovative methods to noninvasively monitor beat-to-beat blood pressure, cardiac output, total peripheral resistance as well as autonomic regulation, highly efficient tools to assess cardiovascular and autonomic function have become state-of-the-art for improved diagnosis of patients.

Over the last few decades experts around the world continue to explore the mechanisms of syncope describing different approaches, concepts and factors that might explain what is going on in a fainting patient. Although being a common disease the pathophysiology of syncope is still a rich research topic[1] and its "diagnosis and management remain challenging tasks in medical practice."[2]

While the approach to diagnose syncope is most often the same for pediatric, adult and geriatric patients[1], it is meanwhile well-known that the circulatory adjustment to the stress of a postural change varies markedly over age.[2]

Recent studies show that considering the full set of continuous cardiovascular parameters is required to enhance the diagnosis and provide age-tailored therapies for syncope:

Wijnen et al.[4] showed that hemodynamic responses are age-related and that the course of syncope definitely differs between young and old patients.

Gonzales-Hermosillo et al.[7] studied young patients in order to compare the hemodynamic and autonomic responses of healthy volunteers with syncope patients during head-up tilt, analyzing heart rate variability and beat-to-beat blood pressure.

Nevertheless, in recent literature the head-up tilt test has been considered a long-term procedure with limited specificity and sensitivity[3] to detect all the different mechanisms which are responsible for syncope. There is a claim for "new, more advanced methods for syncope analysis"[3] that help to better understand the "complex responses provoked by the HUTT."[3] The authors agree that additional or different approaches and methods might be required.[1,2,7,8]

Wu et al. investigated the clinical relevance of carotid sinus hypersensitivity as a possible approach and predictor of syncope and autonomic dysfunctions.[2]

Ruska et al. from the Zagreb Medical University evaluated the COMPASS-31 questionnaire as a supplementary method for HUTT for objective testing of the autonomic nervous system. This method proved "a valuable screening tool to assess symptoms of autonomic dysfunctions as it is associated with impaired ANS."[8]

"REAL IMPROVEMENT OF THE DIAGNOSIS AND TREATMENT OF SYNCOPE IS ONLY POSSIBLE BY TAKING INTO ACCOUNT THE COMPLETE SET OF ASPECTS INCLUDING THE WIDEST POSSIBLE VARIETY OF HEMODYNAMIC PARAMETERS"

Apart from the evaluation of linear patterns, such as hemodynamic and autonomic parameters, approaches describing the underlying dynamics of cardiovascular responses to syncope might be required.

Makowiec et al. have investigated the so-called multistructure index (MI) describing the asymmetric features of cardiovascular interactions. Differences have been found in the organization of the homeostatic state between healthy people and vasovagal patients."[1]

Buszko et al. from the Medical Universities in Warsaw studied vasovagal syndrome occurrence and proposed another nonlinear approach based on differences in sample entropy and even stroke volume as "measures of irregularity."[7]

Most studies claim a need for further investigations and suppose that it might finally be a combination of many approaches which has the potential to fully elucidate the complex physiological mechanisms of syncope and which could become the gold standard.

However, real improvement of the diagnosis and treatment is only possible by taking into account the complete set of aspects including the widest possible variety of hemodynamic parameters.

The Task Force® Monitor by CNSystems has proven as commonly used diagnostic tool for the assessment of neuro-cardiogenic syncope[8] which "calculates and registers biological signals in a completely reliable and non-invasive way, in the beat-to-beat mode, this being its main advantage."[9]

It is an easy to use tool for currently applied protocols and allows for recording and exporting a full set of hemodynamic and autonomic parameters, which is a solid basis for further research studies. ■

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Critical analysis of MRI-based classification systems for sport muscle injuries

Critical review

A critical review of eight identified cases of muscle injuries in professional FCB players from the club's annual muscle injury database in 2017.

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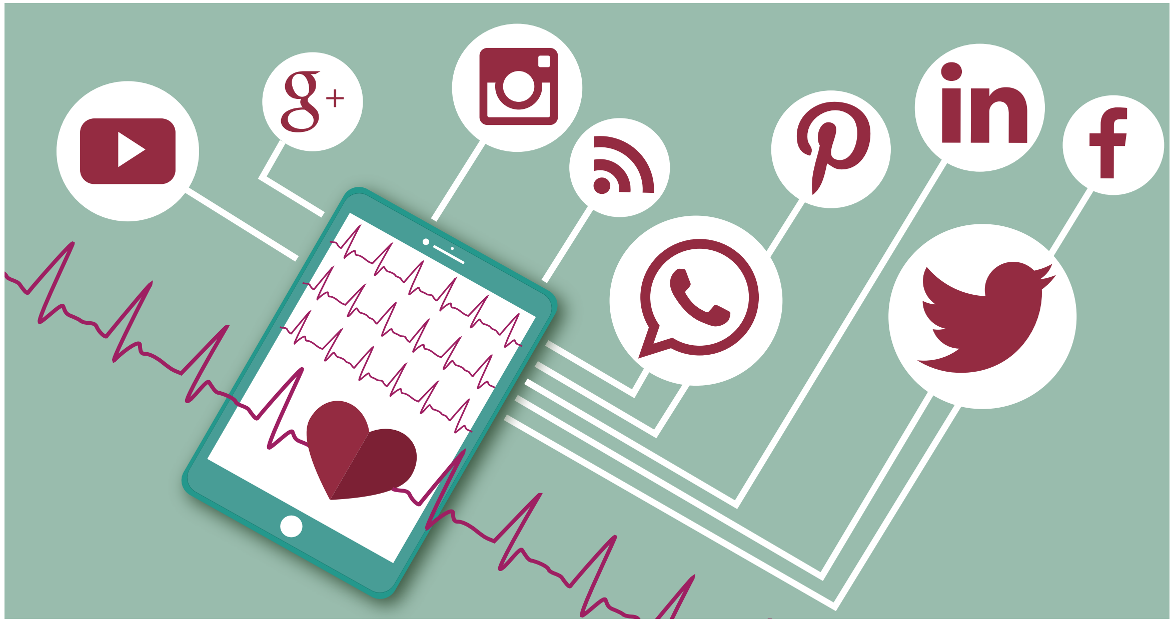

Social media (#SoMe) can now be considered one of the most important methods of communication in healthcare, especially in cardiology. Twitter, in particular, is gaining increasing popularity among clinicians, scientists, and researchers. Currently there are a total of 326 million Twitter users. Some 100 million of these users are active daily with approximately 500 million tweets sent out every day (Omnicore Agency 2018).

The Twittersphere

If you browse through Twitter, you will see that almost every major cardiovascular journal and professional cardiovascular societies and organisations are active on Twitter. These include the American College of Cardiology, the European Society of Cardiology, the Journal of American College of Cardiology, JAMA Cardiology, the American Heart Association, and Heart.org as well as prestigious medical journals including NEJM, Lancet and JAMA. Many healthcare professionals make it a point to tweet if they publish a new paper or study or if they find a paper or study that they find interesting in order to advance dissemination. Twitter is thus an excellent source if you are looking for the latest news and breakthrough research in cardiology.

On Twitter, the two most popular hashtags related to general cardiology include #CardioTwitter and #Cardiology (Walsh 2018), but there are more hashtags relating to cardiology subspecialties such as #radialfirst for coronary intervention, #TAVR for structural intervention, #whyCMR for cardiovascular magnetic resonance, #echofirst for cardiac echocardiography and #YeSCCT for cardiac computed tomography. All are being widely mentioned in tweets across the platform. In addition, Twitter has now made it possible for interested parties to get information from ongoing Congresses in real time by viewing online streaming of major sessions as well as by following congress/seminar hashtags.

Cardiologists and heart researchers and scientists now actively share their ideas, information about current projects and discussions on hot/controversial issues on Twitter and increasingly, research ideas and collaborations first discussed on Twitter begin to take shape. People interested in healthcare and cardiology can find a wealth of information on Twitter by following the relevant people in cardiology and the popular hashtags.

