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## Teaching radiologists machine learning - AI



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Radiology is being transformed by the exponential growth of machine learning and continuously emerging technologies like deep learning, part of the artificial intelligence (AI) revolution in the imaging field. Medical imaging and operations applications are transformed as new methods and algorithms are introduced into radiology's daily practice. Beyond the benefits of embracing these emerging technologies, however, radiologists and imaging experts do not yet have a working understanding both of the benefit and the limitations of machine learning to be able to harness its full potential and integrate it effectively into their clinical workflow.

As machine learning and artificial intelligence are rapidly taking radiology by storm, there is no established curriculum for educating the new generation of radiologists on how to interact with these new technologies, leaving them unprepared to safely and effectively benefit from using these tools.

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Cutting edge technologies are being rolled out and implemented in hospitals around the world, yet most radiologists have not been trained or fully understand how to use them. In an article published in the Journal of the American College of Radiology (JACR), the authors highlight the need to create a machine learning curriculum for radiologists.

Traditionally radiology has been one of the more technologically intensive medical specialties. In the article the authors propose that many significant radiology organisations, like the [Radiological Society of North America's \(RSNA\) Radiology Informatics Committee](#), the [Society for Imaging Informatics in Medicine's](#) Machine Intelligence in Medical Imaging Online Group, and the [American College of Radiology's Data Science Institute](#) are in the position to help to create a commonly agreed upon curriculum among the nation's leading radiologists and imaging scientists to provide teaching and training material that can meet the growing needs of this constantly expanding field.

Any agreed upon and proposed curriculum, the article argues, should then be vetted by the [American Board of Radiology](#) (ABR), the [Association of Program Directors in Radiology](#), the [ACGME's Residency Review Committee](#), and other relevant groups so that basic command of machine learning principles may become part of all radiology residents' core competencies.

These interpretive and non-interpretive skills should be appropriately assessed via standardised evaluations, such as the ABR Core Examination, to ensure participants receive a fundamental understanding of the subject matter, which is necessary as these technologies continue to be incorporated into hospital daily practice. In addition, all machine learning educational programs must include aspects for both trainees and attending physicians, and therefore accredited CME material should also be developed to ensure practicing radiologists stay in touch with the rapidly developing technologies.

It will require very careful planning to deploy an effective educational strategy as implementing a standardised and vigorous curriculum at every teaching institution will have many challenges. Programs will probably have faculty who are not knowledgeable in machine learning and new technologies and may lack the resources to organise formal training opportunities.

To help overcome many hurdles, the use of online based interactive sessions that are accessible to all learners could be created, similar to existing online informatics courses, such as the National Imaging Informatics Curriculum and Course, which was born from a partnership between the [RSNA](#) and Society for Imaging Informatics in Medicine.

A major challenge that remains in implementing a machine learning curriculum in radiology residency programs is that the technology is rapidly evolving, as is the nature of the technologies field, which will hit a wall with the regulatory, economic, and medicolegal issues affecting the implementation of machine learning tools in the clinical setting.

These new technologies still require considerable research and development; therefore, any proposed technology inclusive curriculum has to be adaptable to continuously be updated to reflect new knowledge, discoveries, breakthroughs and policy changes. A national network of mentors could also be established to allow exposure to these opportunities to trainees across the country, as there is limited know-how currently.

The application of artificial intelligence through the use of machine learning and deep learning methods has undeniably created exponential potential for radiology. Radiologists are now moving beyond the fear and skepticism initially surrounding machine learning technology and embrace how emerging technologies will bring the radiologist at the center of the patient care continuum. With the continued development and implementation of machine learning tools, future radiologists must be ready and equipped with knowledge of this technology in order to have the power to implement these tools as they develop.

If they are to advance the standard quality of patient care and realise the benefits of these emerging technologies, radiologists will not only need to implement them in clinical practice but be an active part in the development and clinical application of machine learning models to make sure critical challenges in their profession are addressed.

As radiologists understand the creation of medical images as the basis for interpretation, they too need to learn how understanding algorithms is fundamental for machine learning in radiology clinical practice. There is currently no standard by which radiologists are expected to understand the process of machine learning models even though the technology has started to be deployed in clinical practice. For radiologists to be able to use machine learning models safely and effectively to interpret images they need to be provided education at all levels regardless of their background and experience. A comprehensive machine learning curriculum designed for early career radiologists and trainees is “urgently needed”, as the authors state.

The machine learning curriculum should include all the stages of the technology development and its use in clinical practice including the process of data collection, the algorithm selection, how the model is developed and trained, how it is validated and assessed, what are the requirements for clinical translation, how to interpret performance metrics and the model output and how to identify the modes that fail.

Similar to how radiologists use their knowledge of the process by which an image is created to identify, interpret and account for imaging artifacts, they now must obtain the ability to evaluate algorithms values and recognise potential drawbacks if they are to determine the validity and clinical application of their predictions. A working knowledge of machine learning concepts is imperative for radiologists using machine learning tools to enhance image interpretation and other operations along the imaging chain such as image examination, image acquisition protocols and reporting.

Deep neural networks, the standard for recent imaging applications are not intuitive, because these networks may use millions of parameters and hundreds of layers it is often not feasible to determine the contributing factor when a model fails. They can also be misleading which presents a challenge when radiologists need to rely upon them in clinical practice.

A machine learning model while can be successful in identifying a challenging imaging finding may also immediately misdiagnose a very simple case. Although deep neural networks have presented high levels of accuracy in the [ImageNet](#) competition distinguishing between highly similar species of animals, they also have been misled by adversarial noise that is imperceptible to the human eye.

It is of critical importance that radiologists learn to appropriately leverage a model's output, to have the experience to critically evaluate all the findings without becoming complacent and blindly accepting predictions produced by algorithms.

Even at the early stage of their career as trainees, radiologists have a detailed understanding of the clinical questions and processes relevant to patient care and how the radiology department operates. Unfortunately, most engineers and information technology scientists developing machine learning solutions know little to nothing about the actual practice of radiology and medicine.

This is why it is critical that radiologists be an integral part of the process of developing and translating an algorithm. Radiologists will eventually be the ones using machine learning methods in their daily practice and the output of these models must be clinically relevant and function in real world scenarios as well as provide easy access within the clinical workflow.

In order for machine learning predictions to be valid and applicable in patient care, radiologists must be active partners in the development of the technology, providing the data scientists with the clinical context, how to frame the imaging questions, curating the data sets, ensuring the seamless application in reading rooms and always monitor and validate the algorithm performance.

The cross-collaboration of multidisciplinary stakeholders: data science experts, software engineers, referring clinicians and even patients is the only way to successfully implement and realise the full potential of machine learning in radiology. It also falls upon radiologists to be prepared to deal with the ethical, regulatory, legal and financial issues that will result as this technology further integrates into the healthcare continuum.

Radiologists must be educated and trained in at least the basic understanding of the machine learning algorithm creation process. Ultimately, it is the radiologists who need to marry their clinical expertise and knowledge with the tools machine learning methods provide to be able to use the technology to maximise the benefits for their patients.

This need to provide education to radiologists in new technologies will in turn become an opportunity for radiology trainees to be a part of both academic work and innovative projects in their field, essentially shaping the future and the landscape of their profession.

Sources: [Journal of the American College of Radiology](#) (JACR)

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