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BIR World Partner Network

THE GLOBAL FUTURE OF IMAGING

The British Institute of Radiology (BIR) is an international membership organisation for everyone working in imaging, radiation oncology and the underlying sciences. We aim to support the work of our members and their colleagues to achieve professional excellence, provide continuing professional development for our multidisciplinary community, publish cutting edge research for our authors and readers across the world and influence and connect with the wider professional sector.

The BIR World Partner Network is a community of international societies with the shared goal of advancing the knowledge and understanding of all its individual members. The ultimate aim is to improve the scope and value of imaging and radiation oncology for patients across the world.

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THE GLOBAL FUTURE OF IMAGING
VIEWS FROM RADIOLOGY SOCIETIES AROUND THE WORLD

Around the world, radiology is helping to transform healthcare as it advances at an accelerating rate. The BIR World Partner Network—a global collection of leading societies representing around 600,000 imaging and oncology professionals—collaborated to produce a global barometer showing the changes that are emerging locally and worldwide.

Presidents of 18 professional societies answered a series of questions about the future of imaging: what they considered would be the single most positive development in the next 10 years; the biggest obstacle to progress in imaging in the world; and how imaging professionals can prepare themselves for future success.

THE SINGLE MOST POSITIVE DEVELOPMENT IN THE NEXT 10 YEARS

"If the human mind combines with all the tools AI provides, the results will be magnificent"

Dr Daniel Mysler. President, Radiology Society Argentina

Unsurprisingly, artificial intelligence (AI) stood out as the most positive development in imaging in the next 10 years.

Many respondents noted that AI might better optimize service delivery such as no-show prediction, worklist management and automated triaging of cases by acuity, improving safety and saving time that can be dedicated to more complex tasks by radiologists.

The President of the Chinese Society of Radiology noted the potential for AI to improve decision making, optimize safety and quality, and mitigate the shortage of radiologists. He also discussed the role radiologists could play in interacting with clinicians and patients, explaining reports to patients and helping to guide patients moving onto the next stage.

"Radiologists will be able to devote even greater efforts to providing a better medical service together with other disciplines"

Professor Zheng Yu Jin, President, Chinese Society of Radiology

"AI will facilitate and augment the detection and characterization of lesions, formulation of differential or principle diagnoses, and clinical decision making in various modalities of imaging," according to the Hong Kong College of Radiologists.

The Indian Radiological and Imaging Association suggests that the most crucial and far-reaching consequence of AI could be reducing MRI scan time, including faster MRI acquisitions.

Representing 500,000 radiographers worldwide, the International Society of Radiographers and Radiologic Technologists (ISRRT) points out that as, "radiographers embrace these new tools… they will become more efficient allowing them to focus on the patient and the human interaction of care which is ultimately the key to great healthcare delivery."

"Using AI to determine prioritization will enable radiologists to address the most urgent cases"

Dr Daniel Mysler, President, Sociedad Argentina de Radiologia

Quelling fears expressed by some societies that AI might replace their jobs, or dramatically transform their roles, the Russian Society of Radiology asserts that, "these new tools will give a tremendous boost to medical imaging and save radiologists from many routine and time-consuming tasks", and the German Röntgen Society suggests that digitization would be one of the biggest challenges, but would support rather than replace radiologists.

"Will new technologies replace our work? No, but they will change our way to work substantially"

Professor Gerald Antoch, President, German Röntgen Society

The American Roentgen Ray Society spells out how the application of AI will vary by location and need, but caution that its potential harms must be addressed, including the use of unrepresentative data sets, data integrity and safety issues, and ethical concerns.

"Many datasets used to predict disease probability have been developed from data that do not represent population diversity and may exacerbate health inequity"

Dr Ruth Carlos, President, American Roentgen Ray Society

The Radiological Society of South Africa take is upbeat, noting that radiologists are uniquely positioned to actively fashion how the field will be transformed by AI. "Radiology will transform from a subjective perceptual skill into an objective science. An increase in the armamentarium of quantitative tools will speed up our journey along the path of precision medicine."

The Chinese Taipei Radiological Society foresees an AI driven shift towards a more advisory role for radiologists, consulting on difficult cases and "liberated from tedious diagnostic reporting". They also suggest that over time, employment opportunities are more likely to be in interventional radiology.

Drawing attention to advances in molecular and hybrid imaging in personalized healthcare, the BIR stresses that "current research has enormous potential to change the way medicine is practised", adding that hybrid imaging offers distinct advantages over what is already available. "Visual and quantitative information provides functional insights into biological and pathological processes, and work with biomarkers will allow earlier disease detection, a means to monitor efficacy of drug therapy and to assess disease recurrence."

THE BIGGEST OBSTACLE TO PROGRESS IN THE NEXT 10 YEARS

The second question addressed obstacles to progress in imaging around the world. Access to advances in care, both in terms of geography and funds, to procure equipment were high on the list, as was the limited means patients have to pay for the influx of new technologies.

FAARDIT (the Argentinian Federation of Radiology) describes a situation exemplified in many less developed economies. "The continual development of technology and the rapidity with which it occurs means the non-developed countries, such as Argentina, almost always remain in a certain technological backwardness in ability to apply this new knowledge."

> **"Non-developed countries… almost always remain in a certain technological backwardness in ability to apply this new knowledge"**
>
> Professor Alberto Antonio Marangoni, President, Argentinian Federation of Radiology

SERAM, the Spanish Society of Radiology, also remarks on access restrictions. "In Spain, we still feel the effects of the economic crisis that began in 2008, and that has caused technology in many centres to be obsolete, since there has not been a policy on equipment renewal."

Yet even in developed economies, access issues remain. According to the Canadian Association of Medical Radiation Technologists, "because medical imaging equipment is very expensive to purchase and service, many Canadian jurisdictions find it difficult to secure the funding necessary to keep up with the latest state of the art." She highlights that there are clear challenges—the purchasing of equipment, and the need to expand, nearly constantly, the IT infrastructure required to store and take advantage of all the information being produced.

> **"Those in a position to afford these new technologies could advance in leaps and bounds, whereas those left waiting could see themselves slip behind the curve"**
>
> Gailyne MacPherson, President, Canadian Association of Medical Radiation Technologists

Australia's expansive rural land mass epitomizes the challenges to geographical access for large proportions of the population. "Populations in rural and remote areas experience higher out-of-pocket expense, poorer health outcomes, poorer access to imaging and timely reports," writes the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT).

In Brazil, the Brazilian College of Radiology notes that significant socioeconomic disparities create different scenarios when comparing the different regions of the country. In the South, better educational and social conditions create a radiology environment similar to the most developed countries, whereas the poor quality of life in the North and Northeast limits the expansion and progress of imaging.

> **"Populations in rural and remote areas experience higher out-of-pocket expense, poorer health outcomes, poorer access to imaging and timely reports"**
>
> Adam Westrink, President, Australian Society of Medical Imaging and Radiation Therapy

Having an inadequate supply of radiologists who will have received up-to-date training in the most recent advances in AI, radiomics and other technologies was also identified as an obstacle. The Israel Radiological Society (ISRA) emphasized the shortage of radiologists both worldwide, and in Israel in particular. "Radiology is very popular among medical school graduates but due to government restrictions, the number of open positions for training is limited."

Japan, which has the most CT and MRI devices in clinical use globally, has a problem providing qualified specialists to run the equipment, and attracting new recruits, often fuelled by misinformation about jobs being replaced by AI, according to the Japan Radiological Society.

In the UK, the Clinical Radiology UK Workforce census 2018 demonstrated that hospitals are unable to adequately recruit into consultant radiology posts with six out of ten posts remaining unfilled at 12 months.

HOW IMAGING PROFESSIONALS CAN PREPARE FOR SUCCESS

The third question directly addressed what imaging professionals need to do to best prepare themselves for success. The ISRA notes that radiology is crucial in medicine. "It is the CNS of the medical system. Only by understanding the role we have can we keep being appreciated by our colleagues and patients."

ISRRT emphasizes that, "medical Imaging is a career encompassing technology that continues to change and evolve, and as professionals it is imperative that radiographers/radiologic technologists are prepared to be life-long learners throughout their career."

SERAM notes the importance of understanding the new technologies. "There is no better way to understand them than to lead them. Radiologists have to learn not only the manifestations of the pathologies in the new techniques, but to be able to speak as equals with the engineers who program the machines."