"PEOPLE INTERESTED IN HEALTHCARE AND CARDIOLOGY CAN FIND A WEALTH OF INFORMATION ON TWITTER BY FOLLOWING THE RELEVANT PEOPLE AND THE POPULAR HASHTAGS"

How #SoMe benefits cardiology

The use of social media in cardiology is an excellent medium to empower patients by allowing them the opportunity to increase their knowledge, understand their medical condition and overall educate themselves. All medical professionals including doctors, nurses, physiologists, radiographers and physiotherapists can engage in lively discussions in an open forum, where often the patients can be both observers and participants, linking directly to the source of the information. Social media is thus an excellent tool in the era of personalised medicine and the "informed patient."

The use of social media in cardiology is a healthy and innovative trend which provides several benefits including:

- The opportunity for healthcare professionals in cardiology to interact with each other.
- To share the latest, relevant and interesting information related to cardiology.
- Improving the distribution of this information to a wider audience, including patients.
- Promoting published work and research projects and/or clinical breakthroughs.
- Influencing healthcare policies and regulations through healthy discussions and debate.

Whether it is through blogs, articles, clinical publications, congress sessions, and presentations or images, Twitter and other social media platforms provide the ultimate opportunity for both patients and doctors to interact, engage and share relevant information. Cardiovascular disease remains a leading killer and interest in new research, preventive measures and novel treatment is always of interest to both healthcare professionals and patients alike

Dr Vass Vassiliou, an Academic Cardiologist, from the United Kingdom, Chair-elect of the Population Science and Public Health section of the European Association of Preventive Cardiology, European Society of Cardiology shared his thoughts on the use of social media in cardiology in an interview with HealthManagement.org. He says that "Social Media is gaining significant popularity amongst the medical and allied health professionals. It enables a platform where dissemination of research can materialise very quickly, at no cost, for the benefit of colleagues and patients across the world. I was very touched when a doctor from Uganda tweeted a “thank you” note to a group of us that were regularly tweeting from the European Society of Cardiology in Munich, in August 2018 using a dedicated #ESCcongress hashtag as through this we enabled them to “patiently follow most of the updates from Uganda!” and “thanked us for advancing science!” something that would have been impossible without #SoMe. Therefore, #SoMe plays an important role in the education of medical professionals and patients through open discussions, case presentations and fast dissemination of important new research, hoping that this can provide better patient management across the globe." ■

KEY POINTS

- ✓ #SoMe can now be considered one of the most important methods of communication in healthcare, especially in cardiology
- ✓ On Twitter, the two most popular hashtags related to general cardiology include #CardioTwitter and #Cardiology
- ✓ Other important hashtags relating to cardiology subspecialties include #radialfirst, #TAVR, #whyCMR, #echofirst and #YeSCCT
- ✓ #SoMe play an important role in the education of medical professionals and patients through open discussions, case presentations and fast dissemination of important new research.

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Critical analysis of MRI-based classification systems for sport muscle injuries

Critical review

A critical review of eight identified cases of muscle injuries in professional FCB players from the club's annual muscle injury database in 2017.

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Abstract

In cases of suspected muscle injury, sports medicine professionals use imaging methods such as ultrasound (US) and Magnetic Resonance Imaging (MRI) to confirm the diagnosis.

Various classification systems are available for determining the degree of severity of muscle injuries. The staging of muscle injuries depends on the qualitative and quantitative characterisation of several radiological findings by MRI. However, not all classifications use the same criteria to determine the severity of the injuries.

During the 2017-2018 seasons, the medical department of Fútbol Club Barcelona (FCB) has used these classifications to evaluate the prognosis and time to return to sport (RTS) for professional athletes following injury. However, the histological complexity and particularity of each muscle belly mean that image classifications are not infallible.

Introduction

Muscle injuries account for more than 30% of sports injuries (Ekstrand et al. 2011) and have severe implications for professional teams (Elliott et al. 2011). The most common mechanism of muscle injury in football players is muscle strain (indirect muscle injury) in the lower limbs, during eccentric contraction.

In the professional setting, player availability is paramount. When players become injured, it is important to accurately determine the severity of their injury, ie the time until they return to sport, as well as the risk of re-injury (Orchard et al. 2005; Waterworth et al. 2017). This requires an accurate diagnosis of the injury, which is particularly important for muscle injuries.

Currently, the most widely used techniques for confirming and assessing the extent of sports-related muscle injuries are ultrasound (US) and Magnetic Resonance Imaging (MRI), and the information obtained using these techniques helps to guide management, which directly affects prognosis (Blankenbaker and De Smet 2004: Fleckenstein et al. 1989).

MRI can be used to characterise the muscle injury in detail, and with high sensitivity, which allows the radiologist to categorise its severity according to various classifications. Therefore, these classifications guide the sports physician's therapeutic approach.

Various injury classifications have been proposed with the aim of connecting the imaging findings to the results of the clinical examination, and thereby to improve the grading of muscle injury severity and reduce the risk of re-injury. Recently, three new classifications have been proposed: the Munich Consensus Classification (Mueller-Wohlfahrt et al. 2013), the British Classification System (Pollock et al. 2014), and the FCB Barcelona and Aspetar Classification (Valle et al. 2017). These classifications focus on various factors that are key for good diagnosis and prognosis: mechanism of injury, location of the injury, presence of fibre retraction, extent of oedema (cross-sectional area), and previous injuries (re-injury).

"THE HISTOLOGICAL COMPLEXITY AND PARTICULARITY OF EACH MUSCLE BELLY MEAN THAT IMAGE CLASSIFICATIONS ARE NOT INFALLIBLE"

Despite the utility of these classification systems, injury classification remains challenging due to differences in muscle architecture, injury extension, activities when the lesion occurred, the mechanism of injury, and even the player's personality. Since each of these classifications uses different parameters to categorise muscle injuries, this can lead to conflicting treatment decisions.

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The aim of this paper is to update current knowledge in sports medicine imaging by evaluating the use of these classifications, and the discrepancies that arise between them. Specifically, we demonstrate the use of these classifications for categorising muscle injuries in 8 specific cases of muscle injury in football players seen at the FCB Medical Center.

Materials and Methods

We identified eight cases of muscle injuries in professional FCB players from the club's annual muscle injury database in 2017. We selected these cases based on several criteria:

i) The player was affiliated with the FCB professional football team at the time of the injury;

ii) The injury was located at the myoconnective junction of an important muscle for football (hamstring, rectus femoris, adductor or calf muscles);

iii) According to diagnosis, the treatment criteria were conservative (injuries requiring surgery, such as pure tendon tears, were excluded).

All injuries were evaluated during physical examination by a sports medicine physician (one of the two team doctors), after which MRI was performed in our own medical centre. All injured players underwent the same initial physiotherapy plan and re-adaptation protocol, which were managed by the same sports physiotherapist. Finally, the decision to return to sport was taken according to the criteria of FCB medical staff.

MRI studies were generally acquired within 24 hours post-injury, at the FCB Medical Center using a CANON MRI 3T VANTAGE TITAN, and were reported by an MSK radiologist sports specialist. We used a multi-purpose coil with speeder technology, which allowed us to acquire 5 sequences according to the standardised protocol for evaluating muscle injuries in the lower extremities (described in **Table 1**). The patients were positioned in supine decubitus, and the examination was performed on the injured limb only, and focused on an area marked with a cutaneous vitamin marker.

The MRI findings allow the follow-up US examinations to be targeted to the most relevant areas, assessed by using linear transducers (centre frequency greater than 10–17 MHz) (Allen 2007).

The MRI studies of each case were reviewed by two MSK radiologists (SM, with 10 years of experience; and JI, with 4 years of experience), who were blinded to the clinical information apart from the location of the injury. In case of discrepancies, the case was reviewed by XA, who has >25 years of experience. In parallel, a doctor of sports medicine (XY, RP or GR) reviewed the clinical history in terms of injury mechanism, and also the clinical exploration and US findings.

The radiological findings evaluated were: tendon rupture, peritendon oedema, loss of tendon tension, pennation angle, interstitial oedema of the myotendinous junction, blurring (rupture of fibres), intermuscular oedema and haematoma.

We used the magnetic resonance imaging results to categorise each case according to the classifications selected in our study. **Table 2** lists the different categories according to each classification. After categorising each case, we performed an exhaustive analysis of the concordances and discrepancies.

