



A Future Without Human Error? A Critical Look at AI's Growing Influence in Medical Education

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Dear Editor

In recent years, we have witnessed the rapid integration of Artificial Intelligence (AI) into medical education. From adaptive learning platforms and AI-powered virtual simulations to algorithm-based assessments, these technologies are increasingly reshaping traditional approaches to training future physicians. While these innovations offer clear benefits—such as personalized learning, enhanced accessibility, and real-time feedback (1), they also raise important concerns that warrant closer scrutiny. Can AI truly replace the human depth of clinical education? And at what cost? This letter aims to critically examine the integration of AI in medical education, highlighting both its transformative potential and its possible risks to humanistic and ethical dimensions of clinical training. The discussion is structured around key concerns such as cognitive offloading, algorithmic bias, and the erosion of interpersonal competencies, followed by a set of practical recommendations for educators and policymakers.

AI excels at pattern recognition and processing vast amounts of data. Large language models like ChatGPT can assist students in summarizing resources, answering clinical questions, and even generating treatment plans (2). However, medical education is not merely the transmission of information; it is the cultivation of critical thinking, ethical judgment, and human empathy in the context of patient care (3). Can algorithms truly foster these nuanced competencies?

A major concern is the overreliance on AI-generated outputs. The sheer speed and confidence with which information is presented may reduce students' motivation to engage in deep learning or question the validity of answers (4). This phenomenon known as "Cognitive Offloading" can undermine independent clinical reasoning in the long term (5). Empirical studies have shown that individuals tend to offload cognitively demanding tasks to algorithms, even when those tasks involve critical attention and reasoning (5). In the context of medical education, this raises concerns about trainees bypassing the effortful

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process of clinical reasoning in favor of rapid AI-supported answers.

Moreover, many AI tools are trained on datasets that may contain inherent biases. A notable study published in science revealed that a widely used algorithm in the U.S. healthcare system underestimated the needs of Black patients due to structural bias in training data. In practical terms, such biases have led to clinical decision-support systems recommending fewer diagnostic tests or referrals for minority patients, and in educational tools, have skewed case scenarios or performance feedback against underrepresented groups (6).

Another challenge is the potential reduction in human interaction during clinical education. One of the most valuable aspects of medical training is learning through authentic patient encounters. Empathy, emotional response, and interpersonal dynamics are critical skills that cannot be fully replicated by virtual avatars or simulated scenarios. While AI-enhanced simulations can provide safety and consistency, they may inadequately develop “soft skills” and bedside manner (7).

Despite these challenges, we are not advocating against the use of AI in medical education. Instead, we call for a thoughtful, balanced, and ethically grounded integration. Educational frameworks should guide AI use in ways that preserve humanistic values and promote justice. The integration of AI into medical education presents both opportunities and challenges. The following recommendations outline the key principles for preparing future physicians to use AI critically, responsibly, and effectively:

Adopt a thoughtful, balanced, and ethically grounded integration of AI

AI should not be adopted as a novelty or cost-saving shortcut, but as a pedagogical tool that supports—not replaces—core educational values. Ethical considerations should guide its implementation to ensure it enhances, rather than undermines, students’ moral reasoning and professional growth.

Use educational frameworks to guide AI implementation

Educational frameworks should not only address technological fluency but also embed core values

such as empathy, equity, and reflective practice. For instance, competency-based curricula can integrate AI tools alongside modules on ethical decision-making, ensuring that students understand not just how to use AI, but how it aligns with patient-centered care.

Implement dual-track learning models

Combine AI-supported modules with traditional methods such as small-group discussions, mentorship, and case reflection. This dual-track approach ensures that while students gain exposure to advanced technologies, they continue to develop independent clinical reasoning, emotional intelligence, and collaborative skills.

Train medical students as critical evaluators of technology

Rather than passive consumers, students should be empowered to interrogate AI outputs. Assignments that involve comparing AI-generated responses with evidence-based guidelines, or critically appraising algorithm performance in diverse populations, can build evaluative and analytical thinking.

Include modules on digital literacy, algorithmic ethics, and critical thinking

Medical curricula should be updated to include instruction on how AI works, where it may fail, and what ethical dilemmas it may introduce. These modules can be embedded in pre-clinical education and revisited throughout training *via* interdisciplinary collaboration with data scientists and ethicists.

Ensure students understand both the function and fallibility of AI tools

AI should not be considered as infallible. Students should learn about biases in datasets, limitations in algorithm design, and how context shapes AI decision-making. Simulations or case-based learning where AI suggestions are deliberately incorrect can reinforce the importance of human oversight and accountability (8-10).

Ultimately, while AI has the potential to reduce certain human errors, its uncritical use may lead to a decline in physicians’ accountability, weakening clinical decision-making and human connection. In sum, while AI technologies offer remarkable tools

for enhancing learning, their implementation should be aligned with ethical, pedagogical, and humanistic principles. Only through a deliberate and critical approach can we ensure that future physicians are both technologically competent and deeply empathetic. The future of medical education depends not only on what machines can do, but on what humans should not forget.

Keywords: Artificial intelligence in medical education, Algorithmic bias, Clinical reasoning,

Humanism in healthcare

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Conflict of Interest

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