> **"There is no better way to understand [new technologies] than to lead them"**
>
> Dr Pablo Valdés Solís, President, Spanish Society of Radiology

The last word goes to the Radiological Society of South Africa. They assert the overarching principle that in the age of AI, "the value will likely be the tangible expression of the human qualities of caring, empathy, compassion, ensuring ethical values and being advocates for the patient, guiding and empowering patients along their imaging journey."

> **"Poised on the cusp of the fifth industrial revolution, radiologists are uniquely positioned to actively fashion how the field will be transformed"**
>
> Dr Kuben Naidu, President, Radiological Society of South Africa

DR RUTH CARLOS

President, American Roentgen Ray Society (ARRS)

Professor, Department of Radiology at Michigan Medicine

The American Roentgen Ray Society (ARRS), founded in 1900, is the first and oldest radiology society in the United States. The mission of the Society is to improve health through a community committed to advancing knowledge and skills in radiology.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

The single most positive development in the world of imaging will be the widespread application of artificial intelligence (AI) and machine learning in multiple spheres of medical care. How AI will be implemented will vary by location and need. In high resource, high expenditure countries, AI will be used to better manage service delivery such as no-show prediction and variable scheduling density or worklist management and automated triaging of cases by acuity.

Use of AI's diagnostic capabilities will be integrated into the workflow as adjuncts for radiologists. In low resource environments, AI can facilitate collection and analysis of diagnostic information on mobile devices. Its analytic capabilities can be used to inform health policy and program efficiency. Enthusiasm for AI should be tempered by recognizing the potential harms. Many datasets used to predict disease probability have been developed from data that do not represent population diversity and may exacerbate health inequity.

With consolidation of cloud computing and data-hosting companies, the wealth of data made available to commercial entities raises concerns of data integrity and safety. Ethical issues of the technology remain unresolved. Nevertheless, AI has great potential to improve the delivery of imaging care across the range of practices and settings.

"the only constant is change"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

As we generate more technologies and evidence to support the use of these technologies in routine clinical practice, the biggest obstacle remains access to these technologies. Access can be broadly construed as 1) logistic—can patients get appropriate imaging appointments at a convenient location and time; 2) geographic—can patients physically get to imaging facilities; 3) financial—can patients afford to get imaging care. Financial barriers to care are increasingly affecting the access. Reimbursement policy may have unintended consequences that warrant more scrutiny. For example, elimination by some insurers of CT reimbursement when conducted within a hospital setting potentially increases access hardship and may lead to delayed or forgone care.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

The only constant is change. Proactive leadership and adaptability will help imaging professionals to succeed. This requires us to step out of our reading rooms and into the "room where it happens." Take responsibility for the entire imaging encounter beginning with scheduling the appointment and ending with clinician action after report communication and provision.
Own the value chain.

PROFESSOR DR ALBERTO ANTONIO MARANGONI

Vice-President, Argentinian Federation of Radiology (FAARDIT)

Chief of Radiology Department at Sanatorio Allende, Córdoba, Argentina. Professor at Medicine School, Catholic University, Córdoba, Argentina

The Argentinian Federation of Radiology, brings together diagnostic imaging professionals from around Argentina (approx. 2,000), grouping 21 radiology societies from across the country. The Federation's main activity is to provide training tools, organize the international annual Convention and edit the Argentinian Radiology Publication (RAR) for all radiologists in the country and support their continuing medical education.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Artificial intelligence (AI) is one of the most positive developments for imaging. It is something that can help the radiologist to avoid possible errors in diagnostics. I think that the most advanced technologies will bring us a new modality for the interpretation of images.

This should be considered as a challenge and not as a threat.

Radiologists should be part of the development of these new tools that will allow the possibility of warning us about the presence of a certain number of nodules, stones or cysts. But also AI will allow radiologists to speed up reporting time and allow greater security in the interpretation of the huge number of images that are currently produced in CT, MRI or PET.

Radiation dose reduction is, for me, another development that is very important and useful because radiation dose is a very big problem for patients and is a real concern for all radiologists around the world.

Finally, I think that molecular imaging will be an important development for the future, not only of radiology but of medicine in general. Radiologists should support this development because it will serve, perhaps, to transform the concept of diagnosis in medicine. In relation to this, the possibility of evaluating structural alterations will be the greatest challenge for the future.

"this should be considered as a challenge and not as a threat"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

In both, I think that the economic costs of medical equipment are the most important obstacles to progress imaging.

A lack of fellowship offers for residents or radiologists from emergent countries due to the validations of medical tittles and/or no bursaries available.

The continual development of technology and the rapidity with which it occurs means the non-developed countries, such as Argentina, almost always remain in a certain technological backwardness in ability to apply this new knowledge in being able to apply new knowledge that is published in international literature. The same economic problem leads to radiologists in this part of the world having difficulties in attending the major world congresses, due to the high cost of the memberships of the most important Societies in the world, as well as the cost of travel and accommodation.

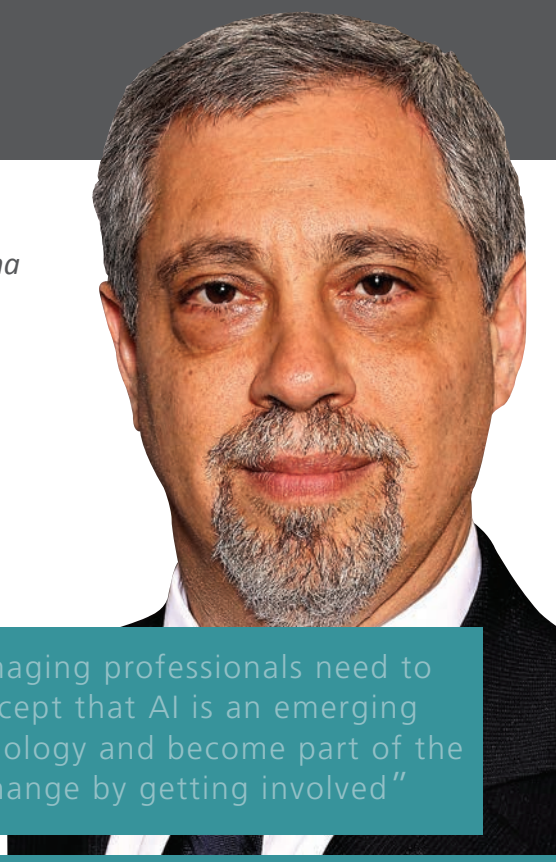
In addition, image-based research suffers from a lack of investment. Young radiologists could be encouraged to dedicate themselves to carrying out research which could benefit global knowledge in many ways and further encourage the new generation.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Imaging professionals must do a lot of teaching and class participation and use different platforms for virtual internet programs. They must attend congresses in person as well as visit the most important radiology centres in Europe or the USA.

Radiologists can acquire a better consideration of the images and the general spirit of other points of view that would allow them to improve their diagnoses.

DR DANIEL MYSLER



President, Sociedad Argentina de Radiologia (SAR)

Chief, Department of Alexander Fleming Institute, Buenos Aires, Argentina

The Argentine Society of Radiology (SAR) is a scientific society that brings together all Argentinean professionals of diagnostic imaging. It offers an academic framework in which members can train as specialists, maintain their continual medical education and obtain their professional certificate. It also organizes congresses, conferences and courses, with a wide participation of professors of recognized national and international trajectories. SAR publishes Argentine Journal of Radiology (RAR), the first in its specialty in South America. SAR also maintains a fruitful relationship with partner societies from the rest of the world and offers a social and cultural framework to all its members.

"imaging professionals need to accept that AI is an emerging technology and become part of the change by getting involved"

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

In my opinion, in the next 10 years the most positive development in medicine as a whole will be the advance in artificial intelligence (AI).

In radiology this advance will be seen in many areas.

Radiomics will help to improve accuracy, since it will enable the addition of a layer of precision to studies and will be used to predict prognosis and response to treatment.

Imagining biobanks will help with the correlation between imaging phenotype and genotype.

AI can help radiologists in deciding a patient's optimal dose and will help in highlighting possible radiation risks that can be associated with cumulative dose and a patient's vulnerability.

Structured reporting suggests the adoption of common data that allows information to be collected, stored and used by different institutions.

Daily administrative work done by radiologists will diminish. Using AI to determine prioritization will be able to help radiologists to address the most urgent cases.

It will be possible to improve quantification because of higher quality reports. Multidisciplinary work with other centres and with other medical specialities will be improved, creating a co-operative network.

AI combined with a decision support system could help physicians choose and provide the most appropriate imaging procedure based on the level of scientific evidence and the level of emergency.