Results

In this section, we present eight cases of muscular injury and describe our clinical approach, radiological features, therapeutic behaviour, time to return to sport, and final outcome. While the injuries studied involved different muscle groups (five long head of the biceps femoral, one semitendinosus, one rectus femoris, one soleous), all except one (myoaponeurotic junction, **Case 7**) are treated as lesions of the myotendinous junction (MTJ). Six lesions of the MTJ affected thick connective tissue, and one affected fine connective

Table 1. 3T MRI Protocol

	TR	TE	SECTION THICK-NESS	GAP	FOV*	MATRIX	RESOLUTION
COR T2W FS	5000	44	2.5	0.6	26X29	288X320	0.9 x 0.9
AX T2W FS	5200	44	3.5	0	25X25	256X256	0.97X0.97
SAG T2W FS	3700	60	2.8	0	27X24	192X272	1.4X0.88
COR T1W	980	11	2.5	0.6	26X29	288X320	0.9X0.9
AX T1W	900	11	3.5	0	25X25	352X352	0.71X0.71

* For calf MRI, we used smaller FOVs, but all other imaging parameters remained the same.

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Table 2. Summary of the muscle classification systems used in this study.

Munich Consensus Statement		British Athletics Muscle Injury Classification		FCB Barcelona and Aspetar Classification	
Grade 1A (Fatigue-induced muscle disorder)	Negative MR imaging/US findings.	0a/b	MR imaging normal/MR imaging normal or patchy oedema.	Mechanism of injury (M)	I (indirect). T (direct).
Grade 1B (Delayed-onset muscle soreness: DOMS)	Negative MR imaging/US findings or oedema only	1a (Small myofascial tear)	Oedema at the fascial border, <10% extension into muscle belly; <5 cm CC length.	Locations of injury (L)	P (proximal). M (middle). D (distal).
Grade 2A (Spine-related neuromuscular muscle disorder)	Negative MR imaging/US findings or oedema only	1b (Small muscle-tendon junction tear).	<10% of CSO of muscle the MTJ; <5 cm CC length; may note fibre disruption of <1 cm.		0 (Negative MRI).
Grade 2B (Muscle-related neuromuscular muscle disorder)	Negative MR imaging/US findings or oedema only	2a (Moderate myofascial tear). 2b (Moderatemuscle-tendon junction tear).	Oedema evident at fascial border with extension into the muscle or oedema evident at the MTJ; Oedema of CSA between 10%–50% at maximal site; CC length 5-15 cm; architectural fibre disruption <5 cm.	Grading of severity (G)	1 (Oedema without intra-muscular haemorrhage or architectural distortion).
Grade 3A (Minor partial muscle tear)	Fibre disruption on 1.5 or 3-T MR images; intramuscular haematoma.	2c (Moderate intratendinous tear)	Oedema extends into the tendon with longitudinal length of tendon involvement (<5 cm); < 50% of maximal tendon CSA. No loss of tension or discontinuity within the tendon.		2 (Oedema with minor muscle fiber architectural distortion ± minor intermuscular haemorrhage, but no gap between fibers).
Grade 3B (Moderate partial muscle tear)	Significant fibre disruption, probably including some retraction, with fascial injury and intermuscular haematoma.	3a (Extensive myofascial tear). 3b (Extensive muscle-tendon junction tear).	Oedema at the fascial border with extension into the muscle or at the muscle-tendon-junction; > 50 % CSA at the muscle-tendon-junction; >15 cm CC distance; architectural fibre disruption > 5 cm.		3 (Any quantifiable gap between fibers with partial retraction ± intermuscular haemorrhage).
Grade 4 (Subtotal/total muscle tear or tendinous avulsion)	Subtotal/complete discontinuity of muscle/tendon; possible wavy tendon morphology and retraction, with fascial injury and intermuscular haematoma.	3c (Extensive intratendinous tear)	Oedema extends into the tendon with longitudinal length of tendon involvement >5 cm; >50% of maximal tendon CSA; probably loss of tendon tension, no discontinuity.	Tendinous lesion (r)	r (presence or not depends of tendinous involvement).
		4 (Full thickness tear of muscle)	Complete discontinuity of the muscle with retraction.	No. of muscle re-injuries (R)	0: 1st episode 1: 1st re- injury 2: 2nd re- injury.

tissue (raphe). We observed a broad range of RTS for these injuries, varying from 9 to 40 days. **Table 3** details the muscle affected, location of the injury, injury type, the thickness of the connective tissue involved, and the final categorisation of the injury in each classification system. Below, we describe each case in detail.

Case #1 (Figure 1)

Subject and circumstances of injury. A twenty-five-year-old professional football player who stopped playing after being referred for sudden pain in the posterior proximal third of the right thigh while sprinting and fighting for a ball during an official match. He was unable to continue playing and needed to be substituted. Palpation and stretching were painful and he was unable to do an isometric contraction.

Imaging: Diagnostic 3T MRI performed within 24 hours showed musculotendinous junction (MTJ) strain of the central tendon between the long head of the biceps femoris muscle and the semitendinosus muscle. Fat-saturated T2 weighted images demonstrated hypersignal of the central tendon with longitudinal intratendinous disruption (5.5 cm long, and 3.3 mm thick), and minimal intermuscular fluid/haemorrhage. There was surrounding oedema (CSA: 10-25% with biceps predominance). Only isolated defects in the distal fine connective tissue were seen. There was very slight loss of biceps tendon tension. As an incidental finding, cicatricial changes seemed to correspond to an old but unknown injury.

Diagnosis: Munich Consensus Classification (MCC): 3b

British Classification System (BC): 3c, FCB Barcelona and Aspetar Classification (FCB-A): IPpG3rRX

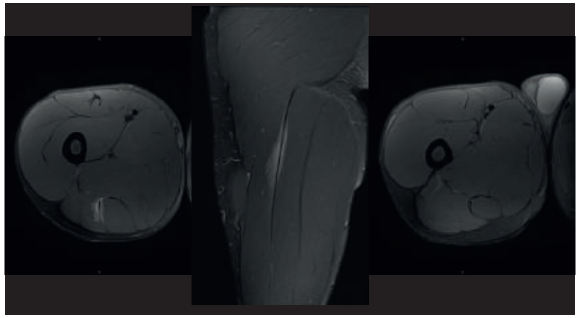

Figure 1 (Case #1). MTJ strain of the central tendon between the long head of the biceps femoris muscle and the semitendinosus muscle. As MRI signs we find paratendinous oedema, tendinous longitudinal disruption and a very slight loss of biceps tendon tension.

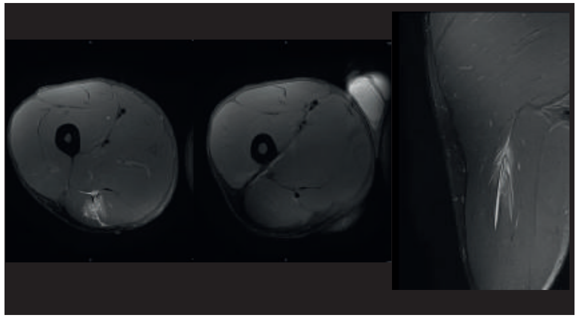

Figure 2 (Case #2). MTJ of the central tendon of the long head of the biceps and in semitendinosus muscle. MRI signs include peritendinous oedema, peripheral and partial disruption of the tendon, intermuscular fluid and intramuscular haemorrhage, and a very slight loss of tension in the semitendinous tendon.

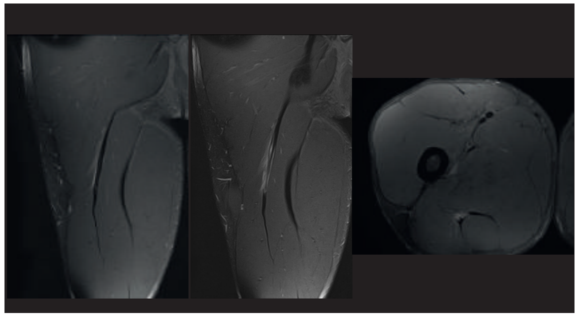

Figure 3 (Case #3). MTJ strain of the central tendon of the long head of the biceps femoris muscle. As MRI signs, we find cicatricial changes in the central tendon, with peritendinous oedema, tendinous mixed disruption, minimal intermuscular fluid/haemorrhage, and a very slight loss of tension in the biceps tendon.

Management/outcome: Conservative treatment was proposed. MRI after fourteen days demonstrated healing with signs of partial recovery of the tendon and decreased oedema of the muscle. The player returned to play at 29 days without evidence of re-injury.

