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The future of X-ray modality in Radiology

Opinion Paper

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Introduction

Since the 1970s, advances in CT and MRI technology have shifted the focus of diagnostic radiology towards cross-sectional imaging. Within this technological (r)evolution, conventional X-ray systems have not progressed as quickly.

However, the healthcare ecosystem in which X-ray operates is transforming drastically. The human population keeps both rising and aging: it is projected that by 2050, there will be close to 10 billion people globally, 1 in 5 of whom will be over the age of 60 [1,2]. The combination of these two trends is escalating the number of chronic diseases that must be managed. In turn, this is putting pressure on the traditional hospital activities of diagnosis and treatment. Shrinking workforces within the hospitals are further exacerbating the issue. Propelled by governmental policies and trends in lifestyle choices (personal health, for example), this is causing focus to swing from diagnosis and treatment (inside the hospital) towards screening and prevention (outside the hospital). This shift has been reinforced in the past three years by the COVID-19 pandemic, which strongly accelerated digitalization and required hospitals to focus more on acute care, while forcing non-acute cases to move to remote care.

X-ray as an affordable and accessible imaging exam will play an indispensable role in this new healthcare ecosystem. Since 2020, Agfa Radiology Solutions has assembled an advisory board that is composed of senior radiologists and technologists from seven different countries. Together, they are exploring the future role of X-ray as a diagnostic tool, and the potential strategies.

This opinion article discusses six key transformation areas the advisory board has determined to be crucial to the future of X-ray.

Empowering patients

For patients undergoing a radiology exam in the hospital, 'quality of care' is typically perceived in tangible (rather than intangible) parameters. For example, patients expect fast service, comfortable waiting rooms, friendly personnel, and a smooth and painless imaging exam as a high standard of care. On the other hand, they do not judge parameters such as image quality or a correct diagnosis as 'quality of care', because they entrust these to the healthcare professionals. At the same time, imaging exams are not a daily occurrence for most people. As with many other medical exams, they therefore often stimulate feelings of fear: of the unknown and/or of pain.

An important trend in healthcare is the move towards a patient-centric model, in which enhanced patient care and wellbeing drive the landscape. Part of this model is patient empowerment, including enabling patients to make their own choices. Throughout this paper, the advisory board foresees a shift in the healthcare landscape, towards patients eventually wanting to be responsible for their own healthcare decisions. The option for healthcare professionals, especially radiologists, is to support this shift and enable patient empowerment in order to build better relationships with their patients [3].

The key to such empowerment is for healthcare professionals to inform their patients. Only with correct and understandable information will patients feel confident and responsible for acting upon it. At the same time, providing such information to the patient will, in many ways, also comfort them. Several chapters below touch on artificial intelligence (AI) trends that can support the delivery of information to both patients and healthcare professionals, in a streamlined manner.

Patient empowerment

In the near future, the Metaverse may be able to take patients through a virtual imaging experience that will remove the 'unknown' aspect of a hospital visit, before it takes place. In a softer form, patients would be shown an interactive tutorial video in the waiting room. The easiest form of all would perhaps be a chatbot that answers simple questions and concerns, again setting the right expectations for the imaging exam.

Radiology reports can also be written in a way that allows the patient to understand the results. Patients must have a proper grasp of the imaging exam results to be able to act upon them. One of the many factors that make radiology images difficult to understand is a lack of anatomical knowledge. The X-ray modality can assist in this area, for example by including an anatomical image with the X-ray image.