There are several medical/legal issues that arise from the surge of AI, such as who is responsible for the patient's final report and findings that need to be sorted throughout the years. But we believe AI will ultimately help to improve personalized medicine.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

Instead of obstacles, I would like to think that there are several challenges concerning the implementation of radiomics to our daily routine.

The biggest challenge I can see is how to alter the preconceptions of the people that will be working on a daily basis with AI. When talking with several colleagues about this subject I can sense there is a special anxiety to the changes that AI will cause on their jobs and on their lives. For us, it is important that this fear is appeased since we have to think of AI like an ally in our job, not as our enemy. And that is that is the biggest challenge we are facing right now.

In our country the biggest obstacle we can find when thinking of implementing AI is the lack of financial resources. In Argentina we have to deal with two types of health providers: the state that offers public medical assistance and several private practices.

Public health in Argentina has been deteriorating throughout recent decades, so for the government to think of AI as a priority and to invest money on it is nearly unthinkable. While in the private sector it is more likely that AI can be implemented. Nevertheless, applying it will be hard since there is no regulation about how the financial investment will recovered.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

On one hand, when mankind tries to achieve better results than AI alone the outcome will be poor, but on the other hand, radiologists will be able to devote even greater efforts to providing a better medical service together with other disciplines combined with all the tools AI provides, the results will be magnificent. Imaging professionals need to accept that AI is an emerging technology and become part of the change by getting involved.

MR ADAM WESTERINK

Treasurer, Australian Society of Medical Imaging and Radiation Therapy (ASMIRT)

Acting Radiographer Assistant Director at Department of Medical Imaging, Royal Brisbane & Women's Hospital, MNHHS

The Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) is the peak body representing medical radiation practitioners in Australia. Our aims are to promote, encourage, cultivate and maintain the highest principles of practice and proficiency of medical radiation science, always mindful that the welfare of the patient should be at the centre of everything we do.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

There are two concepts that are well known and well publicized within the medical imaging profession.

1. Large volumes of data are a natural by-product of the services that are provided by imaging professionals.
2. Systems and tools based on foundations of artificial intelligence (AI) and machine learning (ML) are beginning to be integrated into clinical practice.

The intersection of these two principles, and the clinical integration of programs for analysis of data leading to patient-focussed changes to service delivery, will be a significant positive development predicated in the next 10 years.

The impact of change in this area of imaging will assist in mitigating future challenges in providing value-based, and efficient healthcare frameworks. Robust analysis of imaging data will inform review and development of new models of care; models of care that will ensure sustainability of imaging into the future.

AI and ML are by no means new concepts, but the marker of success or impact will be when clinically validated systems become accepted as best practice within imaging. This also needs to be coupled with tangible and transparent benefits to service delivery and patient care.

The technological evolution in this area will be fast and furious, so proactive preparation will be the key. The well-developed AI and ML solutions should deliver the option for widespread global uptake without major disruption, as they blend with existing workflows and applications.

"keep the patient at the centre of everything"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

It is becoming increasingly challenging to meet the complex health needs of growing and ageing populations with existing resources. This situation is not unique to medical imaging and the trend exists across the healthcare landscape globally. Unique, however, is the exponential growth in demand for imaging examinations. All forecasting indicates that these challenges are here to stay. Strategic planning is paramount in ensuring that our professions are able to dynamically respond by ensuring that models of care are contemporary, evidence-based and able to absorb external threats.

In Australia, our unique geography presents additional obstacles and challenges. This was highlighted in a recent parliamentary review of the availability and accessibility of diagnostic imaging equipment in Australia. Populations in rural and remote areas experience higher out-of-pocket expense, poorer health outcomes and poorer access to imaging and timely reports.

Supporting and developing a workforce which is agile enough to respond to these challenges, as well as advocating for fair and equitable access to imaging is critical. Professional streams within medical imaging must work together towards common goals, and must be vocal in any broad discussions about population health management.

We may also recognize that continuing to strive for improved patient care and improved patient experience may in itself be a challenge in future healthcare environments.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Principles that hold true now, will hold true for the future. Keep the patient at the centre of everything that you do. Support yourself and your colleagues to learn, develop and grow as professionals through collaboration in local, national and international forums. Embed into clinical practice the values that underpin healthcare—respect, integrity, compassion, high performance and teamwork. Embrace your profession and be reassured that your contributions to healthcare have a positive impact on each of the patients that you care for.

PROFESSOR DR ALAIR SANTOS

President, Brazilian College of Radiology
Colégio Brasileiro de Radiologia e Diagnóstico por Imagem (CBR)

Associate Professor of Radiology at Federal Fluminense University in Rio de Janeiro

The Brazilian College of Radiology (CBR) is the institution that certifies radiologists in Brazil. With about 15,000 radiologists, the focus of CBR is the excellence of radiology formation and permanent vigilance for respecting the principles of good medical practice and advancing our specialty in Brazil.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Radiology has gone through several changes in the way the specialty is performed over the last five decades. The introduction of CT, in the early 1970s and MRI, in mid 1980s were turning points for our specialty. When looking at the next 10 years, the incorporation of artificial intelligence (AI) in radiology will be a major breakthrough, but also a tremendous paradigm shift in the way radiology is practiced around the globe. With the fast introduction of AI devices into clinical practice and their support, many laborious activities in the specialty will be done faster and more effectively, saving time for more elaborated and complex tasks by radiologists. Of course, this will require a complete change in conception of the profession and also in the training of the new generations of radiologists, who will be working in this new scenario. Radiologists' role will be more frequently required and appreciated for making links between the whole imaging armamentarium and patients' needs for personalized healthcare, while preserving the pillars of evidence-based medicine. Those changes will require that radiologists act more as consultant than simply describing findings in formal reports.

The impact of these changes will be incorporated at different paces. In the more industrialized societies, this scenario is not far away, with some centres practising ahead of their time. For other countries, the changes will go with a slower pace, but it will be real in the near future, as optimising the process, reducing costs and improvement in healthcare are major determinants of this transformation.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

One of the biggest challenges for radiology development throughout the world is to combine the rapid advances in technology recently incorporated to the specialty with humanized and personalized healthcare. Embracing technology should not indicate a deviation from patient-centred care, as a first impression could suggest. Radiologists should persist in their motivation to stand as an important part of the medical care, regardless of the level of complexity.

In relation to our country, we have some specific problems in Brazil. The continental dimensions of the country, combined with significant socioeconomic disparities create quite different scenarios when comparing the south and south-east to the north and north-east regions. In the former, better educational and social conditions create an environment for radiology similar to the most developed countries, whereas the poor quality of life in the north and north-east limits the expansion and progress of imaging. To bring radiology education to the most remote areas of the country, online educational initiatives are the best solutions implemented so far.

However, providing access to major developments in the radiology field, like MRI scanners and interventional radiology suites is more complicated as they largely depend on governmental macroeconomic politics.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

There is no simple rule here. Traditional key elements like dedication and engagement, along with a strong training in residency is crucial for successful professionals. However, with the focus on a new scenario, the radiology residence program should focus not only on technical aspects of the specialty, but also include formation in administration and leadership.

"the continental dimensions of the country, combined with significant socioeconomic disparities create quite different scenarios"

DR JANE PHILLIPS-HUGHES

President, British Institute of Radiology (BIR)

Consultant Radiologist at Oxford University Hospitals NHS Trust

The British Institute of Radiology is an international membership organisation for everyone working in imaging, radiation oncology and the underlying sciences. We aim to support the work of our members and their colleagues to achieve professional excellence, provide continuing professional development for our multidisciplinary community, publish cutting edge research for our authors and readers across the world and influence and connect with the wider professional sector.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

It is tempting to talk about artificial intelligence (AI), analytics and informatics, which without doubt will have a major influence on our working lives over the next 10 years and beyond. However I suspect others will cover this ground and so, with the assumption that this will be an integral part of all imaging department work I am going to concentrate on another rapidly growing field.

I'm not sure if this counts as a single development, but I think that current research into molecular and hybrid imaging in personalized healthcare has enormous potential to change the way medicine is practised. Perhaps within 10 years the impact will be limited to certain centres and territories but eventually there will be changes on a global scale.

Advances in technology mean that medical imaging is evolving from a simple visual demonstration of anatomy and pathology to include information on physiology, pharmacology, cellular and molecular biology.

Hybrid imaging provides visual and quantitative information and provides functional insights into biological and pathological processes, and work with biomarkers will allow earlier disease detection, a means to monitor efficacy of drug therapy and to assess disease recurrence.