Case #2 (Figure 2)

Subject and circumstances of injury. Twenty-four-year-old professional player referred for muscle cramp in the proximal third of the right hamstring during the last 15 minutes of a football match, although he was able to finish the game. After the match, walking was limited by the pain, and stretch and palpation were also painful.

Imaging: Diagnostic 3T MRI was performed within 24 hours, and showed cicatricial changes in the free tendon of the biceps, and a variant of normality in the central tendon (thick connective tissue is found in long head of the biceps and also in semitendinosus muscle). MRI shows proximal MTJ strain of both muscles. Fat-saturated T2W images demonstrated hypersignal of the central tendon with partial and peripheral disruption, surrounding oedema (CSA: 16-31% with predominance of semitendinosus) and intermuscular fluid/haemorrhage. Only isolated defects in the distal fine connective tissue are seen. Very slight loss of semitendinosus muscle tension is observed.

Diagnosis: MCC: 3b, BC: 3c, FCB-A: IPpG3rR0

Management/outcome: Conservative treatment was proposed. MRI after fourteen days demonstrated healing with signs of partial recovery of the tendon and decreased oedema of the muscle. Return to sport at 34 days without evidence of re-injury.

Case #3 (Figure 3)

Subject and circumstances of injury. Thirty-three-year-old football player referred with symptoms of fatigue in the posterior proximal third of the right thigh after playing two consecutive international matches with his National team. After returning to the Club, the physical exam showed painful palpation and the player had difficulty in stretching his hamstring.

Imaging: Diagnostic 3T MRI was performed more than 7 days later. MRI shows MTJ strain in the central tendon of the long head of the biceps femoris muscle. Fat-saturated T2W images demonstrated longitudinal strain of the tendon with transversal extension (3.3 mm transversal gap) and minimal intermuscular fluid/haemorrhage. There was no significant surrounding oedema (subacute lesion). We observed a very slight loss of tension in the biceps tendon. The free tendon was very thick, probably because it was a progressive injury over time (subacute), which leads to extra scar changes.

Diagnosis: MCC: 3b, BC: 3c, FCB-A: IPpG3rR1

Management/outcome: Conservative treatment was proposed. MRI after 20 days demonstrated healing with signal recovery of the tendon and closure of the tendon gap. Return to sport at 22 days without evidence of re-injury.

Case #4 (Figure 4)

Subject and circumstances of injury. Twenty-four-year-old football player who presented sudden acute pain in the proximal third of the right hamstring during a very high speed running action during a match, running a distance of around 20 metres. He needed to be substituted immediately. Physical exam showed considerable pain during palpation; walking was impossible, and he needed to use crutches.

Imaging: Diagnostic 3T MRI was performed within 24 hours. MRI shows a long free tendon (11 cm, tendon length from the ischial tuberosity to the origin of the central tendon of the biceps), and an early intramuscular division of the central tendon, as variants of the normality. Imaging also showed MTJ strain of the central tendon of the long head of the biceps femoris muscle. Fat-saturated T2W images demonstrated hypersignal of the tendon with multiple partial disruptions

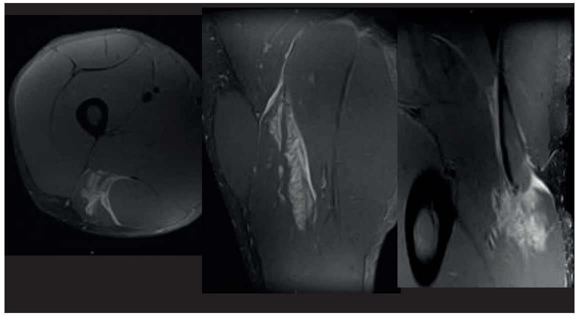

Figure 4 (Case #4). MTJ strain of the central tendon of the long head of the biceps femoris muscle. As MRI signs, we find interstitial oedema, tendinous consecutive disruptions, significant intermuscular fluid/haemorrhage, and loss of tension in the biceps tendon.

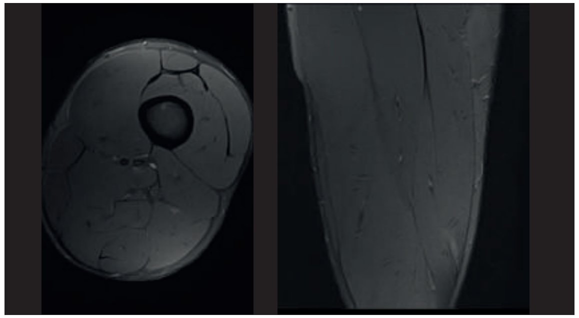

Figure 7 (Case #7).: Myoaponeurotic strain in the deep zipper of the long head of the femoral biceps muscle. MRI signs included interstitial oedema and minimal intermuscular fluid/haemorrhage.

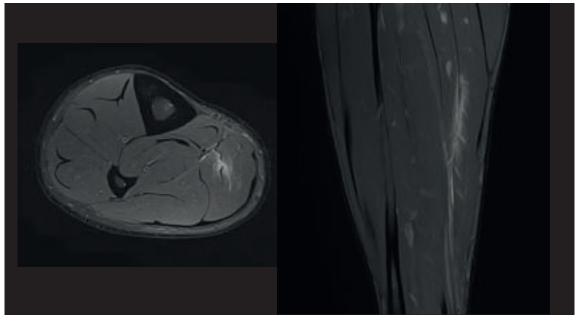

Figure 8 (Case #8). MTJ strain of medial aponeurotic fascicle of the soleus muscle. MRI signs included oedema, aponeurotic disruption, minimal intermuscular fluid/haemorrhage, and mild loss of the aponeurosis tension.

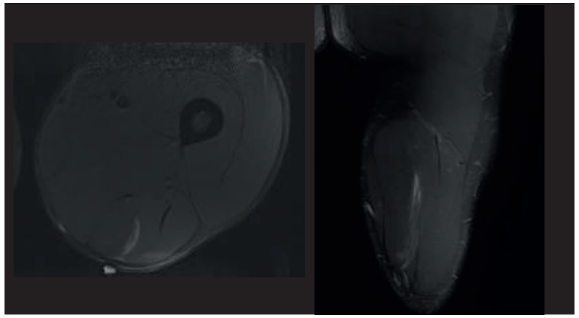

Figure 5 (Case #5). MTJ strain of the semitendinosus raphe. As MRI signs we find periraphe oedema and very slight amount of intermuscular fluid/ haemorrhage.

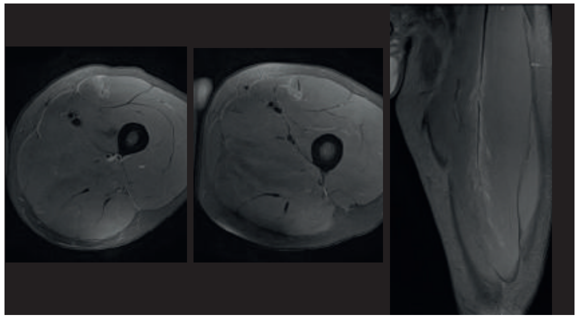

Figure 6 (Case #6). MTJ strain of the central septum of anterior rectus femoris muscle. MRI signs include peritendinous oedema, tendinous mixed disruption, minimal intermuscular fluid/haemorrhage, and mild loss of septum tension.

(consecutive rupture in the distal part), surrounding oedema (CSA: 36%), and significant intermuscular fluid/haemorrhage, including vascular structures. Loss of tension in the biceps tendon.

Diagnosis: MCC: 4, BC: 3c, FCB-A: IPMpG3rR0

Management/outcome: Conservative treatment was proposed. MRI after 17 days demonstrated healing with partial signal recovery of the tendon and closure of the tendon gap. Return to sport at 22 days without evidence of re-injury.

Case #5 (Figure 5)

Subject and circumstances of injury. Twenty-one-year-old player who suffered a cramp in the posterior middle third of his right thigh at the end of a football match. During physical examination palpation was tender, not painful, walking was possible, the range of motion was complete, stretching was only minimally painful, and isometric contraction was possible with only minimal pain.

Imaging: Diagnostic 3T MRI was performed after 7 days. MRI showed MTJ strain of the semitendinosus raphe. Fat-saturated T2W images demonstrated trace raphe (connective tissue of average thickness equivalent to aponeurosis) irregularity with surrounding oedema (CSA: 7.5%), and very slight intermuscular fluid/haemorrhage. No loss of tension was observed.