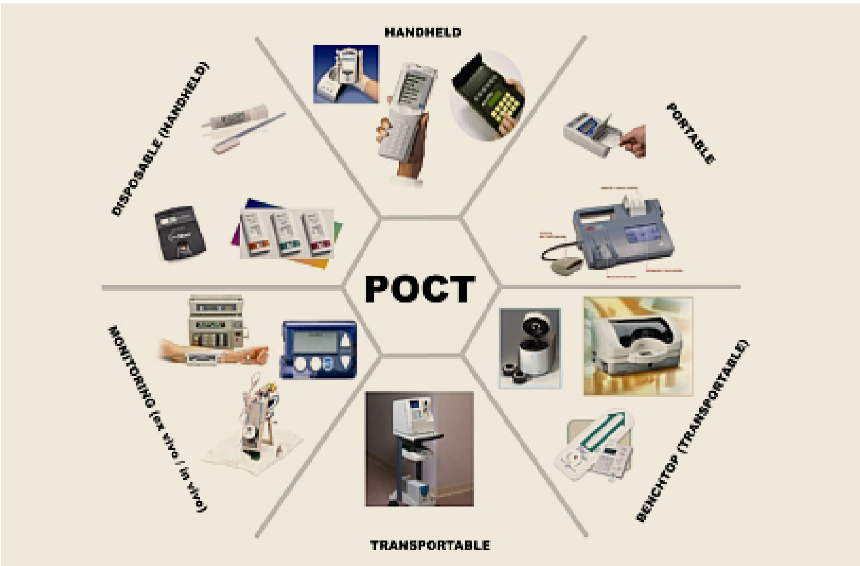
Another patient concern is about the harmful effects of radiation. One way to mitigate this is by including the administered radiation dose in the radiology report, together with an assessment of the potential health impact. Since this will be negligible in many cases, especially for X-ray, such information can reassure the patient and potentially reduce the fear for the next imaging exam. The chapter about augmented operators discusses more about the future role of medical imaging technologists and radiologists, with, in terms of patient-centricity, the patient as pilot, the technologist as co-pilot, and the radiologist as the navigator. Automating and standardizing the imaging protocol is key to empowering technologists to put their focus on optimizing the patient experience instead.

In each chapter, AI cannot be avoided, due to the large role it may play in the field of patient-centricity. As mentioned earlier, it is difficult for patients themselves to judge the quality of the images or the suggested diagnoses. AI can leverage strong empowerment here: it could lower the threshold to request a second opinion, for example, through uploading an image to an AI module for analysis. Another, similar idea is to take a picture of the medical image with a smartphone which then automatically analyses it using AI. This is an excellent example of how tools and evolving technologies will increasingly enrich the decision-making power of individuals. In the end, however, it will be up to the empowered patient to decide who and what to trust.

The growing role of point-of-care X-ray

The COVID-19 pandemic exposed the exceptional pressure placed on healthcare institutions around the world. With the high number of patients arriving daily in hospitals in early 2020, these institutions struggled with limited resources and funding for diagnosing and treating them all. Furthermore, the pandemic uncovered pitfalls in healthcare operations and the delivery of care to patients. Since then, the healthcare industry has been looking for ways to relieve the pressure on healthcare facilities by shifting to remote care where possible, and by implementing operational standards that benefit both patients and healthcare staff. One of these is by developing the point-of-care (POC) concept.

The goal of POC is simple: to provide diagnosis or treatment closer to the patient. This can be at the hospital, where care is given at the patient's bed, or at doctors' offices, nursing homes, sports centers or even patients' homes. Implementing this concept in radiology offers a variety of benefits for patients, their loved ones, the healthcare professionals, and the healthcare industry.



Source: BioSpectrum Bureau

The benefits of bringing imaging to the patient

- Bringing imaging to the patient decreases the risk factors of moving patients around the hospital. Patients who are immobile or too ill would not need to be transported to imaging suites. Patient safety in the hospital would be improved by the lower infection risk, while the staff handling patient transport would save time, allowing them to focus on the patient examinations.
- Implementing AI algorithms on an X-ray device will help reduce imaging time and decrease corrections made by operators, resulting in fewer retakes.
- Real-time results lead to quick diagnoses and, ultimately, treatment, which can bolster patient satisfaction. They also speed up triage for patients in emergency departments, and reduce the time under anesthesia for patients in the OR, for both imaging procedures and surgery.
- POC imaging also enables imaging to be carried out successfully outside the hospital.