Cancer treatments will improve as advances in molecular imaging scanners allow more accurate understanding of specific disease processes, and this will allow development of new and more specific biomarkers. In turn, more specific and targeted "personalized" treatments will be possible, with improved efficacy.

It will be possible to diagnose and to intervene earlier in the disease pathway, and perhaps even to modify or prevent disease development. Toxicity from non-targeted and ineffective therapies will be much reduced.

In summary, in the near future hybrid and molecular imaging techniques will play a pivotal role in personalized healthcare. We should plan accordingly.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

In the UK we have a significant problem with workforce numbers and no obvious quick-fix to remedy this.

The Royal College of Radiologists carries out an annual UK workforce census. In the 2018 study, they reported a year on year increase in demand for complex cross-sectional imaging with a 54% increase in demand for CT and a 48% increase in MRI examinations over the previous five years.

The census showed recruitment in hospitals for consultant radiology posts was severely inadequate, with six out of ten posts remaining unfilled at 12 months.

There is a huge impact on service delivery, with only 2% of departments fulfilling their reporting requirements within contracted hours. The financial implications of this are enormous as alternative means such as outsourcing, in-sourcing and *ad hoc* locums are used to attempt to provide the required service. Consequently many radiologists have to cover workforce gaps.

Those in consultant positions take on the burden, resulting in one in three reporting work-related stress that negatively affected their work. Accordingly, a significant number now retire early, influenced by factors such as work life balance and also pension tax penalties.

Bodies are lobbying hard for increased training places. Skill mix, for example with radiographer role development and reporting, is used increasingly across the country too, however there is also a shortage of radiographers.

So, workforce issues are a big problem and undoubtedly an obstacle to progress in imaging in the UK at this time.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

A solid clinical background knowledge will always stand you in good stead. In many cases, the radiologist will be required to advise on the best imaging pathway for a patient from their presenting symptoms and signs.

In addition, keeping abreast of technological advancements in healthcare is extremely important. AI, big data, and analytics are all here to stay. Radiologists will need to understand these factors in order to work with them and those who further develop them, in order for appropriate and clinically useful advancements to be made, to the benefit of patients and clinicians alike.

"recruitment in hospitals for consultant radiology posts was severely inadequate, with six out of ten posts remaining unfilled at 12 months"

GAILYNE MACPHERSON

President, Canadian Association of Medical Radiation Technologists (CAMRT)

Provincial Director Diagnostic Imaging QEH at Health PEI
Montague, Prince Edward Island, Canada

The Canadian Association of Medical Radiation Technologists represents approximately 12,000 members across Canada in the disciplines of medical radiological technology, nuclear medicine, magnetic resonance imaging and radiation therapy. We are both the certifying body for these disciplines and the association for members in practice. As an association, a large part of our focus is on moving the profession forward by anticipating new trends and identifying gaps in care.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

I believe the single most positive development in the world of imaging will be artificial intelligence (AI) and all its applications. In Canada, we are just starting to see applications of AI emerge from vendors. In addition to high-profile machine learning work, we are also seeing applications of AI that are geared more specifically to the MRT (Medical Radiation Technologist) role. For example, software that will question technologists on positioning and reproducibility during imaging. I believe this has the potential to impact on (*i.e.,* reduce the need for many) follow up exams.

With an increasing focus on patient-centred care, these newer AI-driven software applications also have the potential to help patients receive a diagnosis in a more timely and efficient way. I believe AI will free MRTs (and other professions) to change the focus of our professional role from more technical imaging experts to patient caregivers with imaging expertise. I believe that because of this shift, MRTs will also have the opportunity to become more integral (and more respected) members of the overall healthcare team.

Of course, all of this will require for MRTs to take the helm for their own profession and ensure that the place they see for themselves in an AI-infused healthcare system is a goal they are all working towards.

"those in a position to afford and buy these new technologies could advance in leaps and bounds, whereas those left waiting could see themselves slip behind the curve"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

I believe the biggest obstacle to progress in imaging around the world is the astounding pace at which technology is advancing and changing right now (making much of the equipment in place obsolete), combined with the prohibitive expense of the newer equipment (and the supporting IT infrastructure). Because medical imaging equipment is very expensive to purchase and to service, many Canadian jurisdictions find it difficult to secure the funding necessary to keep up with the latest state of the art. Though all MRTs want to know they are offering each patient the best possible care no matter where they are situated, the sheer pace of change at the moment is making this more difficult.

A second aspect to the latest technological advances is the expansion of information being generated—a huge challenge in its own right. The past two years, our association has run a "Gamechangers" symposium to look at emerging technology and trends. There we have had numerous presentations on the expansion of data, showing that the amount of information available is doubling every two years. It will be difficult to keep up to this on two fronts. First, the aforementioned purchasing of equipment capable of delivering the most information-rich diagnostic information possible. Second, the need to expand (nearly constantly) the IT infrastructure required to store and take advantage of all the information being produced.

Those in a position to afford and buy these new technologies could advance in leaps and bounds, whereas those left waiting could see themselves slip behind the curve.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

I believe that imaging professionals need to prepare themselves by seeing themselves as caregivers and critical thinkers with imaging expertise. As we see the lines blurring between modalities, and upcoming disruptors (like AI), we need to see and present ourselves primarily as caregivers and members of the total care team.

PROFESSOR ZHENG YU JIN

President, Chinese Society of Radiology (CSR)

Professor of Radiology at
Beijing Union Medical College Hospital

The biggest radiology society in China, CSR is a non-profit national community dedicated to radiology research and clinical treatment and was founded in 1937 in Shanghai. As a subordinate of the Chinese Medical Association (CMA), CSR set its purpose for uniting all radiologists as well as radiologic technologists nationwide, and actively promotes the development of Chinese radiology.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Artificial Intelligence will no doubt be the most positive development of our world in the next 10 or even 20 years. Although the number of our society members reaches over 80,000, our nation is still facing severe problems due to the shortage of radiologists. There remains a heavy burden for Chinese radiologists for the vast amount of reports needing to be done every day.

AI has become the hottest topic in our daily life, not only for research but also for clinical practice. Validating the AI tools into medical practice will not only improve the decision-making part but also optimize the safety and quality of radiology service throughout the entire workflow.

Yet, while AI helps our radiologists save reporting time, our radiologists should go a further step forwards to face the patients and to interact with clinicians. Radiologists have the knowledge to talk to patients and to explain radiology reports as well as guide patients moving onto next stage.

Radiology has shown its important value in, but not limited to, diagnosis, differential diagnosis, pre-operative staging, surgery strategy planning, treatment outcome evaluation, follow-up, disease recurrence monitoring, *etc.,* both qualitatively and quantitatively. Radiologists also have the knowledge to work together with clinicians since radiology has become the crossroads in many diseases' clinical pathway. So, in the near future, with the help of AI, radiologists will be able to devote even greater efforts to providing a better medical service together with other disciplines.

"policy-makers...need to work together with medical professionals so that the best tailored regulations can be made"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

New techniques are the main power behind medical service development. While national regulations lead the way in this development, policy-makers need to be informed of the most up-to-date knowledge of medical techniques and need to work together with medical professionals so that the best tailored regulations can be made.

Other than these, there are many things that we could do to better facilitate the progress of medical imaging. First, an even closer collaboration with clinicians will enable radiologists to better know real clinical needs more clearly, thus enhancing the link between radiology and other medical disciplines. Second, Chinese radiologists need research PhD partners who can work closely with them within the hospital. This will again be based on more open policies for academic/university hospitals. The last but not the least challenge for China will be the uneven level of medical services as well as medical education throughout this really big and developing country. In big cities, radiologists are more experienced both in clinical practice and in clinical research. Efforts need to be made to deliver more efficient continuous education as well as clinical practice quality control, and professional societies are important here. Systemic professional standards and guidelines that meet the needs of the Chinese healthcare system will be required.