Diagnosis: MCC: 3b, BC: 1b, FCB-A: IMG2R0

Management/outcome: Conservative treatment was proposed. MRI after 21 days demonstrated healing with partial signs of recovery of the MTJ. Return to sport at 27 days without evidence of re-injury.

Case #6 (Figure 6)

Subject and circumstances of injury. Twenty-four-year-old professional player referred for acute moderate pain in middle third of his right quadriceps during a change of direction in a match. He chose to leave the game to avoid a more severe injury. Local palpation was clearly painful and stretching of the quadriceps was also painful.

Imaging: Diagnostic 3T MRI was performed within 24 hours, and showed MTJ strain of the central septum of the anterior rectus femoris muscle. Fat-saturated T2W images demonstrated hypersignal of the tendon with partial disruption in two areas (the proximal one showing a 2.5 mm transversal gap, and the distal one showing a 2.2 mm longitudinal gap), surrounding oedema (CSA: 19.4%) and very slight intermuscular fluid/haemorrhage. Mild loss of tendon tension. Note that the central septum showed varying thickness, suggesting cicatricial changes.

Diagnosis; MCC: 4, BC: 3c, FCB-A: IMpG3rRX

Management/outcome: Conservative treatment was proposed. Return to sport at 40 days without evidence of re-injury.

Case #7 (Figure 7)

Subject and circumstances of injury. Thirty-two-year-old professional player who suffered a cramp in the distal third of his hamstring during a side-cutting manoeuvre while running. He initially felt that he had suffered a minor injury. Palpation was slightly painful, the range of motion was complete, and concentric and eccentric muscle contraction was possible without loss of strength.

Imaging: Diagnostic 3T MRI was performed within 24 hours. MRI shows myoaponeurotic strain in the deep zipper of the long head of the femoral biceps muscle. Fat-saturated T2W images showed hypersignal at the aponeurotic border without significant fibre disruption (CSA: 10%), and very slight intermuscular fluid/haemorrhage. No loss of tendon tension was observed.

Diagnosis: MCC: 3a, BC: 1a, FCB-A: IDdG1R0

Management/outcome: Conservative treatment was proposed. MRI after 20 days demonstrated healing with signs of partial recovery of the tendon and closure of the tendon gap. Return to sport at 28 days without evidence of re-injury.

Case #8 (Figure 8)

Subject and circumstances of injury. 33-year-old player who reported feeling discomfort at the end of a football match. He had a history of muscle injury in the same leg.

Imaging: Diagnostic 3T MRI was performed two days later, and showed MTJ strain of the medial aponeurotic fascicle of the soleus muscle. Fat-saturated T2W images demonstrated hypersignal of the muscle fibres consistent with oedema (CSA: 4.9%) associated with a gap in the medial aponeurotic fascicle (about 4 mm) and moderate intermuscular fluid/ haemorrhage. Mild loss of the aponeurosis tension was observed.

Diagnosis: MCC: 3b, BC: 3c, FCB-A: IDpG3rR0

Management/outcome: Conservative treatment was proposed. Return to sport at 9 days without evidence of re-injury.

Discussion

In this paper, we have categorised sports injuries using three different classification systems, and have found discrepancies in terms of the severity of the injury. In turn, we find that injuries with similar radiological characteristics result in RTS of different durations.

US offers a fast, inexpensive and dynamic muscle assessment for detection and severity assessment of muscle injuries. However, it has low sensitivity in the diagnosis of some type of lesions (deep muscle compartments, proper connective tissue evaluation) (Balius et al. 2014).

3-Tesla MRI technology allows us to obtain better images of muscle architecture and muscle injuries, especially the level and quantity of connective tissue injured. MRI is usually performed unilaterally (affected limb only) by using a dedicated surface coil to ensure higher resolution images with thinner sections and smaller field of view. A skin marker should be placed over the area presenting symptoms, according to the clinical orientation. It is helpful to perform fluid-sensitive sequences (T2 weighted in our case) with a moderate echo time (TE) (less than 50 ms) to obtain proper resolution of the connective tissue (Siriwanarangsun et al. 2016). These sequences allow for **i)** the detection of oedematous changes around the myotendinous and myofascial junctions, **ii)** an accurate assessment of the connective tissue, and **iii)** the delineation of intramuscular or perifascial fluid collections or haematomas. T1-weighted spin-echo sequences are useful for assessing subacute haemorrhage or haematomas, and also for detecting atrophy and fatty infiltration and scar tissue in chronic injuries. To accurately evaluate the morphology and extent of muscle injuries, multi-planar acquisitions (axial, coronal, and sagittal) are required.

In our experience, early acquisition of magnetic resonance imaging is important for adequate diagnosis of acute muscular injuries. However, a recent study reported that there were no significant day-to-day changes in the extent of the oedema during the first week following acute hamstring injury (Wangensteen et al. 2017).

Striated muscle tissue stands out for its great contractile function, which depends largely on the connective tissue associated with it and the essential role of this connective tissue for maintaining the integrity and proper function of the muscle (Fuller et al. 2006, Balius et al. 2013). The skeletal muscle architecture contains connective tissue at different locations and with different thicknesses. Its predominant role is to transmit the contractile forces, although in case of fasciae, raphes or extracellular matrix, it also acts as a structural unit (Gillies and Lieber 2011; Brukner et al. 2018). In addition, in case of pure contractile connective tissue, we can observe differences between free tendons and intramuscular tendons or connective tissue (Brukner et al. 2018). While this differentiation is clinically very important for determining the severity and prognosis of muscle injuries, in the literature these structures have generally been referred to indistinctly (Balius et al. 2013).

Also, currently classifications only partly distinguish between these structures. We propose that currently classifications include the type of the functionally or structurally compromised tissue, as well as its thickness (mild, medium or significant). We consider fascias and raphes as having mild thickness; aponeurosis, septa and distal portion of the intramuscular tendon as having medium thickness; and the proximal portion of the intramuscular tendon and free tendon as having significant thickness (**Table 3**).

In addition to the complex histoarchitectural configuration of the muscle, the distribution of the connective tissue within it is unique and unrepeatable for each muscle belly (Balius et al. 2013; Lieber and Friden 2000). Given the great variety of muscle groups and the multiple factors that influence injuries, the recovery time of these injuries is very variable, even for injuries that occur in the same muscle or muscle group (Lieber, Friden 2000). Current muscle injury classifications encompass all muscles indiscriminately, which is a limitation for objectively determining the degree of severity. Based on our analysis of the players in this study, we believe that many injuries with different severities are included in the same category based on the MRI results. Despite this, the time to RTS differs markedly between cases, mainly because it also depends on other non-imaging factors. Of all of these cases, **Case 6** shows the most consistent categorisation according to the three classification systems, in terms of the degree of severity and prognosis. In this case, we consider that there has been a significant compromise of the "functional" thick connective tissue, which was associated with a long RTS (Prakash et al. 2018).

These classifications do not take into account congenital or adaptive anatomical variants (underlying scar), which are fundamental in the analysis, as we have shown in **Cases 2** and **4**. On the other hand, the appearance of incidental cicatricial lesions in the absence of a clinical history of a previous injury could cause problems in classifying the injury (**Case 1** and **6**). Similarly, we have observed progressive clinical presentation over time, or "subacute", (**Case 3**), with late acquisition of MRI in which cicatricial lesions were associated, and where it was difficult to assign the category "R".

Each injury has anatomical particularities that could result in an over-evaluation of its severity, and therefore prolong the RTS. For example, in **Case 4** the lesion involved vascular venous structures that caused abundant interstitial and intermuscular fluid. The RTS was the same as in **Case 2**, although **Case 2** was classified as a **3b** injury according to Munich Consensus Classification. In contrast, the Munich classification does not consider isolated interstitial oedema to be an indirect lesion (**Case 7**).

According to the FCB-Aspetar classification, from a radiological point of view, we consider that for some injuries we overestimated the degree of severity (**Cases 1, 2, 3, 6 and 8**). This issue is based on whether the "G2-3" consideration depends a quantifiable gap between muscle fibres. That said, we note that this classification has the advantage that it allows one to directly categorise connective tissue injuries using the letter "r". In the FCB-Aspetar classification, in some cases it can be difficult to determine the location of the lesion between proximal and distal, depending on the tissue involved. This is true in **Case 5**, in which the raphe was involved, and in which it has been difficult to reach a consensus to determine if it is proximal or distal.

