JHPLT
Journal of Health Professions Learning and Technology

COMMENTARY

Vol. 1, No. 3 (Jul-Sep 2026) | e7

Published 6 August 2026

Complementary, Not Competing: The Practical Value of AI-Powered Virtual Patient Simulation Alongside Manikin and Human Simulation in Health Professions Education

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ABSTRACT

Simulation is central to modern health professions education, and high-fidelity manikins and human simulation, including standardized patients, have a strong and well-earned evidence base for developing psychomotor skills, teamwork, and clinical judgment. These modalities are resource intensive, however, requiring dedicated labs, equipment, and substantial faculty time, which constrains how much practice each learner can receive. Screen-based virtual patient simulation, and in particular the new generation powered by large language models, offers a complementary approach that is highly scalable, lower in marginal cost, available on demand, and able to capture detailed interaction data for assessment and program evaluation. This article gives full credit to manikin and human simulation while arguing that AI-powered virtual patients add important practical value and, for cognitive and communication outcomes such as knowledge, clinical reasoning, and history taking, can achieve a comparable learning yield. Drawing on meta-analytic evidence that instructional design rather than physical fidelity is the primary driver of learning, randomized trials of virtual and AI-simulated patients, and recent evaluations of large language models in medicine, I propose a blended model in which each modality is used for what it does best.

Keywords simulation; virtual patients; manikins; standardized patients; artificial intelligence; large language models; health professions education; clinical reasoning

Introduction

Simulation-based education has become a cornerstone of preparing health professionals, allowing learners to practice without risk to patients, and meta-analyses show that it is consistently associated with improved knowledge, skills, and behaviors [1]. Three broad modalities dominate current practice: high-fidelity manikins housed in simulation labs, human simulation using standardized or simulated patients, and screen-based virtual patient simulation. Each has distinct strengths. The purpose of this article is not to argue that one modality should displace another, but to give manikin and human simulation their due while making the case that AI-powered virtual patients now add practical value, and in some domains a comparable learning yield, that warrants their expanded use as part of a blended curriculum.

The Established Value of Manikin and Human Simulation

The evidence for manikin and human simulation is substantial and should be acknowledged plainly. The NCSBN National Simulation Study, a large longitudinal randomized controlled trial, found that prelicensure nursing students who had up to half of their traditional clinical hours replaced with high-quality simulation showed no meaningful differences in clinical competency, licensure pass rates, or readiness for practice compared with peers in traditional clinical placements [2]. Human simulation has an even longer pedigree; standardized patients have been used for decades to teach and assess history taking and communication precisely because a trained person can reproduce the nuance of a real clinical encounter [6]. A defining strength of lab-based simulation is the facilitated debrief, and evidence from within and beyond health care shows that structured debriefing is a powerful driver of learning, improving subsequent performance by roughly a quarter on average [3]. Manikins also remain essential for the psychomotor and team dimensions of care, such as procedures, resuscitation, and crisis resource management, that screen-based tools cannot replicate. Any argument for virtual simulation must begin by recognizing that these modalities set the standard.

What Actually Drives Learning in Simulation

At the same time, a careful reading of the evidence complicates the intuition that more physical fidelity always means more learning. In a large meta-analysis of instructional design features, Cook and colleagues found that outcomes were most strongly associated with elements such as feedback, repetitive practice, mastery learning, and a range of task difficulty, rather than with the fidelity of the simulator itself [4]. A broader meta-analysis of simulation-based learning in higher education reached a similar conclusion, reporting large overall effects and finding that instructional support and scaffolding mattered more than the authenticity of the simulation [5]. This distinction is central to the present argument: if learning is driven mainly by design and guided practice rather than by physical realism, then a lower-fidelity screen-based modality that delivers excellent feedback and abundant practice can be expected to produce strong outcomes.