How can the POC strategy be applied for radiology equipment, and specifically for X-rays? X-ray machines have evolved in recent history from stationary systems, to include mobile systems that can be brought directly to the patient's bedside. In some cases, mobile X-ray units have been brought to patients' homes, especially during the pandemic. Studies have shown that image acquisition using mobile X-ray equipment can be safely performed at patients' homes or nursing homes, without compromising safety and image quality [4,5]. X-ray equipment technology has been slowly evolving to provide less-bulky solutions that enable more healthcare givers to acquire images outside the hospitals.

Other types of radiology equipment have pushed the boundaries of design, as companies have developed systems for use in patients' homes, which take into account the human factor. One example is handheld ultrasound machines [6], which are designed to acquire an ultrasound image with the same quality through self-scanning (by an adult) as from an expert scanner. Just like these ultrasound devices, X-ray units have the potential to be portable, compact, and easy to use, with AI enablement and a miniaturized form factor, i.e., wearable technology.

Can X-ray devices be completely operated by patients without endangering them through unnecessary radiation exposure, and enable easy positioning without compromising image quality? In this advisory board's opinion, without the proper understanding and industry advances, the responsibility for image acquisition will lie with the clinicians and not with patients. Hence, we may not be able to fully disengage radiological expertise from the X-ray imaging chain, to empower patients to take full responsibility for their health screening and tests. It is, however, not impossible that eventually, with technological advancements, global regulations and standards may mature enough to empower patients to take responsibility for their health.

Progressing technology beyond X-ray photography

Within the continuum of medical imaging, plain X-ray today primarily fulfills the role of a cheap and accessible first-line exam. In many cases, an X-ray lacks diagnostic power. It allows an initial assessment, but often requires referral to more advanced imaging modalities such as CT and MRI. Looking back over the last decade, technological innovation has accelerated much more in other imaging modalities than it has in X-ray. Therefore, we believe that there is an opportunity now for X-ray to move beyond simple 'X-ray photography', and to redefine its role in clinical practice. This chapter describes the main technological transformation areas for X-ray that we foresee in the years to come.

Improving access to imaging and patient satisfaction, while realizing efficiency gains

Field emission sources, such as cold cathode tubes (to give one example), are finding their way into commercial products. These next generation sources are the cornerstone to building very compact, lightweight, and agile devices that increase access to imaging and enhance patient comfort. An important limitation of field emission sources is that, typically, the maximum power output is smaller than that of rotating anode sources. Future development might be able to overcome this, but nevertheless we are convinced that field emission sources will find their way into clinical practice, at first as a complement to today's X-ray units.

One step beyond compact mobile devices are 'ultraportable' devices, such as handheld X-ray devices. Beginning to become commercially available as well, ultraportable devices allow imaging outside the hospital and at the point of care, for example in ambulances, nursing homes, sports fields, personal homes, primary care practices, etc. This, again, increases access to imaging, but also enables earlier and better decision-making, unlocking the potential for more accurate screening. However, it should be noted that ultraportable imaging will be a complement to mobile imaging inside the hospital, since the latter requires standardization and higher quality standards.

A similar trend has developed in ultrasound imaging, moving from mobile to compact to ultraportable. In addition to the concerns regarding radiation safety, we see two additional challenges: who will be operating the device outside the hospital, and who will read the images? AI has a big role to play in both: we can think of it as guiding the operator through the workflow, and then analyzing the acquired images afterwards. By extension, teleradiology and even teleradiography can offer solutions.

Ultimately, we could imagine a fully automated 'X-ray imaging booth' that produces an X-ray image and analysis, without any operator intervention. While this sounds futuristic, it may in fact not be so far away as we think.

Enhanced pathology visualization to enable improved patient outcomes

The first group of technologies centers around novel X-ray sources and detector technologies. One important trend in CT is the move towards spectral imaging, enabling clear tissue discrimination and even color mapping. Spectral flat-panel detectors (for example, dual-layered detectors) and kV-switching tubes also enable this technology for plain X-ray imaging. Typical applications of spectral X-ray are related to the chest, such as rib suppression or lung nodule detection. The move to photon-counting detectors can fully unlock the potential of spectral X-ray. However, the cost does not yet allow scaling for flat-panel detectors.