Another important factor in determining RTS is the physical condition of the player. For example, while **Case 3** involved an injury with poor prognosis and involvement of thick functional connective tissue, this did not result in a higher RTS than other less severe cases. In this same case, the mixed morphology of the connective tissue involvement could have conditioned a longer RTS. Thus, it would be interesting for future classification to include the type of rupture of the connective tissue (longitudinal, transversal, mixed, etc.); currently classifications only distinguish between partial and complete ruptures.

Finally, we believe that while several radiological signs are used in existing classifications, not all of allow consistent grading of injury. In our opinion, oedema (CSA) and intermuscular fluid are not very influential factors in the severity of the injuries. In contrast, compromised connective tissue has a highly relevant role but is currently only poorly specified in current classifications.

Standardised classifications for defining the severity and prognosis of muscle injuries help sports medicine professionals to determine the most appropriate therapeutic approach and RTS. However, the histological complexity and peculiarity of each muscle belly means that current image classifications are not infallible. In addition, not all of the many radiological signs available are equally relevant in terms of prognosis. Perhaps developing a severity classification for each muscle group,

Table 3. Summary of the cases included in this study.

Case	1	2	3	4	5	6	7	8
Muscle injuried	The long head of the biceps femoris and the semitendinosus muscles		The long head of the biceps femoris muscle		Semitendi-nosus	Ante-rior rectus femoris muscle	Deep zipper of the femoral biceps muscle	Soleus
Location of lesion	Central tendon				Raphe	Central septum	Myoapo-neurosis	Medial fascicle
Connective tissue thick-ness (CTT) affected	+++	+++	+++	+++	+	++/+++	++	++
Munich Consensus Classification	3b	3b	3b	4	3b	4	3a	3b
British Classification System	3c	3c	3c	3c	1b	3c	1a	3c
FCB Barcelona and Aspetar Classification	IPpG3rRX	IPpG3rRO	IPpG3r R1	IPMpG 3rRO	IMG2RO	IMpG3r RX	IDdG1RO	IDpG3 rRO
Return to sport (days)	29	34	22	34	22	40	28	9

and taking into account each factor in a particular way, would bring us closer to a more consistent and effective evaluation system for muscle injury.

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Abbreviations and acronyms

Fútbol Club Barcelona (FCB), Return to Sport (RTS), Myotendinous Junction (MTJ), Munich Consensus Classification (MCC), British Classification System (BC), FCB Barcelona and Aspetar Classification (FCB-A). ■

KEY POINTS

- ✓ US and MRI are currently the most widely used techniques for confirming sports-related muscle injuries.
- ✓ MRI is the most sensitive technique for properly characterising muscle injuries.
- ✓ Recently, three new classifications have been proposed: the Munich Consensus Classification, the British Classification System, and the FC Barcelona and Aspetar Classification.
- ✓ Standardised Classifications help professionals in sports medicine to define the most appropriate therapeutic strategy and RTS following muscle injuries.

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For full references, please email edito@healthmanagement.org or visit https://iii.hm/se5

Achieving zero avoidable patient deaths by 2020

The Patient Safety Foundation rounds up best practices at its annual congress

The 2019 World Patient Safety, Science & Technology Summit held in January presented best practices for preventing avoidable patient deaths and a guide to how hospitals can achieve this by 2020.

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I have just returned from the 7th Annual World Patient Safety, Science and Technology Summit. I still remember vividly the impact I felt when I attended my first summit in 2013. I had been in healthcare for over 25 years but, at that time, was fairly new to the arena of patient safety and risk management. When I arrived at the summit, I had preconceived expectations that the event would be similar to the dozens of healthcare conferences I had attended in previous years. What I observed was extraordinary. The summit was unlike anything I had ever experienced at professional conferences.

Each year, the Patient Safety Movement (PSM) creates an atmosphere in which healthcare professionals, patients and patient families can openly and candidly talk about preventable deaths and serious avoidable harm events that occur too often in hospitals across the nation. PSM's goals include promoting transparency about process and system failures in healthcare that lead to these catastrophic events and providing solutions for eliminating preventable harm and deaths.

What surprises most people is that preventable medical errors are the third-leading cause of death in the U.S. That equates to over 200,000 people a year who enter a hospital to be treated for an ailment or injury that normally wouldn't prove fatal and end up dying due to an error that could have been prevented if the proper patient safety processes were in place. This statistic doesn't take into account the thousands more who are inadvertently harmed and survive with physical and emotional challenges they have to live with the rest of their lives.

The power of patient stories

The PSM summits include several panels of healthcare experts and patient advocates discussing a specific patient safety concern. Each panel session starts with a poignant video that tugs at the heartstrings of everyone in the room. In the case of a preventable death, the videos often showcase the tragic loss of life and the impact on the family. In the case of avoidable harm, the videos normally include the actual patient describing the impact the error had on their personal life.

Perhaps the comment most commonly heard from summit attendees is how much they were inspired to action after hearing real-life stories of families who lost a loved one due to a preventable medical error. Patients and their families are intertwined into every aspect of the summit, and they even have a place as panel members to bring the patient's voice to the center of the conversation.

Listening to the stories and meeting the individuals affected by healthcare failures have had a tremendous impact on my life and the work I do. As a patient safety officer and respiratory therapist, I am always looking for proven ways to make healthcare safer and prevent avoidable harm. My first PSM summit motivated me beyond any medical conference I had ever attended. I returned to my hospital with an extended list of actionable items that I wanted to share with colleagues and implement.

There were six panel discussions covering the gamut of patient safety concerns

Bill Clinton with Joe Kiani. Clinton's message to hospitals and healthcare providers was 'don't give up' on zero deaths

Since that first PSM summit back in 2013, I have attended five summits. I've had the opportunity to learn from the best and brightest in the business about their challenges and what is working for them. The experts include healthcare professionals, researchers, scientists, patient safety and risk management specialists, technology industry engineers, and governmental policy makers. The PSM summit recharges my "personal internal batteries" so that I can ensure my hospital is aware of the top patient safety challenges facing hospitals and what best practices can be implemented to address them.

Actionable Patient Safety Solutions (APSS)

The Patient Safety Movement Foundation was started seven years ago to not only bring awareness to the urgent problem surrounding preventable healthcare error-related deaths, but to formulate specific actionable solutions that hospitals can adopt to improve patient safety and prevent the unnecessary deaths of those in their care. Today, there are 18 Healthcare Challenges around which more than 30 Actionable Patient Safety Solutions (APSS) have been developed by teams of medical and patient safety experts. The goal set in 2012 was zero preventable patient deaths by the year 2020 (#0X2020) and requires everyone in the healthcare ecosystem, including hospital administrators, clinicians, nurses, engineers, technologists, patient advocates, and policymakers, to get involved.

"TO ERR IS HUMAN BUT TO NOT PUT IN PLACE PROCESSES THAT CAN AVOID HUMAN ERRORS IS INHUMANE"

This year's message from the PSM's Founder and Chairman Joe Kiani was very clear: Only one year remains before 2020, and every hospital needs to adopt and implement APSS in all 18 Challenge categories if we are going to achieve zero preventable deaths. For this to happen, there truly has to be a paradigm shift in patient safety around the world. What used to be acceptable as a Safety I perspective of creating an environment where "as few things as possible go wrong" needs to move to a Safety II perspective that emphasises ensuring "as many things as possible go right." Zero preventable deaths and harm incidents must be the goal of every hospital. Accepting anything less is not fair to those patients and families trusting us with their lives.

Overview of this year's event

This year's summit included presentations from some of the most well-known individuals in healthcare and patient safety from around the world. Reflecting the movement's accelerating global expansion, this year's summit was co-convened by the American Society of Anesthesiologists and the European Society of Anesthesiologists. Daniel J. Cole, MD, of the ASA and Kai Zacharowski, MD, of the ESA represented each of their respective organisations with keynote addresses outlining how they have focused on patient safety and preventing harm.

