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The Role of Artificial Intelligence in Healthcare Simulation: Opportunities and Challenges for Health Professions Education

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ABSTRACT

Simulation has become a cornerstone of health professions education, offering safe, repeatable practice that improves knowledge, skills, and, to a degree, patient outcomes. Artificial intelligence (AI), and in particular large language models and generative systems, now promises to extend simulation beyond fixed scenarios and manikins toward adaptive, conversational, and individually tailored learning experiences. This brief review summarizes the emerging role of AI in healthcare simulation, including AI-driven virtual and standardized patients, automated feedback and performance assessment, and rapid scenario generation. Evidence indicates that technology-enhanced and virtual patient simulation improve learning outcomes, and early studies of generative AI demonstrate strong performance on clinical reasoning tasks. At the same time, concerns regarding factual accuracy, bias, data privacy, the validity of automated assessment, and the potential erosion of human interaction temper enthusiasm. Realizing the promise of AI in simulation will require rigorous evaluation, transparent and equitable design, and faculty development, so that these tools augment rather than replace the relational core of clinical education.

Keywords Keywords: artificial intelligence; healthcare simulation; health professions education; virtual patients; large language models; generative AI; clinical education

Introduction

Simulation-based education allows learners to practice clinical skills, decision making, and teamwork in an environment where errors carry no risk to real patients. Gaba's influential vision framed simulation not as a single technology but as a broad strategy for improving safety and performance across health care [1]. A large systematic review and meta-analysis by Cook and colleagues found that technology-enhanced simulation, compared with no intervention, is consistently associated with improvements in knowledge, skills, and behaviors, and to a lesser extent patient outcomes [2]. Virtual patient simulations, in which learners interact with computer-based clinical cases, show comparable educational benefits while offering a scalability that physical simulation cannot easily match [3]. Artificial intelligence now stands to reshape how these simulations are designed, delivered, and evaluated.

Applications of AI in Healthcare Simulation

AI contributes to healthcare simulation in several converging ways. First, generative language models can power conversational virtual and standardized patients that respond dynamically to open-ended questions, enabling history-taking and communication practice at scale rather than through scripted branching alone. In an integrative review, Chan and Zary catalogued applications of AI across medical education, including intelligent tutoring, adaptive content delivery, and automated assessment [4]. Second, AI enables automated feedback and performance assessment, analyzing learner actions or dialogue to deliver immediate, individualized formative feedback. Third, generative systems can rapidly author new scenarios, case variations, and assessment items, reducing the substantial faculty time traditionally required to develop simulation content [7].

Emerging Evidence for AI Capability

The clinical reasoning capabilities that make these applications plausible have advanced rapidly. Kung and colleagues reported that ChatGPT performed at or near the passing threshold on the United States Medical Licensing Examination without specialized training, suggesting a capacity for medical reasoning relevant to case-based simulation [5]. Broader analyses of GPT-4 in medicine similarly describe strong performance on diagnostic and explanatory tasks, while explicitly cautioning about its limitations [6]. Together these findings indicate that contemporary models are capable enough to sustain realistic, unscripted clinical dialogue within a simulated encounter.

Challenges and Risks

The same analyses caution that generative models can produce confident but incorrect statements, may reproduce biases present in their training data, and raise unresolved questions of data privacy and accountability [6]. In simulation specifically, automated assessment must be validated against established educational outcomes before it can be trusted for high-stakes decisions, and the scoping review by Preiksaitis and Rose emphasizes the need for faculty development, clear governance, and attention to equity as generative AI enters medical education [7]. A relational risk also warrants attention: much of the value of simulation lies in human debriefing and interprofessional interaction, which AI should support rather than supplant.

Conclusion

AI offers a credible path toward simulation that is more adaptive, scalable, and individualized than current approaches, supported by a growing evidence base for both simulation broadly and the underlying AI capabilities. Its responsible adoption depends on rigorous validation, transparent and unbiased design, protection of learner and patient data, and preservation of the human relationships at the heart of clinical education. Used thoughtfully, AI can strengthen the well-established benefits of simulation while opening new possibilities for interprofessional and technology-enhanced learning.

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