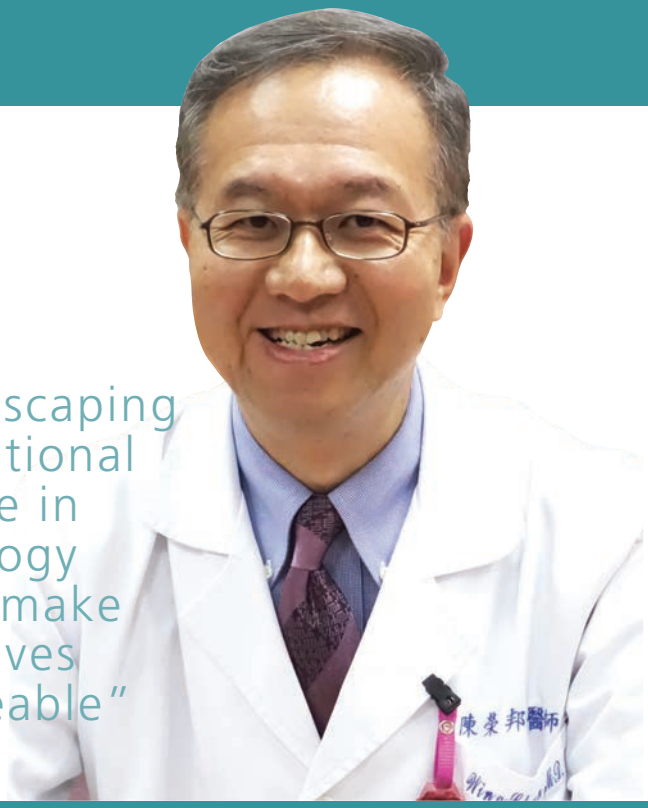
WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Radiology is one of the best invested as well as developed areas in the medical field. Yet still, countless questions remain to be answered in our area. Radiologists should have faith and trust in the future of their own career. Continuous medical education needs to be delivered due to the ultra-fast development of medical imaging techniques. To know what we need to know, to learn what we need to learn.

PROFESSOR WING P CHAN

President, Chinese Taipei Radiological Society (RSROC)

Department of Radiology, Wan Fang Hospital, Taipei Medical University, and Department of Radiology, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Chinese Taipei



Founded in 1951, the Chinese Taipei Radiological Society has been active in furthering research, education and clinical practice in radiology. The RSROC devotes itself as the centre of communication for all issues in radiology related areas. The goal of the society is to bring all related medical fields together to benefit each patient.

"only by escaping the traditional culture in radiology can we make ourselves irreplaceable"

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Following the development of software for Artificial Intelligence (AI) automated image interpretation and reporting, clinicians will be less dependent on radiologists. Radiologists will become advisors sought out for consultations with difficult cases. They will be liberated from tedious diagnostic reporting and will work with a small number of staff, possibly with cross-industry co-operation and investment in scientific research and development. Most radiologists will gradually shift focus from imaging interpretation to interventional radiology (IR).

Medical developments and patient demands are complementary. Demand will stimulate the development of science and technology; conversely, new technologies will create patient needs.

With advances in catheters, imaging equipment, and technology, IR has progressed from an emergent treatment for gastric bleeding to applications in broad medical fields such as cerebral thrombectomy, uterine fibroids, prostate enlargement, osteoathritic knee pain, *etc.* Minimally invasive surgery with less painful and faster recovery and shorter hospital stays will provide patients with better treatment options.

On the premise of meeting patients' medical needs, we should become first-line clinical radiologists and establish multi-disciplinary co-operation through IR technology, not only to communicate with clinicians, but also to gain patient trust, cultivating irreplaceable clinical value (*i.e.,* who is best at caring for patients rather than who touches the patient first).

To get out of our reading rooms, we must have our own outpatient clinics or clinical co-operation clinics as well as hospital beds. We must first strengthen our clinical knowledge, starting with the resident training programs, and cultivate and accumulate clinical skills and IR technology. Second, we must reasonably distribute income and benefits with the clinical side, combining with various professions without competing or replacing them to provide better services for patients.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

It is difficult for regional development to break away from world trends. There are currently about 1,300 radiologists in Chinese Taipei, and about 200 of them perform most of the IR in daily practice. Presently, IR is in the beginning of its grass-roots period. It is urgent that a sound foundation be established along with advanced education and training courses. We should plan to formulate sub-specialty examinations and certification standards that meet international standards. Because of a shortage of IR instructors, we must accelerate the introduction of new knowledge and talent through cross-border learning and international co-operation.

On the other hand, radiology is currently considered a second-line department in hospitals. Therefore, compared to first-line departments, it might have fewer patient responsibilities and limited revenue. This is unfavourable when attracting talent. However, when intervention is the primary purpose of radiology, stress and after-hour workloads increase over those in an image interpretation environment. Therefore, a reasonable payment system (including medical insurance and an in-hospital distribution system) must be established to effectively develop the department.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Facing the trend of transformation, radiologists should not be limited to second-line positions when communicating with other physicians. They should bravely walk out of their comfort zones and prepare for first-line practice. Only by escaping the traditional culture in radiology can we make ourselves irreplaceable, display more aggressive personalities as well as timely and proactive attitudes, and demonstrate enhanced abilities in communicating with patients.

PROFESSOR DR GERALD ANTOCH

President, Deutsche Röntgengesellschaft e.V. (DRG, German Röntgen Society)

Director of the Department of Diagnostic and Interventional Radiology, University Hospital Düsseldorf

The German Röntgen Society is a medical society with one of the longest traditions of medical societies in Germany. Its task is to promote radiology in its medical application, in research, and teaching.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Since 1895, when Wilhelm Conrad Röntgen discovered X-rays, radiology has been the source for many ground-breaking inventions, driving progress in the medical field. Currently we are seeing a rapid development in the medical profession in general and of radiology specifically through digitalization, which will further accelerate throughout the next 10 years. Artificial intelligence (AI), machine learning and neuronal networks are not just buzzwords. Radiologists worldwide already include them in their everyday work. In the near future, they will develop new imaging solutions together with physicists, software-engineers, and data-scientists. Take radiomics, for example, the analysis of quantitative image characteristics. In a few years' time, image information invisible to the human eye will lead to additional findings through radiomic data analysis. By correlating radiological data with other data, *e.g.* patient history, pathology, or genetics, we will gain a new instrument to detect health problems substantially earlier and more specifically.

AI will help create personalized precision medicine worldwide, delivering individual treatment options. AI will be able to determine non-invasively whether a patient will profit from a certain therapy thus adding information on patient prognosis. Radiologists worldwide need to understand these potential fields of application of AI and are strongly encouraged to help shape the future of radiology and medicine by becoming the driving force to develop and implement AI in the clinical routine.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

DIGITAL TRANSFORMATION
We already hear swansongs on the radiological profession, prophecies predicting the elimination of radiology due to digitalization. Indeed, digitalization is one of our biggest challenges lying ahead. AI and a more comprehensive use of medical data will change all our everyday jobs, in radiology and all health professions. Will new technologies replace our work? No, but they will change the way we work substantially. Digital technological development will facilitate many routine tasks leaving the interpretational authority with the professionals. Based on a constantly increasing work-load, radiologists may even have to rely on such a development which may culminate in a digital sort-out of non-pathologic imaging studies, relieving radiologists of imaging studies not requiring highly qualified radiological expertise. The biggest obstacle to this development is a lack in validated, reliable data.

RELIABLE DATA
For digitalization and especially for the application of AI, validated radiological and non-radiological data are key to train algorithms. Today, there are two different worlds: web developers on one side, who have the code and the money, and radiologists and other hospital professionals on the other with the data. We will need to work together and learn from each other to produce the best outcome for our patients.

RADIOLOGICAL UNITY
Teamwork directly connects to the second challenge. Despite all transformations in job descriptions and upcoming new specializations, we can only keep the quality level and effectiveness at the highest standards if we preserve and strengthen the unity of radiology as one specialist discipline, in clinical application and in research. Sub-specialization within the field of radiology is, without question, of utmost importance. However, shattering our field into multiple independent sub-societies will weaken radiology and may be considered the only current threat to our field of expertise.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

WE NEED TO LEARN:
Only if we, as imaging specialists, understand the principles of AI and radiomics, and only if we develop them actively, will we be able to drive innovation further and preserve success in our field.

WE NEED DATA:
More precisely, we need qualified curated data to validate, standardize and certify future AI applications in diagnostics.

WE NEED TO WORK TOGETHER:
We need to pool our interests—as radiologists and across disciplines—to stay successful. This applies not only to current collaborations, such as with specialists from nuclear medicine, referring physicians, radiographers or physicists, but specifically applies to future collaborations with software engineers and IT companies.