Next, we expect that new contrast mechanisms and agents will enable X-ray to visualize new pathologies. Phase contrast imaging (PCI) converts phase variations in the X-rays emerging from the object into intensity variations at the detector. The technology is currently being proven in clinical studies, but the applications are promising. PCI could make it possible to detect chronic obstructive pulmonary disease (COPD), measure differences in bone density for osteoporosis, and maybe even reveal bone tumors.

Finally, digital tomosynthesis (DT), sometimes referred to as '2.5D imaging', is a low-dose imaging technique that reconstructs 3D images from 2D radiographs. Already frequently applied in mammography, there are a number of use cases in general radiography as well. From subtle fracture detection to pneumothorax identification, the depth of information from DT makes it possible to see more than on a plain X-ray, thus reducing missed cases. Thinking ahead, there is a lot of potential in combining DT with compact mobile devices. Bringing 2.5D imaging to the patient's bedside could reduce both the number of CT scans and patient transports, generating a significant cost savings and efficiency gain.

AI: from decision support to improvement of overall population health

Today, the diagnostic value of X-ray images is still limited; additional examinations are often needed to reach a definitive diagnosis. Thanks to its powerful processing, AI can analyze data coming from a range of medical investigation sources (including X-ray imaging): for example, correlating information from different medical imaging modalities to clinical reports, lab results, etc. Combining all of the information can enable a more accurate global diagnosis, including information about underlying conditions that might otherwise be difficult to associate, or that could be easily missed. This can lead to early detection, consistent patient follow-up, and personalized treatments, which inherently have a big impact on the overall population health.

AI could therefore transition from decision support to preventive/predictive medicine, if the algorithm is able to learn which conditions can lead to a pathology or are more likely to deteriorate, or if it could predict how the patient will react to certain treatments. A particularly important step for AI in radiology towards preventive/predictive medicine is consistent image quantification. This would have a lot of value in pathologies where regular patient follow-up is required, and it is possible to build up knowledge on the progression of the disease. Simple detection (likelihood of the presence) of a pathology without correlation has little value, so a standard needs to be established to objectively identify whether the condition is improving or deteriorating. For instance, an AI algorithm could ideally quantify the pathology (clinical + imaging parameters) and predict outcome, mortality, referral to ICU, long-term effects, etc. Although this is a very challenging multidisciplinary task, (which will need an immense amount of data, and many years to be implemented and validated), without it, full clinical adoption might remain limited.

Adoption of AI algorithms in clinical practice

Despite of the well-known advantages of using AI algorithms in clinical practice, their integration has been very slow, hindered by:

- The high cost for a limited clinical benefit. Furthermore, the payers are not always the benefiters, which creates a conflict of economic interest for implementation [7]. New reimbursement and payment models could overcome this issue [8-10].
- Lack of solid clinical evidence and/or only studies performed in all types of populations are jeopardizing the credibility of the clinical claims of AI companies [11].
- Although most algorithms claim a time-savings benefit, they are actually increasing radiologists' workloads, with extra images and data to analyze. This is because most algorithms perform only one radiology task, meaning that many algorithms are needed to perform a full radiology workflow [12].
- There is not a clear driver for AI integration. If it is left up to the radiologists alone, it will take a very long time. Patients and industry should take the lead: patients as the data owners, with industry providing the technological push. Furthermore, this integration should be led and supervised at a national healthcare level, supporting the determination of which algorithms are safe to use and eligible for clinical use.
- The AI industry landscape is very scattered. There are a lot of smaller players, which makes it difficult for end-users to make the right choice. Consolidation is required to simplify this decision in the near future.

Augmented operators

Unlike in the case of most other imaging modalities, little has changed in the way of working with X-ray imaging equipment for over a century. X-ray imaging is still one of the most difficult modalities to operate to obtain an image of optimal quality. The relative technical complexity combined with ever-increasing work volumes and the workforce shortages (both of radiologists and technologists), is putting the quality and sustainability of radiology departments at risk. Hence, a 'supervised' automation of radiology tasks is needed to improve the quality of care, without neglecting the inherent human side of patient care.