Other recognised experts presenting at the summit included Peter J. Provonost, MD, Chief Clinical Transformation Officer at University Hospitals, David B. Mayer, MD, Executive Director at MedStar Institute for Quality & Safety, and Richard H. Carmona, MD, 17th Surgeon General of the United States (2002-2006).

Joe Kiani kicked off the summit with a moving presentation that outlined the history of the movement and the successes so far. It was incredible to hear about the number of lives saved since the movement began and the number of hospitals that have made a commitment. The efforts and commitments of more than 4,700 hospitals have contributed to an estimated 273,077 lives saved. In addition to those amazing numbers, 89 healthcare technology companies have signed open data pledges that will improve the way medical devices communicate and share information in an effort to create a Patient Data Superhighway, which uses predictive algorithms to catch patient care issues before they become deadly. Joe Kiani's key message at the summit was that healthcare providers and hospitals around the globe need to move from "hoping for zero to planning for zero preventable deaths." Everyone in the room could sense Joe's passion when he stated, "don't let your miracle of healing get hijacked by some medical error that causes your patient's death. We've got to reject the tyranny of apathy and embrace the brilliance of action out of kindness. To err is human but to not put in place processes that can avoid human errors from becoming fatal is inhumane." He continued to stress the importance of every hospital implementing every APSS.

Panel topics

There were six panel discussions that covered the gamut of patient safety concerns or focus areas of the PSM: a Media Panel discussed how to elevate the coverage of patient safety. A Hospital Leadership Panel examined transparency from a legal perspective. A Healthcare Technology Leadership Panel outlined how data sharing between companies can help to create the aforementioned Patient Data Superhighway. A Transparency and Aligned Incentives Panel had a lively discussion on the effectiveness of transparency and aligned incentives in improving patient safety. A Delirium Panel addressed a preventable condition that is often mistaken as dementia or depression and puts patients at higher risk for a longer hospital stay and death; and lastly, the Leading Causes of In-Hospital Deaths Panel discussed the Safety II approach to making sure everything goes right in patient care. Every panel is on the Patient Safety Movement's YouTube Channel.

Newly released APSS

Two newly released APSS were announced during the summit. The first one falls under the Medication Safety Challenge and addresses drug shortages in the healthcare system that are caused by such factors as business decisions, manufacturing problems, and product discontinuation. Hospitals can mitigate possible delays in treatment protocol and the increased likelihood of medical errors due to subpar substitutes by reducing preventable shortages of vital medicines.

Dr. Steven Scheinman, Dean of Geisinger Commonwealth School of Medicine, introduced the other new APSS: a Patient Safety Curriculum for Schools. Constituting the 17th healthcare Challenge, this new APSS is a core patient safety curriculum that can be adopted by educational programmes for all healthcare professions (nursing, pharmacy, behavioral health, medicine, etc). It is being released after nearly two years of development by a workgroup comprising academics, clinicians, and patient advocates dedicated to improving patient safety through educating the young. The curriculum will go beyond care of individual patients to address systems of care and close a critical gap in student training when they are introduced to patient safety.

Awards

Five-star hospital ranking

The Patient Safety Movement Foundation recognises medical institutions making the greatest strides in patient safety, honouring them with a Five-Star PSMF hospital ranking. Three hospitals were recognised this year for implementing APSS from all 18 Challenges. They are the Children's Hospital of Orange County (CHOC), the University of California Irvine (UCI) Medical Center, and Hospital Español in Mexico City.

Humanitarian awards

Each year, the summit also honors the most impactful individuals for their work in improving patient safety across systems of care.

The Steven Moreau Humanitarian Award was presented to William C. Wilson, MD, Chief Medical Officer, UCI Health, for leading UCI Health to a 5-Star Hospital Ranking.

The Beau Biden Humanitarian Award was presented to Julie Morath, RN, MS, President & CEO, Hospital Quality Institute (HQI). Julie has been instrumental in promoting transparency across the entire state of California, encouraging hospitals to voluntarily report on five hospital-acquired conditions through a special public dashboard on their websites.

The PSMF Humanitarian Award was presented to Tore Laerdal, MSc, Chairman & CEO of Laerdal Medical. Under Tore's leadership, Laerdal has been involved with the PSM since 2017 and is implementing simulation-based training to advance patient safety in over 80+ countries.

Powerful message from former President Bill Clinton

The summit concluded with a keynote presentation by former President Bill Clinton, who recognised the many efforts and successes since Joe Kiani made the commitment to zero by 2020 at the Clinton Global Initiative. President Clinton spoke about the great work the PSM has done so far, with the 273,077 lives saved, the 4,700 hospitals committed to the movement, and 89 technology companies. He reminded the audience that we all signed on to the movement knowing this was going to be a tough road to make a difference, but we are in it for the long haul. President Clinton ended by saying, "My most important message is to please stay active in this, please get more people active in it, and don't give up."

Actionable Patient Safety Solutions

It's possible to eliminate preventable patient deaths in our hospitals. It's possible for every hospital to implement every Actionable Patient Safety Solution. Together, we can achieve zero preventable deaths by the year 2020. APSS are available for download: **patientsafetymovement.org/actionable-solutions/actionable-patient-safety-solutions-apss/** ■

KEY POINTS

- ✓ Medical errors are the 3rd leading cause of death in the U.S. and a leading cause of death around the world
- ✓ Since 2013, the 4,700 hospitals that have made a commitment to the PSM have contributed to 273,077 saved lives
- ✓ 89 healthcare technology companies have signed open data pledges so that researchers can develop algorithms to catch errors before they become deadly
- ✓ Six summit panel discussions covered a range of patient safety concerns that need to be addressed
- ✓ The Summit take-away message was healthcare providers and hospitals must move from "hoping" for zero preventable deaths to "planning" by implementing every APSS today

DATES TO FOCUS ON

March 31st, 2019
Deadline for reduced registration fees

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SEQCML Sociedad Española de Medicina de Laboratorio

Innovation in paediatric rehabilitation

A challenge and an opportunity

Review of innovative technologies used at the ALYN Hospital Paediatric and Adolescent Rehabilitation Centre in Jerusalem; past and future technological trends in the field worldwide, including technologies relating to augmented communication, neuro- and movement-sensing, miniaturisation, powered mobility, virtual reality, tele-rehabilitation, 3D gait analysis.

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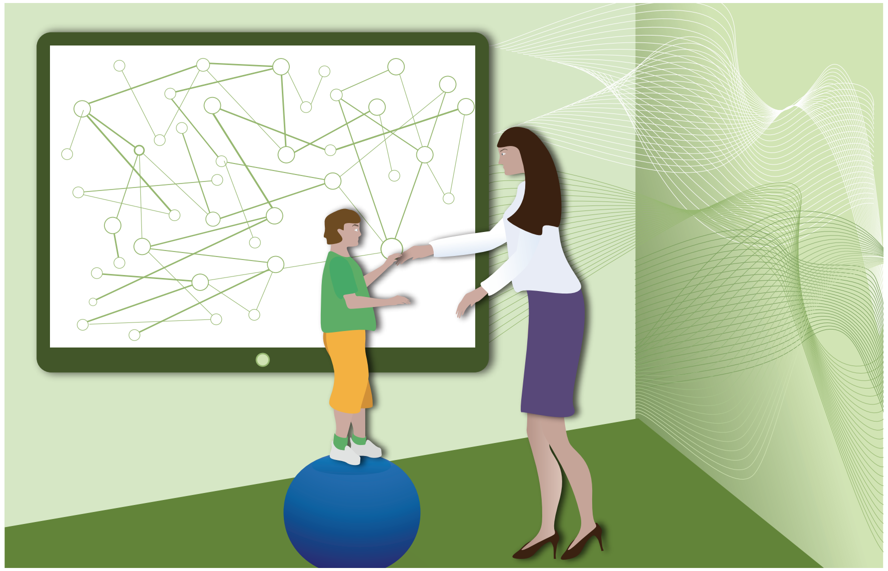

Rehabilitating children presents special clinical challenges not found in the adult world, but also unique opportunities to use innovative technologies to solve them. This paper reviews the newest rehabilitative technologies being used at the ALYN Hospital Paediatric and Adolescent Rehabilitation Centre in Jerusalem, Israel, as well as past and future technological trends in the field worldwide, including technologies relating to augmented communication, neuro- and movement-sensing, miniaturisation, powered mobility, virtual reality, tele-rehabilitation and 3D gait analysis. New developments in assistive-technology product design, why the paediatric assistive-technology market is of growing interest for the high tech sector as a whole, and the need for further research to clarify the role of new technologies in paediatric rehabilitation clinical practice, are addressed.