DR LILIAN LEONG

Founding President & Immediate Past President, Hong Kong College of Radiologists (HKCR)

Honorary Professor at Department of Diagnostic Radiology, The University of Hong Kong

Hong Kong College of Radiologists was incorporated in September 1991. The College was established with the objectives to encourage the study and advancement of the science and practice of radiology, as well as to maintain the good practice of radiology by ensuring the highest professional standards of competence and ethical integrity

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

From my point of view, the single most positive development in the world of imaging in the next 10 years will be the incorporation of artificial intelligence (AI) with imaging.

AI has attracted a lot of attention in the world of medicine, especially in radiology, over the past two years. The recent development of AI in radiology is also well witnessed. There would be great potential for AI to facilitate and augment the detection and characterization of lesions, formulation of differential or principle diagnoses, and clinical decision making in various modalities of imaging.

I believe that the incorporation of AI with imaging is going to have a worldwide effect because most of the data in modern imaging are digitalized and can be easily transferred without geographic limitation, providing a huge data source under common language for analysis, being a strong foundation for the development of AI in radiology. In addition, the application of AI is expected to be in the form of software, which can be easy to deploy on a global scale. Advancement in computer science and networking will further enhance the development and deployment of AI. It is also noticed that many of the leading businesses and governments continue to escalate their investment and support for AI in different applications, which will eventually benefit the adoption of AI in medicine. Last but not least, the increasing awareness and interest in AI among medical professionals and the public all over the world will hasten its development in the medical field.

"the biggest obstacle to progress in imaging around the world is the accessibility of imaging services"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

The biggest obstacle to progress in imaging around the world is the accessibility of imaging services.

In spite of rapid development in radiology, it is only meaningful when imaging services are readily available to clinicians and patients. Imaging is now an essential component of patient care, not only in the diagnosis and treatment planning of many diseases, but also in direct therapy with interventional radiology. Radiologists are core members of multi-disciplinary teams of patient management in tertiary healthcare. With the growing importance of screening, radiology will also be an indispensable component to safeguard the general health of the public in primary care and preventive medicine. All of these will only be successful when imaging services can be provided in a timely manner.

There are several core factors which limit the accessibility of imaging services in different parts of the world, namely insufficient radiologists and related professionals (*e.g.* physicists, radiographers), insufficient imaging machines, difficulty in achieving financial sustainability in the medical care system including imaging service, and difficulty in establishing imaging facilities in remote areas. In my locality, the lack of manpower is the most important constraint to the development of radiology, although the other factors are also present.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Imaging professionals need to develop a sustainable training system to prepare themselves and the whole profession for success.

The training system should cover evidence-based medical knowledge and up-to-date skills. In addition, the system should be able to keep abreast with rapidly evolving technology advancements in the world of imaging, including AI. Meanwhile, this component is relatively deficient as it needs the participation of professionals other than doctors. Last but not least, the system should routinely produce good quality trainers to carry on the training to the next generation of the profession.

DR HEMANT PATEL

President, Indian Radiological and Imaging Association (IRIA)

Gujarat Imaging Centre, Samved Hospital, Ahmedabad, India

The Indian Radiological & Imaging Association (IRIA) is a body of more than 17,000 members (Radiologists) from all over the country. In order to update its members, IRIA organizes Annual Conferences, CME programs, seminars, a resident education program, symposiums *etc.* from time to time. IJRI is the official journal of IRIA and ICR is the official academic wing of IRIA.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Artificial intelligence (AI) in radiology is the dawn of a new era;it will empower and augment the existing radiology eco-system leading to a spectrum of new developments. In my opinion, the most crucial and far-reaching consequence of AI would be reducing MRI scan time. It will be the single most positive development in the coming years which could revolutionize clinical–radiological practice. AI will result in faster MRI acquisitions, better planning and improving the hospital workflow leading to an increase in overall productivity and efficiency. AI assistance will help in improving diagnostic accuracy, prompting better diagnosis and improved healthcare.

In a country like India, with a population of around 1.33 billion, only 33% of the population is urban. A study published in *The Lancet* recently stated that more than 2.4 million people died in India in 2016 due to conditions that could have been treated by healthcare—the highest number per day of "amenable deaths" among the countries studied.

The biggest impact of faster MRI scans would result in patients spending less time in machines, enabling radiologists in imaging centres and hospitals to conduct more tests. This could easily be a breakthrough in our country wherein a lack of access to quality healthcare leads to common scenarios like longer waiting times (sometimes ranging up to six months) for an MRI scan in tertiary government hospitals. I think AI will be a game changer in the next 10 years.

"more than 2.4 million people died in India in 2016 due to conditions that could have been treated by healthcare"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

Healthcare has always been an expensive affair and is considered to be the biggest obstacle for the industry all around the world. In India, with a dearth of quality government medical and imaging setups, the onus of 60–65 % of the patient management falls to private medical hospitals, corporate hospitals and individual setups. In an ever increasing era of inflation, battling patients' needs alongside quality imaging is a tedious task. The biggest obstacle can be tackled by reducing the scanning and operative costs without compromising the quality of the system.

A few steps that might help, include the training of more imaging specialists to meet the excessive demand, training existing radiologists into sub-speciality radiologists and alleviating the high operative, scanning and machinery costs of MRI and CT scans. Increased inter-departmental and multi-disciplinary meetings to emphasize patient-centric values-based imaging principles is the need of the hour. By increasing exchange programmes amongst the radiologists and residents of various countries and by sharing their experiences, new solutions can be unfurled. Persistent innovative efforts will help in making radiology practice shift its focus from volume-based to quality-based and at the same time retaining its potential to tackle the gargantuan case load.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Striving towards a value-based healthcare system is the ultimate future of medicine. Value-based healthcare principles differ from a fee-for-service (or capitated approach), in which the providers are paid based on the amount of healthcare services they deliver. Value-based healthcare is the gauging of health outcomes in contrary to the cost of delivering the outcomes.

A quintessential and critical step in the shift to value-based operations is the development of measurable, radiology-specific performance standards that address and cater to important needs of patients and the medical community. On a larger scale, integrated diagnostic services with clinical disciplines would expand their leadership in bringing efficiency and value across diagnostic health systems.

PROFESSOR JACOB SOSNA

President, Israel Radiological Society (ISRA)

Chairman, Imaging Division,
Hadassah Hebrew University Medical Center,
Jerusalem, Israel

ISRA was established in 1927 and has 450 members. It is the oldest medical society in Israel. It has two main responsibilities: the first is academic and deals with setting the standards for radiology practice and education; the second is professional, aimed at setting the requirements for a sound profession with a strong position within the medical field.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Although intuitively one would say that artificial intelligence (AI) is the most positive development, I believe it is the automatization of radiology including AI that will prevail. This includes aspects related to radiological study performance such as robotic positioning of patients for X-rays and for advanced imaging such as CT or MRI. Automatic scanning or nearly automatic scanning will decrease variability, decease doses for patients and staff as well.

AI may help in this aspect but it is only part of it that will also include robotic sciences similar to the development of autonomic cars. This may also be of help in interventional radiology with much easier introduction of catheters and coils. With regards to interpretation AI may be helpful in specific repetitive tasks. However, in order to make it useful there is an essential component that needs to be met. AI tools need to be fully embedded in our workflow. From many years of experience we know that advanced processing tools are seldom used in practice as well as research because they are not connected with the current way radiology interpretation is done at the PACS station. Computerized tools that are not harmonized with the workflow will fail in the long term.

Another aspect in automatization of radiology work is related to QA. We must be able to decrease variability in interpretation and be sure that our reports are understood by clinicians and by patients in the way we want them to understand the action items. Automatic tools that will make sure that recommendations are accepted and further evaluation done will be a part of the future workstation radiologists will use.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

The main obstacle is the shortage of radiologists in general and in Israel in particular. Radiology is very popular among medical school graduates but due to government restrictions, the number of open positions for training is limited. This factor, as well as the increased need for more radiologists at present, makes the situation even more difficult. We see increased burnout among practising radiologists and even among trainees. Radiology increased workload that is becoming busier is also a threat to academic radiology. There is less free time for research which is less appreciated by department chairmen and hospital administrations.

The solutions are multifactorial and include increasing the number of training positions on one hand and on the other hand increasing the number of positions for radiologists after training. This is a compulsory action as within five years there will be a need for positions for the current trainees that will graduate. Another solution is finding ways to decrease burnout by providing a more reasonable lifestyle and balance between private and professional life that is mandatory for the current Generation Y. Promotion of research is essential for the future of radiology and this must be emphasized and recognized by leaders in the field as well as by our universities and hospital directors.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Imaging professionals need to love our profession and have the desire to do the best they can to promote imaging as well as our patients' health. Radiology is crucial in medicine; it is the CNS of the medical system. Only by understanding the role we have can we keep being appreciated by our colleagues and patients. Every day a radiologist has to ask himself or herself what did I learn today? what did I do well? and in what aspects can I improve?