In the current radiology practice, there is still room for improvement in image acquisition and image interpretation. Such improvement can be supported by AI in terms of standardizing image acquisition, performing automatic quality control, and enhancing the diagnostic value of X-ray imaging reports. Combined with Continuous Quality Improvement (CQI) frameworks or Plan-Do-Study-Acts (PDSA), this can improve quality and reduce costs for radiology departments, while making use of the principle that the "people performing the work will best understand the problems".

The changing role of the medical imaging technologist

AI can potentially aid the medical imaging technologist to improve the quality and efficiency of X-ray image acquisition, by automating the correct patient selection, recognizing the right body part, pre-selecting the most optimal dose settings for the patient, and guiding both patient and system positioning. Afterwards, an automatic image quality assessment can determine if the image is of diagnostic value before the patient leaves the radiology ward (enabling a fast retake if needed) and guide the user about what to improve to get a more optimal image. Moreover, robotization can help with time-consuming tasks such as automatic sanitization of equipment between patients, or equipment self-charging or self-relocation.

This will not only liberate technologists from redundant tasks but will also decrease operational costs related to time efficiency and increase patient safety. This could translate into two future roles for technologists:

- More/different responsibilities: more time to focus on more complex exams, or even to take over some of the responsibilities of the radiologist, with the support of AI;
- Operators with less training can join the radiology workforce and focus on the patient's care, for a better overall experience, while the system supports optimal image acquisition.

The changing role of the radiologist

Despite the use of supporting technology, the radiologist must remain at the center of the entire image chain process. A shift in the radiologist's traditional role will bring them closer to patients and to other specialists, in order to achieve a better patient outcome. Radiologists can become more involved not only in the diagnostic process, but also in treatment and the design of follow-up studies. AI can support the radiologists to achieve greater diagnostic confidence, and to prioritize and reduce their workloads, by flagging normal, abnormal, and urgent findings. By allowing the radiologists to work more efficiently, this will free up their time to focus on other clinical interactions.

Furthermore, as the knowledge owners, with accountability for the ported clinical outcomes, the radiologists should be co-drivers of the technological innovations, together with the tech companies, rather than simple spectators.

Influence of the medical technology industry to facilitate the AI adoption

The medical technology industry spearheads efforts to make these changing roles a reality. They are the leaders (in conjunction with the medical staff) in establishing image acquisition standards while ensuring there is enough freedom at the system level to enable consistent and simple use. Furthermore, they play a crucial role in facilitating AI adoption in clinical practice: by training and educating the imaging staff, and also by raising awareness of the advantages of these new technologies to patients, healthcare systems and other specialists.

Low-cost X-ray equipment for developing countries

Although X-ray is one of the oldest imaging techniques used, it still accounts for the largest number of medical images taken around the world. This is partly due to its affordability, especially compared to other imaging modalities. With the digital age advancing faster than expected, the use of film X-ray imaging is dwindling, as it is replaced by digital X-ray. However, this advancement comes at a higher cost to healthcare institutions, especially those with a lower socio-economic status.

The digital age was meant to increase accessibility without driving costs and expenses to a level that excludes the masses. However, this ideal has not been achieved, due to a competitive industry landscape in which companies push over-engineered innovations for competitive advantage, which ultimately leads to increased price tags and higher maintenance fees. According to the World Health Organization (WHO), around 2/3 of the world's population lacks access to diagnostic X-ray imaging, even though radiology is essential for key medical care [13]. On the other hand, consumers in developed nations are driven towards the latest technology, hoping that it can elevate patient care and enhance care efficiency. As a result, many hospitals in developing nations rely on donations of used equipment that has often reached the end of its expected lifetime. Additionally, donated equipment rarely includes installation and follow-up services.

If we look at the varied socio-economic conditions around the world, we see that there is still a lot of untapped potential for both the medical industry and consumers to benefit from simple and affordable X-ray equipment. This is important in order to maintain or provide even better care, that is accessible to more patients. A simplistic design does not need to compromise on engineering advancements in order to deliver an affordable, digital, portable X-ray machine that can answer the needs of different regions.