Screen-Based Virtual Patient Simulation: Evidence and Practical Advantages

Screen-based virtual patients have a maturing evidence base. A systematic review and meta-analysis by the Digital Health Education Collaboration found that virtual patient simulations improve knowledge and skills and can be at least as effective as traditional or non-digital approaches, albeit with heterogeneity across studies [7]. In a randomized controlled trial in nursing education, clinical virtual simulation produced greater knowledge acquisition and retention than a traditional teaching approach [8]. Beyond comparable learning, the practical advantages are considerable. Virtual simulation is highly scalable and carries a low marginal cost once built, so every learner can complete the same case as many times as needed without competing for a manikin, a lab slot, or a trained actor. It standardizes the encounter, removing the variability inherent in different simulated patients, and it is available asynchronously and remotely, which extends access to distributed and rural programs. Perhaps most underappreciated, every virtual encounter generates detailed interaction data, including what was asked, in what order, and how the learner reasoned, which can be aggregated for individual feedback, competency tracking, and program-level assessment in ways that a live encounter rarely captures. These practical data are a distinctive contribution of the modality, not merely a convenience.

The Artificial Intelligence Inflection Point

The historical limitation of screen-based virtual patients was their reliance on branching scripts, which broke down when a learner asked an unanticipated question and constrained the realism of the dialogue. Large language models remove much of this constraint by generating fluent, contextually appropriate responses to open-ended input. Contemporary models carry substantial medical knowledge; GPT-4o, for example, achieved accuracies of 84.2% and 88.2% across two years of the Chinese National Medical Licensing Examination, well above earlier models [11]. Early studies of AI-simulated patients are encouraging. A GPT-powered simulated patient for history taking produced responses rated plausible in 97.9% of exchanges with positive student experience, while also revealing a tendency to fabricate information when questioned beyond the case script [9]. In a randomized controlled trial, students who practiced with a large language model-simulated patient and received structured feedback demonstrated significantly better clinical decision making than those who practiced without feedback [10]. Together these findings suggest that AI-powered virtual patients can now deliver the conversational realism that earlier screen-based tools lacked, narrowing the experiential gap with human simulation for history-taking and communication practice.

A Complementary Model

The appropriate conclusion is complementarity rather than substitution. Manikins and human simulation should continue to carry the psychomotor, procedural, teamwork, and high-stakes crisis training for which they are uniquely suited, and the facilitated debrief should remain central regardless of modality [3]. AI-powered virtual patients are well positioned to carry a large share of the cognitive and communication curriculum, including history taking, clinical reasoning, medication and patient education, and repeated deliberate practice at scale, freeing scarce lab and faculty resources for the experiences that most require them. Used this way, virtual simulation does not compete with the simulation lab; it multiplies the amount of high-quality practice a program can offer while generating data that can strengthen assessment across the whole curriculum.

Limitations and Responsible Use

Several cautions apply. The comparability of learning yield is best supported for cognitive and communication outcomes; claims of equivalence for psychomotor or team performance are not warranted, and virtual tools should not be positioned as replacements in those domains. The tendency of large language models to produce confident but incorrect content, seen as off-script fabrication in a simulated-patient study [9] and cautioned against for medicine generally [12], means AI patients require careful case grounding, prompt design, and faculty oversight to avoid modeling inaccurate clinical information. Bias, data privacy, and the validity of automated, data-driven assessment also require governance as these tools scale. Finally, the human relationships and nonverbal dimensions of care that live encounters provide cannot be fully reproduced on a screen, which is a further reason to frame AI virtual patients as a complement rather than a replacement.

Conclusion

Manikin and human simulation have earned their central place in health professions education, and nothing about the rise of artificial intelligence diminishes that. The evidence that learning in simulation is driven more by instructional design than by physical fidelity, combined with trials showing comparable cognitive gains from virtual simulation and the new conversational realism afforded by large language models, makes a rigorous case that AI-powered virtual patients add real practical value and, for the right outcomes, a similar learning yield. The most effective programs will not choose between the simulation lab and the screen; they will blend them, assigning each modality the work it does best and using the data-rich virtual environment to give every learner more practice than a lab alone could ever provide.

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How to cite this article

Borckardt, J. J. (2026). Complementary, Not Competing: The Practical Value of AI-Powered Virtual Patient Simulation Alongside Manikin and Human Simulation in Health Professions Education. Journal of Health Professions Learning and Technology, 1(3), e7.

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