"every day a radiologist has to ask himself or herself
what did I learn today? what did I do well?
and in what aspects can I improve?"

DONNA NEWMAN

President, International Society of Radiographers and Radiologic Technologists (ISRRT)

Lead of Nuclear Medicine and PET CT at Sanford Health, Fargo North Dakota United States

ISRRT represents over 500,000 radiographers worldwide with a mission "To improve the standards of delivery and practice of medical imaging and radiation therapy throughout the world by acting as the international liaison organisation for medical radiation technology and by promoting Quality Patient Care, Education and Research in the radiation medicine sciences".

"strategies are needed to ensure medical professionals working in the field of medical imaging are educationally prepared and clinically competent to care for all the patients that will be in need"

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Artificial intelligence (AI) is the single most positive development in medical imaging and radiation therapy and can be considered one of the most innovative advances in our field in the next 10 years. I believe this will change and have an impact on how radiographers deliver healthcare service to our patients.

AI incorporates machine learning and deep learning based on computational models. Most peer reviewed articles have traditionally covered AI's focus on computer-aided imaging interpretation for the radiologist.

Today, we are beginning to see more discussion on how AI will contribute to the radiographer's daily practice. The current AI technology presented in medical imaging and therapy for a radiographer's daily role offers applications for decision support, worklist designations, workflow distributions, scheduling assistance to resolve challenges associated with no-show appointments and repeating examinations.

AI software also aids radiographers to perform more efficiently, to appropriately prioritize services and to distribute workloads for the more effective use of available resources. The future of AI appears to be moving towards novel software tools that can automate quality control, induce lower radiation doses, improve positioning and improve sequencing in imaging.

As radiographers embrace these new tools and implement the connected clinical applications in their daily practice, they will become more efficient allowing them to focus on the patient and the human interaction of care which is ultimately the key to great healthcare delivery.

In addition, as software evolves, AI will allow radiographers to focus on what they do best, to uphold their role as the interface between patients and technology as well as to mediate the procedure for the radiologist and the referring physician.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

I believe that the biggest obstacle to progress in imaging around the world is a lack of human resources for our profession. Strategies are needed to ensure medical professionals working in the field of medical imaging are educationally prepared and clinically competent to care for all the patients that will be in need of healthcare over the next 10 years. With the projected shortage of 18 million healthcare workers, the ISRRT is among international global leaders working to develop strategies that will contribute to healthcare in countries. These strategies will contribute to helping meet the demand of healthcare workers needed in order to achieve the World Health Organisation's global strategy for Universal Health coverage which is planned to be achieved and sustained by 2030.

Generally, when there is a shortage the trend is to lower educational standards to meet the need and provide more healthcare workers. As a global leader representing over 500,000 radiographers worldwide, the ISRRT believes that we need to invest in the right skill set and to provide high quality education and life-long learning to overcome this projected shortage. The ISRRT also believes in investing in non-traditional strategies to provide this quality education to help ensure that medical imaging professionals achieve the right skill set to be clinically competent. This will lead to sustaining the high performance of radiography services to patients.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Medical Imaging professionals need to ensure that they begin their career by preparing themselves with high quality education. This path will contribute to ensuring they achieve the right skill set to be educationally prepared and clinically competent in the medical imaging profession. Also, as medical imaging is a career encompassing technology that continues to change and evolve, as professionals it is imperative that radiographers/radiologic technologists are prepared to be life-long learners throughout their career. These two things will ensure you have everything you need to deliver Quality Patient Care.

PROFESSOR YUTAKA IMAI

President, The Japan Radiological Society (JRS)

Professor at Tokai University School of Medicine,
Tokai University Hachioji Hospital, Hachioji, Tokyo, Japan

JRS, founded in 1940, has been the leading official society in the field of radiological science in Japan. The main aim of the society is to promote radiological science in collaboration with various related societies and the international co-operation for the progress of radiological science. Currently JRS has over 9,500 members.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

The most expected development in the next 10 years would be the application of artificial intelligence (AI) to radiation medicine. AI would support human work efficiently such as taking images, diagnosing imaging, and treating patients *etc.*

Meanwhile, it will be difficult to predict how far radiological technology would be developed. Learning based on the experience of a single radiologist is limited, and we should use AI information produced by big data and verified by many medical institutions.

AI could secure objectivity due to its quantitative analysis. Recently, in the medical field, quantitative data mining has become necessary for providing more precision medical care. Radiomics is a methodology of comprehensive analysis for describing disease process, tumour phenotype or patient prognosis using pathognomonic features extracted from a large number of medical images. AI could help us to suggest one of the possibilities of radiological diagnosis and oncology in clinical medicine. Radiologists should use AI information as one of the useful devices.

There is no way to avoid human error. However AI could reduce human error if you could apply AI to your work in clinical medicine. Computer aided detection (CAD) would help to eliminate human error, however an adequate setting that allows reductions of false positives or false negatives is necessary.

AI could enhance a radiologist's career for a long time. A radiologist's career with AI would be more enhanced and prolonged than without it. In addition radiological diagnosis using AI might become an international standard.

People should understand that only a radiologist can check the possibility of AI errors in the radiology field.

"there is no way to avoid human error. However AI could reduce human error if you could apply AI to your work in clinical medicine"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

Although Japan has the most CT and MRI devices in clinical service in the world, the number of radiology specialists who operate these devices is insufficiently low. Therefore, the acquisition or education of radiology specialists is necessary. Dr Nishie reported that at least 2.09 times more full-time diagnostic radiologists are needed to complete all CT and MRI reports in Japan.

Under these circumstances, recently there has been a false rumour that radiology specialists are one of the jobs to be replaced by AI in the near future, so young people who aspire to becoming radiology specialists were decreasing last year.

JRS is currently promoting the importance of the radiology profession in recent clinical medicine to the public through many open lectures.

Our messages are as follows.

1) Radiology involves not only the diagnosis of medical problems—it also entails the selection of appropriate treatment for each patient.
2) Reporting by qualified radiologists is very important for treating patients.
3) AI is one of the useful devices for radiologists.
4) Only radiologists can check the possibility of AI errors in this field.

We believe that an effort to promote recent social beneficial projects to the public will lead to the enhancement of citizens' understanding and future development of radiology in the country.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Many new treatments have been developed over the years throughout the world. These include endoscopic resection, laparoscopic surgery, robotic surgery, chemoradiation therapy, interventional/minimal invasion therapy, tumour immunotherapy, regenerative medicine, and "wait and watch" strategies.

Radiology specialists should adapt to such new treatments, and improve their skills in radio-diagnostics. In addition to diagnosis, their work should involve personalized medicine and treatment selection.

Radiologists should communicate with physicians and provide value-based images to determine appropriate clinical decisions for a patient's quality of life.

PROFESSOR VALENTIN SINITSYN

President, Russian Society of Radiology (RSR)

Chair of Radiology at Faculty of Fundamental Medicine, Head of Radiology Department at University Hospital, Lomonosov Moscow State University, Moscow, Russia

RSR was founded in 1916. Today the Society has over 3,200 active members. It consists of 36 regional radiological Societies. RSR is a member of ESR and ISR. It holds annual congresses on the second week of November, around the International Day of Radiology.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Like many of my colleagues, I believe that the most positive development in diagnostic imaging will be the use of information technologies (IT) and artificial intelligence (AI). I am not afraid that IT and AI will replace human radiologists. They are new tools which will give a tremendous boost to medical imaging. They will save radiologists from many routine and time-consuming tasks and will help us to use our intellectual potential at its fullest capacity.

IT and AI will improve all the major directions of radiologist's activities such as handling patient workflow, the interpretation of images, control over the treatment of patients, and the communication with medical colleagues and patients. Digitization of radiology and use of the internet have already deeply influenced all fields of a radiologist's activities, and the era of AI is just a logical continuation of this process. I believe that all diagnostic examinations will be pre-processed with different kinds of IT and AI tools before a radiologist will get there for final analysis and reporting. Merging myriad imaging networks all over the world—both small and large—will give us unprecedented opportunities for handling and processing imaging data. We probably do not yet understand the full scale of these global changes which are going to completely change the landscape of our profession in the coming years. I entered radiology in the era of analogue, film-based radiology when nobody had heard of PCs and the internet, and I witnessed a real revolution when medical imaging was digitized. Now we are ready for the next big leap in imaging and I hope to see the outstanding results of such a metamorphosis pretty soon.

