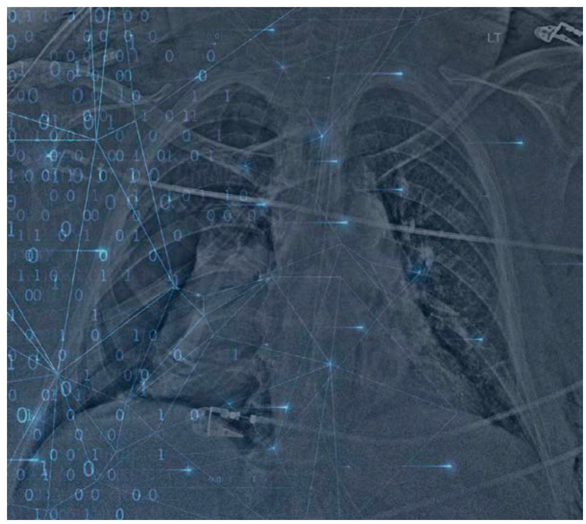
Collaborative Artificial Intelligence in Practice: The Next Steps

James M. Blum, M.D., F.C.C.M., David M. Kuehn, M.D., F.A.C.R.

In the next 24 h, countless patients around the world will complain of chest pain, have a rhythm disturbance, feel lightheaded, lose consciousness, or suffer from a variety of other conditions resulting in a provider ordering an electrocardiogram. A piece of paper will ceremoniously print, with all 12 leads presenting for that provider's interpretation. The providers will examine the tracings, and they will likely then shift their focus to the computer's interpretation at the top of the page, looking for confirmation of their initial thoughts. Occasionally, this automated, digital review will result in a reconsideration of the provider's initial interpretation and result in an urgent call to a cardiologist and/or some other intervention. While there is limited evidence that such technology affects outcomes and virtually no randomized trials showing outcome differences, the technology is widely implemented and utilized presumably because providers find the computer-generated electrocardiogram interpretations useful in certain settings.



"When considering applying an artificial intelligence algorithm to assess [endotracheal tube] position, questions inevitably arise surrounding the value of the technology and how it will integrate with existing clinical practice."

This month's journal features an article by Huang *et al.*[1] that demonstrates computer-generated interpretations in the radiologic and critical care domains. The authors describe a deep learning–based automatic detection algorithm that is designed to provide insight regarding the appropriate placement of endotracheal tubes (ETTs) in the critical care population. It is considered a standard of care for a patient to have a chest radiograph performed after endotracheal intubation in the intensive care unit (ICU). Frequently, subsequent chest radiographs are obtained for changes in patient condition, after subsequent procedures, or, in some cases, for surveillance of appropriate device placement. Many of these radiographs are obtained at off hours and rely on busy, frontline ICU providers to provide the initial interpretation. The portable supine chest radiograph is often of decreased quality, and it is not uncommon for findings to be missed or overlooked for numerous reasons. Given the inherent limitations of portable imaging and the presence of medical devices such as pacer leads, central lines, electrocardiogram wires, and enteric tubes, the frontline provider may have difficulty recognizing misplacement of the ETT. Pressing clinical demands may delay the frontline provider from timely image review. Sometimes, the complications of a misplaced ETT can result in life-threatening conditions that may have been avoided with rapid, accurate review of imaging.

When considering applying an artificial intelligence algorithm to assess ETT position, questions inevitably arise surrounding the value of the technology and how it will integrate with existing clinical practice. Some providers may feel that reliance on the computer will lead to a decline

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James M. Blum, M.D., F.C.C.M.: Department of Anesthesia, University of Iowa Carver College of Medicine, Iowa City, Iowa; Department of Computer Science, University of Iowa College of Liberal Arts and Sciences, Iowa City, Iowa.

David M. Kuehn, M.D., F.A.C.R.: Department of Radiology, University of Iowa Carver College of Medicine, Iowa City, Iowa.

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in clinical skill, resulting in frontline ICU providers who will no longer be able to interpret studies. Others may feel the technology is encroaching on their "practice territory." Additionally, there may be those who believe artificial intelligence on its own is sufficient or superior, negating the need for clinician oversight of the source data. None of these thoughts are wholly valid in the short term, but the technology forces a discussion of the new domain of artificial intelligence collaboration in medicine.

Clinicians are used to a sense of individual responsibility for patient welfare and testing that provides near certainty in many diagnostic domains. As an example, there is little doubt that a patient is anemic when they have a hemoglobin of 6 mg/dl, and it is the clinician's responsibility to diagnose and treat it accordingly. The use of artificial intelligence in clinical medicine is different, and its use may be best demonstrated by the time-tested example of electrocardiogram computerized interpretation. Clinicians utilize this computerized electrocardiogram interpretation as a tool that helps them to make better decisions and triage concerning findings to experts in the field in a timely fashion. Everyone acknowledges that there are flaws in this technology that require human oversight, and most hospitals in the United States require that electrocardiograms are eventually reviewed by a cardiologist.[2,3] However, when there is a computer-identified concern about an ST elevation myocardial infarction, the human review is performed more quickly than when an electrocardiogram appears to be normal or has a mild rhythm disturbance such as a previously existing second-degree heart block.

The use of artificial intelligence tools like Huang *et al.*[1] describe will continue the evolution of critical care practice just as automated electrocardiogram interpretation has evolved cardiac acute care. Rather than patients being potentially exposed to hours of inappropriate ventilation or ETT placement that jeopardizes the airway, critical care providers will have immediate confirmation of appropriate positioning. These images will still need assessment to ensure there is not other pathology that cannot yet be detected by computer processing. This assessment will need to be done by both the immediate ICU provider and a radiologist to ensure the highest level of care in addition to confirming the ETT placement is appropriate.

There is a growing interest in the use of artificial intelligence for image interpretation in medicine, and it is making inroads into daily medical practice.[4] However, there are a number of steps required before a specific artificial intelligence technique can be applied in clinical practice starting with the regulatory hurdles, including performance of validation studies required for Food and Drug Administration approval. The creators then need to determine whether the algorithm would be most effective as a stand-alone system or offered as an integration into an existing clinical or radiologic image viewer (picture archiving communication system), a decision that would require licensing negotiations with large vendors of picture archiving communication systems. After commercial release, during hospital implementation, the necessary computational power on servers or cloud services and a fast network will need to be available. After implementation, clinicians at individual facilities will likely seek to internally validate the effectiveness of the technology in their own patient population. Finally, there will be the opportunity for clinicians determine the best way to utilize the algorithm and determine its cost effectiveness.

Will this result in an eventual shift away from human oversight of ETT placement in chest radiographs by ICU clinicians as the authors suggest? Perhaps in the distant future, but in the near term, such technology will contribute to a very necessary dialogue about how we should utilize artificial intelligence in a collaborative clinical practice.

Competing Interests

Dr. Blum is a chair of the Clew Medical Scientific Advisory Board (Netanya, Israel) that develops artificial intelligence technologies in critical care. He has received consultant fees and stock options. Dr. Kuehn is not supported by, nor maintains any financial interest in, any commercial activity that may be associated with the topic of this article.

Correspondence

Address correspondence to Dr. Blum: james-blum@uiowa.edu

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