**EDITORIAL COMMENT**

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# Artificial intelligence in radiology: who's afraid of the big bad wolf?

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## Abstract
This Editorial comment refers to the article "Medical students' attitude towards artificial intelligence: a multicenter survey," Pinto Dos Santos D, et al Eur Radiol 2018.
### Key Points
• *Medical students are not well informed of the potential consequences of AI in radiology.*
• *The fundamental principles of AI—as well as its application in medicine—must be taught in medical schools.*
• *The radiologist specialty must actively reflect on how to validate, approve, and integrate AI algorithms into our clinical practices.*

**Keywords** Diagnostic imaging · Education · Medical · Artificial intelligence (AI) · Machine learning

**Abbreviations**
AI   Artificial intelligence
DL   Deep learning

Artificial intelligence (AI) is everywhere these days. AI, and in particular deep learning (DL), has recently demonstrated impressive results on large datasets in various domains. The health sector, rich in information and complex processes as well as repetitive intellectual tasks, will be one of the first to be affected [1]. Medical applications have already resulted in a strong push for the use of DL algorithms for medical image analysis. The success of deep learning methods for automated image analysis in areas such as facial recognition or automatic object detection have put medical imaging at the forefront of AI applications in health. Already, algorithms offer performance comparable to that of the best specialists for the detection of small cancers on mammography [2], the classification of skin lesions for detection of malignant melanoma [3], or the analysis of the retinal fundoscopy for early diagnosis of diabetic retinopathy [4]. The thought leaders of artificial intelligence have well understood this, repeating to the world's media that deep learning will do better than radiologists in 5 years and medical School "should stop training radiologists now" [5]. The symbolism is strong and goes far beyond the medical world: here is a highly qualified and often highly paid profession that will be replaced by machines! Whether it is a prophecy or a provocation, the message resonates.

The study by Pinto Dos Santos D, et al [6] seeks to evaluate the understanding and attitude of German medical students towards artificial intelligence in the field of medicine in general and radiology in particular. This is a very timely topic and the survey is well designed. Beyond its immediate results, this study raises deeper questions that are difficult to answer: How will the future doctors feel about the role of AI in the medical world of tomorrow? Is it just a matter of time before artificial intelligence replaces us? And finally, because so much of the role of diagnostic radiology concerns image analysis—an approachable task for DL—could radiology not be the symbol of major changes to come in the world of healthcare, akin to a

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canary in a coal mine, and serve of an advanced warning of greater dangers to come?

This study demonstrates that medical students believe that AI will revolutionize radiology and medicine in general. Overall, they think that this revolution will contribute to improving the quality of patient care. To the question "These developments make radiology more exciting for me", only 30% of respondents agree, with 70% of them disagreeing. Although the authors did not directly ask medical students in their survey if they would be less likely to choose a career in radiology because of AI, the above question indirectly suggest this. This is confirmed by another recent publication by Gong et al [7] that performed a similar survey in all 17 Canadian Medical Schools. This survey was more directly focused on the future of radiology in the eyes of medical students. The authors found that 67% of Canadian medical students agreed that AI would reduce the demand for radiology while 48% are anxious for the future of the radiology specialty.

Herman Melville writes in *Moby Dick*: "Ignorance is the parent of fear." What emerges from the survey by Pinto Dos Santos D, et al [6] is the overall low level of information of medical students about AI. Only 50% of the medical students were aware that AI is a hot topic in radiology and less than one third of respondents stated that they had basic knowledge of the underlying AI technologies. Students also pointed out that their information came more from the media than from university teaching. Moreover, the students who were the most informed were also those who were the least afraid of this new technology. This indicates that there is a lot of room for teaching undergraduate students the fundamental principles of AI [8]. Yet fresher thinking is needed about how AI will be practically used in radiology. The reality is that AI technology will transform the radiology profession in a way that deserves to be better understood and taught at medical school. As demonstrated in the Canadian survey, medical students are not so much afraid of the replacement of radiologists, but rather of a "displacement' with many tasks that could be replaced by machines and lead to a potential reduction of demand for radiologists [7]. Because these algorithms are by their nature standardized, repeatable, and scalable, they could be deployed to analyze a large number of images in hospitals around the world once an algorithm has been developed and validated, enabling radiologists to focus on other aspects of their practice. It is necessary for radiologists to learn to use this new technology to improve the management of our patients. AI will most certainly replace some of the tasks that radiologists do today and help us to be more accurate in other tasks.

Multiple questions are still unanswered: How will operations, insurance, funding, and business models be impacted with the arrival of this new technology? How can we improve the care provided to our patients while preserving the long-term integrity of our profession? How will we be able to rid ourselves of repetitive, boring, and thankless tasks—such as the detection of metastases and their longitudinal follow-up—to concentrate on actions requiring the integration of complex clinical and radiological data best suited for human intuition and insight?

One of the difficulties of this change is the rapidity of technological developments. On the one hand, algorithms are becoming more efficient and more effective every day, and on the other hand, healthcare systems are becoming more complex and the evaluation of the true impact of new technologies is extremely difficult to measure. This is a paradox that our colleagues who perform research in AI sometimes have difficulty understanding: just because a technology seems to perform well in a particular population does not mean that its practical implementation in a healthcare system will have a positive impact on patient care.

Many believe that AI will destroy jobs and destabilize institutional balances that have taken years to establish and we must protect our profession and personal data to contain and limit the impact of these new technologies. But the opposite argument could easily be made that, indeed, we have a moral obligation to use and promote AI tools that will improve the performance of radiologists and accelerate decision-making processes while limiting the cost of imaging examinations. It is our responsibility—with the help of regulators—to define a strong and rigorous assessment process that is required if we want these new tools to truly improve the quality of care. It is not only a question—as has too often been done in the past—of showing the performance of a test, but rather of formulating precise hypotheses and defining the populations to which tools can be appropriately applied, with strong tests of robustness in other populations and other health systems; evaluating how AI tools will change medical decision-making and patient management when implanted in a care process; to document effectiveness on patient outcomes from a clinical point of view and, finally, to ensure the post-approval monitoring of performance, as we so commonly do for drugs in the pharmacovigilance process [9]. With these precautions in place, no one should be afraid of the impact of AI in medicine, including the impact on the profession of radiologists, which will be major, with no doubt.

## Compliance with ethical standards

**Ethical approval** Institutional review board approval was not required because this is an editorial comment and no study was performed.

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