The minimum features for a simple X-ray machine should not compromise on performance and patient safety, yet must be universally applicable, regardless of the patient's location: such as in a city versus a remote area. An all-in-one design should include the basic X-ray components, including X-ray tubes and image receptors, plus AI functionalities, digital consoles for direct viewing, built-in image storage, and cordless functionality. And it should support novice operators to acquire images using built-to-last devices.

Considerations for the medical device industry

- Develop creative business models that range from a low-cost basic solution to a more premium model, depending on the spending power of the healthcare institution.
- Offer a long-term maintenance contract that may relieve the capital expenditure budget constraints for healthcare institutions and ensure the cost of ownership is pushed towards operational budgets.

Conclusion

X-ray examinations still constitute between 40% to 70% of a typical radiology department's activity. Radiologists should be encouraged to think about the future development of diagnostic X-ray, as a reliable and low-cost imaging alternative that provides standardised, quantifiable and high-quality images. Industry should support this development, while maintaining the need for diagnostic accuracy, reproducibility, efficiency of workflow and cost-benefit balance.

About the authors

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Paul Parizel is a board-certified radiologist and neuroradiologist, and completed fellowships in neuroradiology at Massachusetts General Hospital, Harvard Medical School, and Hôpital Erasme, University of Brussels. He was a professor and chair of the Dept of Radiology at Antwerp University Hospital and a member of the Board of Trustees, representing the Faculty of Medicine and Health Sciences.

Since 2019, Prof. Parizel works as the "David Hartley Chair or Radiology", with an academic appointment at University of Western Australia (UWA) and part-time clinical appointment at Royal Perth Hospital (RPH) in Perth, Western Australia. He is currently the Chair of Clinical Radiology Research Committee (CRRC) of the Royal Australia & New Zealand College of Radiology and as Director of Western Australian Imaging Facility node of the National Imaging Facility.

Prof. Parizel has an h-index of 49, has authored or co-authored over 400 peer-reviewed scientific papers, more than 40 book chapters and has edited or co-edited several textbooks.

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Through 24 years as an NHS consultant radiologist, Nicholas Spencer has played a leading role in the development and delivery of a large multi-site radiology service at the Mid Yorkshire Hospitals. He has specialist clinical skills in Head & Neck and MSK Radiology, working as a core member of a regional specialist H&N Cancer MDT team for 18 years. In these roles, he has gained experience in department design and commissioning, equipment procurement and led a number of Radiology and other IT projects.

Nick has served the Royal College of Radiologists as an elected member on its Service Review Committee (2010-) and Radiology Faculty Board (2013-6). He is current president of UKIO, the UK's largest Radiology and Clinical oncology conference, which has moved online for 2020. He has experience as medical director at Medical Imaging Partnership, an innovative accredited UK radiology service provider (2010-17).

He is an honorary Senior Lecturer at the University of Bradford, and external examiner at CanterburyChrist Church University, working to develop and evaluate radiographers in post-graduate environment.

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Johan de Mey is head of the radiology department of the Free University of Brussels. He is also an academic university professor teaching about pathologic radiology and emergency radiology. His clinical expertise domain is interventional vascular and non-vascular radiology.

He graduated as MD in 1987 at the Vrije Universiteit Brussel (VUB) and was resident in radiology until 1991. In 2005 he graduated as PhD with a thesis titled: CT-fluoroscopy in interventional radiology. He is head of the department of radiology at the UZ Brussel since 2005. The research in the department of radiology at the Brussels University hospital is covering all radiology topics with a focus on new technology.
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She is Team Leader (chest radiology) for the written evaluation committee of the European Diploma in Radiology. She was organizer and presenter of the Junior Image Interpretation Quiz at the European Congress of Radiology (Vienna, 2017). That same year, she participated as Expert in a mission to Koror, Palau with the International Atomic Energy Agency.

