ORIGINAL ARTICLE

Artificial Intelligence: Threat or Boon to Radiologists?

Michael Recht, MD[a], *R. Nick Bryan, MD, PhD*[b]

Abstract

The development and integration of machine learning/artificial intelligence into routine clinical practice will significantly alter the current practice of radiology. Changes in reimbursement and practice patterns will also continue to affect radiology. But rather than being a significant threat to radiologists, we believe these changes, particularly machine learning/artificial intelligence, will be a boon to radiologists by increasing their value, efficiency, accuracy, and personal satisfaction.

Key Words: Machine learning, computer-assisted diagnosis/detection, value, efficiency, artificial intelligence

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Several recent articles have warned that machine learning (ML) or artificial intelligence is a significant threat to radiologists and radiology as a specialty [1,2]. In addition, two other significant threats, the move of patient care out of hospitals to outpatient locations and the changing methods of reimbursement, have also been identified. We agree that these trends, particularly ML and artificial intelligence, will lead to significant changes for radiology and how radiologists will practice. However, rather than leading to the diminished significance and value of radiologists, we believe that radiologists and radiology will continue to thrive. In fact, we believe that ML and artificial intelligence will enhance both the value and the professional satisfaction of radiologists by allowing us to spend more time performing functions that add value and influence patient care and less time doing rote tasks that we neither enjoy nor perform as well as machines. We address each of the identified threats in the following text.

DEINSTITUTIONALIZATION OF HEALTH CARE

As detailed by Chockley and Emanuel [1], patient care is moving out of hospitals and into outpatient settings such as ambulatory surgical centers, outpatient imaging centers, urgent care facilities, and even patients' homes. In addition, readmissions of hospital patients are also being significantly decreased because of the combination of incentives and penalties embedded in the Patient Protection and Affordable Care Act. Chockley and Emanuel argued that this move out of hospitals may have dire consequences for radiologists by leading to a decrease in demand for imaging. In fact, this move away from inpatient imaging and toward outpatient imaging has already happened to a significant degree. On the basis of publicly available data from the *Neiman Almanac* concerning Medicare Part B, inpatient imaging volume decreased by 36% from 2006 to 2014 [3]. Outpatient volume during the same time period decreased by 6% whereas imaging volume resulting from emergency department visits increased by 38%. In 2006, inpatient volume accounted for 28% of all imaging volume, but by 2014 it accounted for only 21%. Revenue from inpatient volume decreased by 31% from 2006 to 2014 and accounted for only 10% of all imaging revenue in 2014. Even with the loss of additional inpatient volume that is not counterbalanced by an increase in outpatient volume, the effect on radiology and radiologists is likely to be minimal. In fact, if additional imaging volume is

[a]Department of Radiology, NYU Langone Health, New York, New York.
[b]Dell Medical School, The University of Texas at Austin, Austin, Texas.
Corresponding author: Michael P. Recht, MD, Department of Radiology, NYU Langone Health, 660 First Avenue, 3rd Floor, New York, NY 10016; e-mail: michael.recht@nyumc.org.

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switched from inpatient care to outpatient imaging, there may be a positive effect on revenue for radiologists. Because outpatient imaging equipment is often owned by radiologists, they can receive both technical and professional revenue at outpatient centers, whereas hospital equipment is most often owned by hospitals, limiting radiologists' revenue to only professional revenue.

PAYMENT REFORM

Chockley and Emanuel [1] also cited the move from pure fee for service to alternative payment methods such as bundled care or pay for performance as a significant threat to radiology and radiologists. They believe that these payment models will lead to decreased demand for imaging, thus leading to decreased demand for imagers. It is clear that the move from pure fee-for-service payment models to alternative models, especially those that make ordering physicians responsible for the cost of imaging, will decrease the demand for unnecessary and "wasteful" imaging. Additional factors that will also decrease imaging demand include the introduction of clinical decision support systems that are incorporated into clinical physician order entry systems to ensure that only appropriate examinations are performed. What is unclear, however, is that the elimination of unnecessary examinations is truly a threat to radiologists. As the population continues to age and as more sophisticated imaging techniques are developed, the loss of unnecessary and inappropriate examinations may well be counterbalanced by an increase in necessary, valuable, and appropriate imaging examinations.

In addition, a recent study demonstrated that between 1999 and 2010 growth in the number of images per examination was disproportionately increased compared with growth in imaging utilization [4]. Although cross-sectional imaging volumes increased by a factor of 2, the number of images that needed to be interpreted increased by a factor of 10. On the basis of imaging volumes and the number of images per examination, the study calculated that the average radiologist needed to interpret one image every 3 to 4 seconds to meet the volume demands. Since 2010, the number of images per cross-sectional imaging examination has continued to increase because of improvements in both hardware and software, with some examinations now routinely consisting of more than 1,000 images. Therefore, even if imaging utilization may decrease because of the elimination of inappropriate ordering of imaging, the workload of radiologists and, consequently, the demand for radiologists will most likely not be significantly decreased.

It is true that a decreased number of imaging examinations and a move to alternative payment models, such as pay for performance, that emphasize value over volume might lead to a decrease in radiologists' salaries. However, this emphasis on value rather than volume will also be a factor that protects radiologists from obsolescence. There is no doubt, as discussed in the next section, that machines will replace several functions radiologists currently perform, particularly quantification, segmentation, pure pattern recognition, and data mining. However, the value of radiology and radiologists is far more than the sum of those functions. Radiologists' added value includes the correct protocoling of examinations, participation in multidisciplinary conferences, the integration of imaging results with other aspects of a patient's care such as pathology and laboratory results, and clinical findings. In addition, as exemplified by Imaging 3.0™ [5], radiologists are having more extensive interactions with patients. These interactions include explaining the results of imaging examinations and, in many cases, especially involving interventional procedures, taking primary responsibility for the care of patients. In addition, radiologists are becoming more integrated within clinical care teams, with reading rooms embedded into clinical floors and offices [6]. Machines "trained" in pattern recognition or data extraction will not be able to perform these value-added functions and therefore will not be able to replace radiologists. Rather, they will be an aid, allowing radiologists to perform even more of these value-added functions.

ML: ULTIMATE THREAT OR SAVIOR

Given the many scientific articles, newspaper and magazine articles, and even TV ads about ML, big data, data mining, artificial intelligence, and so on, it is not surprising to see a plethora of articles dramatizing these technologies' influence on medicine in general and radiology in particular. How can radiologists ignore IBM's Watson reading an x-ray during halftime of an NFL game? However, rather than decreasing the value of radiologists, we and others believe that computers using traditional or more sophisticated ML algorithms will be highly beneficial to our specialty, allowing us to be more operationally efficient and diagnostically accurate [7].

For radiologists, the key question is, "Can a machine learn to do what we, radiologists, do?" There are secondary, corollary questions with technological implications. "Can we teach a machine what we know and to do