"the funding of radiology and radiologists and the organisation of imaging services in any country does not fit with the best scenarios"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

There are many objective and subjective obstacles to the further progress of imaging over the globe and in my country. But probably the most important one is a mismatch between the demand and supply; between the opportunities of modern imaging and its practical implementation. First of all, the funding of radiology and radiologists and the organisation of imaging services in any country does not fit with the best scenarios.

We know that modern radiology has a lot of fantastic opportunities. Their implementation may lead to better diagnoses and treatment of millions of patients resulting in better outcomes and prognoses. For example, in many cases, replacement of X-ray (*e.g.* chest and emergency cases) with low-dose high-speed CT would lead to a more timely and accurate diagnosis. There is a lot of scientific data proving it. But from organisational points of view, no country so far can afford to do such a transition.

The same applies to MRI. Demand for this type of diagnostic imaging is very high, and in many cases it could be a first-row examination, replacing US and X-ray. In my country (Russia), there is also a particular problem related to the creation and implementation of national imaging referral guidelines. Nevertheless, I hope that these problems will disappear or become less pressing in the coming years.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

To preserve our profession and make it even more important and visible for the benefit of our patients, radiologists must obtain more and more both radiological and clinical knowledge. We should foresee all global changes in contemporary medicine and be ready for them to stay at the forefront of progress.

DR KUBEN NAIDU

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The RSSA is the professional association of radiologists in both the public and private sectors in South Africa. We also have members from Zimbabwe, Namibia and Botswana.

"future radiologists will also be integrators of information. Radiologists should be taught the principles of data science, statistics and analytics"

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

The evolution of artificial intelligence (AI) will be the most important development sculpting change in the world of diagnostic imaging in the next decade. Poised on the cusp of the fifth industrial revolution, radiologists are uniquely positioned to actively fashion how the field will be transformed.

With the rapid change from analogue to digital radiology, we will witness the convergence of big data and AI. Radiology will transform from a subjective perceptual skill into an objective science. An increase in the armamentarium of quantitative tools will speed up our journey along the path of precision medicine.

Analytics will enable optimal utilisation of equipment and human resources including radiology technologists and radiologists. Our imaging equipment and PACS/RIS/HIS will incorporate AI programs, behaving in a much more intelligent and integrated manner. Smart patient scheduling will result in greater efficiencies. AI will facilitate enhanced, individualized and reproducible imaging protocols and decreased radiation doses. We will see improvement in the technical quality of examinations with more optimal image production.

AI-mediated relegation or exclusion of negative or normal studies from the radiologist's work list will result in significant reduction in workloads. This will be especially beneficial in resource-challenged environments where there are no or few radiologists.

AI-modulated triage will improve turnaround times for urgent cases and reports. Lesion detection and characterisation AI programs will improve diagnostic efficiency and diagnostic accuracy. Tedious and repetitive tasks will be performed by AI programs. Time saved may allow the radiologist to become more visible, spending more time interacting with patients and engaging with multi-disciplinary teams.

On the broadest level, AI, incorporating machine learning and deep learning has the potential to facilitate the realization of the global objective of increasing access to healthcare, improving the quality of patient care and improving health outcomes.

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

The most formidable obstacle to progress in imaging around the world is the scarcity and/or limitation of resources. This includes the availability of imaging equipment and infrastructure, radiology technologists, radiologists, and the interplay of these elements. Populations experience this around the world in disparate manners.

Many developing countries lack basic healthcare services including basic diagnostic radiology systems. Installation of basic imaging systems should include a foundation of X-ray and ultrasound equipment and should be primarily digital and incorporate a simple PACS so that they can be leveraged as future telemedicine units. There are scales of economy to be achieved with early digitization.

In countries with high Gini coefficients there is a maldistribution of resources due to the large divide between under-resourced and affluent communities. This results in divergent health outcomes. This is of particular concern in South Africa where redress is being attempted through introducing a universal health coverage system. South Africa has a combination of private and state provided health care systems. With the new National Health Insurance, the State will be a provider and purchaser of health care services, including radiology, utilizing resources in both the state and private sectors.

In more developed economies, the volume of radiology studies and number of images have increased exponentially over the past few years. The number of radiologists in these environments have not increased proportionally resulting in an increased work burden. Patients may experience longer wait periods for examinations, results may be delayed and accuracy may also be adversely affected due to radiologist fatigue or burnout.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

To ensure their evolution and continued relevance, radiologists will need to revisit their value proposition.

In the age of AI, that value will likely be the tangible expression of the human qualities of caring, empathy, compassion, ensuring ethical values and being advocates for the patient, guiding and empowering patients along their imaging journey.

Future radiologists will also be integrators of information. Radiologists should be taught the principles of data science, statistics and analytics. Clinical knowledge should also be augmented with an understanding of genomics and proteomics. Ultimately radiology reports will need to become more objective, integrative, simple and actionable.

DR PABLO VALDÉS SOLÍS

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SERAM is a scientific medical society assembling most Spanish radiologists, and has has numerous ties with the most prestigious international radiology societies. The main goal of SERAM is to promote, lead, and spread education and research in radiology and image-guided therapy. SERAM has more than 6,000 members.

WHAT DO YOU THINK THE SINGLE MOST POSITIVE DEVELOPMENT IN THE WORLD OF IMAGING WILL BE IN THE NEXT TEN YEARS?

Seeing the rapidity of advances in computing, the emergence of quantum computers, 5G networks *etc.* and how these advances are being applied directly to imaging techniques, it is difficult to predict what might happen within the next 10 years because it is likely that all predictions will fall short and evolution will be faster than we think.

Probably, the acquisition of images will not suffer revolutionary changes, and they will continue to use basically the same sources of energy and the same contrasts. With the new technologies, the machines will make acquisitions much more effective, and the doses will be lower. The MRI equipment will work with a much higher speed and will allow the creation of the so-called synthetic images thanks to the new optimized sequences and the way that the new technologies process the data.

However, we can expect a radical improvement in the handling of information, so that the amount of information handled will grow exponentially. Radiomics and AI tools will be common in our profession. And it is also expected that our profession will change significantly in the coming years. Although the changes will not be homogeneous, there will be centres where the image will be an information management centre, with personalized diagnoses and precision. The radiologist "information manager" will coexist with the radiologist "who takes care of the patient", in a highly attractive specialty that will be at the centre of diagnosis of disease. Of course, this is if we manage to adapt as professionals and lead these changes.

"the radiologist 'information manager' will coexist with the radiologist 'who takes care of the patient', in a highly attractive specialty that will be at the centre of diagnosis of disease"

WHAT IS THE BIGGEST OBSTACLE TO PROGRESS IN IMAGING AROUND THE WORLD, AND IN YOUR COUNTRY IN PARTICULAR?

We believe that in this section there are two different questions: on the one hand, the obstacles to the progress of radiology as a profession; on the other, the obstacles to the development of the image. In the first case, the development of the profession has a series of external and internal obstacles. The image is becoming more attractive, and almost all specialties are developing in imaging techniques. The cardiac image can be a very characteristic example, but not the only one. If we do not achieve a powerful development as a profession, these "turf wars" can be one of the great obstacles for radiology. Regarding the development of imaging techniques, it is probably the economic crisis and the increase in healthcare costs that will make it more difficult for the image to evolve as it should. In our country (Spain). We still feel the effects of the economic crisis that began in 2008 and that has caused technology in many centres to be obsolete, since there has not been a policy on equipment renewal. But the great improvement in imaging techniques that comes can also become a threat or an obstacle. The costs of care processes can be increased by requiring a more precise and personalized diagnosis each time. We can be the victims of our own success and that is why it is essential to define global strategies in the rational implementation of new imaging techniques in the health system.

WHAT DO IMAGING PROFESSIONALS NEED TO DO TO BEST PREPARE THEMSELVES FOR SUCCESS?

Radiologists have always been professionals with a great ability to adapt to new technologies. Now we are immersed, probably, in a revolution in which disruptive technologies will be implanted. In this context, we will need to understand the new technologies. And for that, there is no better way to understand them than to lead them. Radiologists have to learn not only the manifestations of the pathologies in the new techniques, but to be able to speak as equals with the engineers who program the machines. And, simultaneously, develop the concept of patient care and the clinical radiologist. Only if we get both (new skills and patient care) will we be leaders.

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