Bernard Lepoutre, MD
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Bernard Lepoutre is a radiologist with a medical degree from the University of Leuven, Belgium. After one year of Internship in internal medicine, he started his formation as radiologist at the University Hospitals Leuven (Prof AL Baert), with two years of formation in Luxembourg (Prof RF Dondelinger). In 1993, he started working in Eeuwfeestkliniek, a private hospital in Antwerp, where he became head of department after one year. As of the year 2000 Eeuwfeestkliniek Antwerpen merged with Onze Lieve Vrouw Ziekenhuis Deurne to become AZ MONICA. He is head of department since January 2020.
Throughout his career, he had a broad interest in all major fields of radiology, especially in interventional radiology. He has abandoned vascular interventions but is still the leading radiologist in all non vascular interventions in his department except breast interventions.

In January 2020, he joined Agfa Radiology Solutions as CMO.

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Rajiv (Raj) Gupta is an Associate Radiologist in the Neuro and Emergency Radiology Divisions at the Massachusetts General Hospital, an Associate Professor of Radiology at the Harvard Medical School, and a Lecturer in Mechanical Engineering at MIT. He earned his MD at the Cornell University, his PhD in Computer Science at the State University of New York at Stony Brook, MSc Honors (Physics) and BE Honors (Electrical Engineering) from the Birla Institute of Technology and Science, Pilani India. In addition to serving as the Site Miner for the MGH Consortia for Integrating Medicine and Innovative Technology (CIMIT), he directs the Advanced X-ray Imaging Sciences (AXIS) Center at MGH.

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Bhavin Jankharia, MD
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Bhavin Jankharia is a consultant radiologist with almost 25 years of experience and a trustee for the Radiology Education Foundation. His subspecialty interests are in chest, musculoskeletal and cardiac radiology and image-guided intervention. He also has keen interest in the business radiology and healthcare.

Dr. Jankharia was a former president of the Indian Radiological and Imaging Association as well as Editor-in-Chief of the prestigious Indian Journal of Radiology & Imaging. He is currently the President for Indian Musculoskeletal Oncology Society (IMSOS).

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In 2019 Dr. Frauenfelder was appointed as Associate Professor ad Personam for Thoracic Radiology in the Institute for Diagnostic and Interventional Radiology. Since August 2022 he is the director and full professor at the Institute of Diagnostic and Interventional Radiology, University Hospital Zurich, a position he has held since August 2022.

Dr. Frauenfelder did his radiological residency at the University Hospital Zurich and completed it in 2005. During this time, he also worked as a research fellow at the NCCR Co-Me (Computer Aided and Image Guided Medical Interventions) at the ETH, where he investigated the human blood flow using CFD. Since 2011 he is deputy director and operational leader of the institute and was till 2021 member of the department for imaging. His continued education includes the European Diploma of Thoracic Imaging in 2019 and the “MAS in Managed Health Care” ZFH from 2006 to 2008 at the School of Management and Law, Zürcher Hochschule Winterthur.

Thomas Frauenfelder represents the thoracic radiology scientifically, clinically and in teaching both inside and outside the USZ. He is also an active member of the Executive Board of the European Society for Thoracic Radiology.

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Guillaume Gorincour is a pediatric and prenatal radiologist. Graduated from Marseille Medical School in 1999 where he was appointed Professor in September 2013, after residency in Marseille and Lyon and fellowship in Montreal in 2003.
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Currently, Fareena is a Quality Assurance and Regulatory Affairs Specialist a Agfa Radiology Solutions as well as a core member of the Radiology Advisory Board committee.

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Daan Belmans holds a MSc degree in biomedical engineering from the Catholic University of Leuven, and a post-graduate degree in corporate finance. He has 5 years of experience in research and development of medical X-ray equipment, both hardware and software.

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Jeroen Cant holds a MSc degree in Electrical Engineering from the Catholic University of Leuven, and a PhD in Physics from the University of Antwerp. He has 20 years of experience in research and development for advanced clinical applications in X-ray, CT, MRI and PET imaging.

Currently, Jeroen is heading the Image Processing Research Team at Agfa Radiology Solutions. His research interests are in applying computer science and mathematics to solve real world clinical problems in medical imaging.

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Alejandra Ortega is a doctor in biomedical sciences from KU Leuven, Belgium. Her expertise focuses on medical imaging including different modalities such as X-ray, ultrasound, MRI and 3D digital stereophotogrammetry. Her passion is to find engineering solutions to medical problems.

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