Trying to rehabilitate a child is like trying to hit a moving target. This is because growth and change are the essence of child development. Whereas rehabilitating an adult – for example after an accident or illness – means returning that adult to their previous level of functioning, paediatric rehabilitation has a far more ambitious goal: to advance a child along the ongoing pathway of physical, emotional, psychological and social development. For children with disabilities, whether congenital from birth or acquired after illness or trauma, rehabilitation milestones and goals must match the child's chronological age, which, of course, is constantly advancing. Accordingly, we end up aiming for where children should be, rather than where they once were.

Rehabilitating children presents special challenges, but also unique opportunities. The goalposts might be constantly moving, but the young brain is far more agile at learning new tricks than the older adult version. In other words, the plasticity of a child's brain makes it more susceptible to injury (Krägeloh-Mann et al. 2017) but allows children to achieve goals that would be unreachable for adults with the same type of injury (Araki et al. 2017).

Another challenge is that rehabilitation exercises for children must be engaging and fun in order to be effective. Play is a child's work, and conversely, children usually won't work at something challenging unless it is framed and experienced as play. Recasting rehabilitation motor exercises as play, however, has never been easier than in the current era of technology-based entertainment and gaming. Here children have another advantage over adults. Whereas new technologies can be challenging for adults, they appeal to children. Today's children are digital natives who master software-based devices intuitively; in fact, they may be more "abled" in their ability to assimilate new technologies than their adult, digital-immigrant, caregivers.

"TRYING TO REHABILITATE A CHILD IS LIKE TRYING TO HIT A MOVING TARGET"

Embracing innovation and new technologies thus lies at the heart of paediatric rehabilitation today. At our institution we use an eclectic assortment of technologies to help us motivate children and access their inner and external worlds. These techniques include:

- Bedside monitoring of brain activity during rehabilitation therapies, with simplified EEG sensors. This technique helps identify which therapeutic interventions are most beneficial for people who are in a minimally responsive state after traumatic or other brain injury.
- Advanced augmented communication technologies such as eye-tracking devices for operating digital communication platforms.
- Powered wheelchair mobility for children as young as two years of age and using a wide variety of adaptive switches and levers.
- Virtual reality games utilising VR headsets for physiotherapy and occupational therapy sessions.
- Advanced 3D motion-analysis sensors and software for analysing gait and limb movement in order to develop guidelines for splinting and orthopaedic surgery.

ALYN's innovation center is specifically focused on developing new assistive technologies like these.

The most widespread paediatric rehabilitation technology innovations in recent years have been the development of small, portable devices that can replace the large, cumbersome or non-portable medical systems of the past. The result is that today, technology-dependent children — such as those on chronic respiratory support — can participate in a wide variety of child-appropriate activities that were previously beyond their realm of possibility. At our institution, for example, fully ventilated children with portable ventilators and adapted tubing regularly participate in hydrotherapy sessions in our swimming pool.

One of the most promising innovations in paediatric rehabilitation today is the advent of "remote rehabilitation" via the internet. This is a modality in which gaming and virtual reality technologies may be particularly useful in enhancing compliance with treatment sessions run by therapists at remote locations from the child.

For all new technologies, it is essential to follow up the introduction of the technology with research designed to assess the efficacy and applicability of the new rehabilitation modality as compared to existing methods of care. Unfortunately, the number of new devices is high, and the population of children who use them are small and diverse; as a result, most published reviews of technology use in paediatric rehabilitation are, of necessity, qualitative and descriptive in nature, and lack the quantitative data that would allow for meaningful comparisons with more established protocols. For example, although there is a growing number of reports evaluating remote rehabilitation for adults, to date there are few that focus on children, and none that directly compare the outcomes of paediatric remote rehabilitation programmes with those of in-hospital in-person treatments.

Another ongoing challenge in the world of paediatric rehabilitation technology is the cost, availability and suitability of assistive devices for those children who need them. Children come in all shapes and sizes, and are constantly growing and developing, both physically and in terms of their participation in educational and leisure activities. This means that the assistive devices they use must be available in a wide variety of sizes, and have to be replaced or rescaled at regular intervals. In contrast, comparable technologies for adults have a far longer shelf-life and can be mass produced in standard sizes, for a larger patient population, and at less cost. To date, therefore, most assistive devices have been designed and produced for adults, and there is a dearth of innovative technologies and affordable devices customised for children. The upshot is that millions of children around the world are denied access to the assistive technologies that are available to adults in their societies (WHO 2018), even though children potentially have a better chance of overcoming initial injury than do adults. These children are at risk of growing up isolated from society, and may be unable to integrate into educational frameworks and incapable of supporting themselves as adults thereafter.

"RECASTING REHABILITATION MOTOR EXERCISES AS PLAY HAS NEVER BEEN EASIER THAN IN THE CURRENT ERA OF TECHNOLOGY-BASED ENTERTAINMENT AND GAMING"

More recently, however, a paradigm shift has begun in the world of assistive product design. Instead of designing devices for adults and then adapting them for paediatric use, some manufacturers are now designing for paediatric use first, addressing the flexibility and adaptability issues that characterise such designs, and then leveraging those product advantages to the adult market. Similarly, technologies initially designed for children and adults with disabilities, a population for whom mobility, flexibility and ease-of-use are essential design features, have begun to attract the attention of industries for which these features are also important, such as the automotive, sports and mobile device sectors. In fact, some start-ups have intentionally targeted the assistive device sector as their initial market, and only expanded their focus to general audiences later.

To truly help children with disabilities, however, change and innovation is needed beyond the boundaries of technology. Our societal norms and values need to evolve as well. Instead of distancing people who are noticeably different, we must transition to a model of inclusion in which society as a whole, beyond specialised child development and rehabilitation facilities, relates to people not as “disabled,” but rather (as recently suggested) "differently abled.”

It is incumbent upon us, as health care providers, to look to the future and assure the best possible outcome for these children. This is a labour intensive undertaking, requiring comprehensive and ongoing case management and a high degree of cooperation between multiple caregivers and institutions. Early and intensive investment in innovative childhood development and rehabilitation services will incur a high and immediate price tag, and the return will only be realised years down the road. But every developmental step towards maximal participation in society that a child takes early on helps build a future of lifelong independence and improved wellbeing for that child. This, in turn, will translate into reduced healthcare costs and a healthier and happier lifestyle for us all. ■

KEY POINTS

- ✓ Paediatric rehabilitation offers new opportunities for innovation
- ✓ Paediatric rehabilitation as a field grows with medical advances
- ✓ Societal evolvement is needed to improve outcome

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PHILIP BRAHAM

CO-FOUNDER & DIRECTOR - REMEDIUM PARTNERS, UK

TOP QUOTE:
"Solving the NHS doctor shortage isn't an overnight solution – the fact that agency locums haven't 'fixed' the health services' problems is testament to the fact that a long-term solution is needed."

See more at: https://iii.hm/rxp

ALEX CAHANA

VENTURE PARTNER - MEDTECH AND HEALTHCARE
HEAD OF - MEDTECH AND HEALTHCARE
USA

TOP QUOTE:
"Through behavioural economics using monetary (rewards) and non-monetary (reputation) incentives, Blockchain-based solutions can transform people from being passive health service consumers into health producers."

See more at: https://iii.hm/rxq

DENNIS SPAETH

CEO/PUBLISHER - CUTTING TOOL ENGINEERING, CTE PUBLICATIONS, USA

TOP QUOTE:
"Robotic technology has transformed the way we treat patients and conduct surgical procedures. Future advancements in robotics will not only make medical procedures and diagnoses even more efficient but will also make recovery times that much shorter so patients can return to their daily lives."

See more at: https://iii.hm/rxo

NICK ADKINS

FOUNDER #PINKSOCKS ADVISORY BOARD
DOC.AI - CLOUDBREAK HEALTH PALO ALTO, CA ADVISORY BOARD, USA

TOP QUOTE:
"The biggest challenge is resistance to change. People saying no. Legacy thinking of 'oh we've always done it this way'. I think that's rapidly eroding. Technology has now reached a point where you can't deny it."

See more at: https://iii.hm/rxr

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