



Concept

An Introduction to Artificial Intelligence for Clinical Teaching in the Emergency Department

Submission ID	6fd9660a-9ed3-44fa-b635-90963dde50da
Submission Version	Initial Submission
PDF Generation	12 Sep 2025 09:01:39 EST by Atypon ReX

Files for peer review

All files submitted by the author for peer review are listed below. Files that could not be converted to PDF are indicated; reviewers are able to access them online.

Name	Type of File	Size	Page
Intro to AI FINAL.docx	Anonymized Main Document - MS Word	345.4 KB	Page 3

Title: An Introduction to Artificial Intelligence for Clinical Teaching in the Emergency

Department

Running Title: Intro to AI for Clinical Teaching in the ED

Abstract

Introduction:

Clinical teaching, while vital to medical education, is becoming increasingly strained by faculty time limitations, clinical demands, and variability of educator experience. Artificial intelligence (AI), especially large language models (LLMs) such as ChatGPT, offers new opportunities to support clinical education while preserving its human-centered core.

Methods:

This author group consisted of academic emergency medicine (EM) physicians from multiple institutions who facilitated the “Be the Best Teacher: Clinical Teaching Educational Bootcamp” at the 2025 Society for Academic Emergency Medicine (SAEM) pre-conference. While various aspects of clinical teaching were presented, the emergence of AI as a technology that can be leveraged to enhance medical education was a key focus this year. Drawing on their experience and expertise as clinical educators, the group members review current applications and present practical examples for incorporating AI into clinical teaching.

Considerations:

Four key domains were identified in which AI can be integrated to support time-constrained educators: augmenting bedside teaching, generating learner-specific goals and objectives,

enhancing real-time feedback, and modeling appropriate AI use in clinical care. These tools offer scalable, learner-centered support. However, many risks still exist in the early stages of AI use: data privacy concerns, reinforcement of bias, hallucinated outputs, and potential erosion of critical thinking skills.

Conclusion:

When integrated thoughtfully, AI tools such as LLMs can help EM educators overcome long-standing barriers to teaching, enhance feedback and reflection, and create more productive and learner-focused clinical environments. Educators must remain mindful of ethical risks and limitations, and actively model safe and appropriate use for learners already adopting these tools. This paper provides a practical framework for incorporating AI into clinical teaching while upholding the principles of evidence-based, humanistic medical education.

Introduction

In the evolving landscape of medical education, clinical teaching remains a cornerstone of training the next generation of physicians. Persistent challenges, including limited faculty time,

competing clinical demands, variable teaching skills among educators, and the need to deliver quality instruction in a dynamic and high-stakes, all create an environment that often presents significant challenges to providing a high-quality educational experience for learners. Artificial intelligence (AI) has emerged as a promising tool to augment clinical teaching, particularly for educators seeking to enhance their teaching effectiveness and efficiency. As with any new modality, there are benefits and downsides to its use, which we hope to summarize here for clinical educators. A few specific examples are included as a part of this introductory resource; these are not by any means a full representation of options for use in this rapidly evolving field, and readers are encouraged to further explore areas that appeal to them most.

Methods

This author group consisted of academic emergency medicine (EM) physicians from multiple institutions who facilitated the “Be the Best Teacher: Clinical Teaching Educational Bootcamp” at the 2025 Society for Academic Emergency Medicine (SAEM) pre-conference day on May 13, 2025. The curriculum addressed a range of core domains in clinical teaching, including strategies for maximizing instruction in time-constrained environments, applications of cognitive load theory, frameworks for delivering feedback as a structured process, and best practices for navigating challenging learner interactions in the clinical setting.

The emergence of AI as a technology that can be leveraged to enhance medical education across these domains was a key focus this year. Illustrative examples, supporting evidence, and cautionary tales were provided by workshop facilitators. Furthermore, ambient AI technology was employed to generate real-time summary notes, which participants could contribute to and retain, thereby demonstrating easy, real-world use.

Given the variable utilization of AI among workshop participants, the author group drew upon their collective expertise as clinical educators to review current applications and provide practical examples for incorporating AI into clinical teaching.

Defining Artificial Intelligence and Its Use in Healthcare and Medical Education

AI is rapidly transforming the way healthcare is conceptualized and delivered. As clinical practice becomes increasingly complex, the need for innovative approaches to training future physicians grows more urgent. This is particularly evident in dynamic learning environments, where the demands of patient care must be carefully balanced with education.

Broadly defined, AI refers to the capability of machines to mimic human cognitive functions such as learning, reasoning, problem-solving, and decision-making.¹ In healthcare, AI has traditionally been applied to clinical decision support, diagnostic imaging, and administrative tasks.² More recently, however, its potential in education has become an area of growing interest.³

A major driver of this recent interest is the emergence of large language models (LLMs), a class of AI systems trained on a vast corpus of textual data to generate, interpret, and analyze human language. LLMs, such as OpenAI's GPT-5 or Google's Gemini, can understand context, generate coherent responses, summarize content, and simulate human-like dialogue. These capabilities allow LLMs to function as powerful tools for information retrieval, content generation, question-answering, and interactive tutoring.⁴ Unlike previous rule-based systems and narrow AI tools that operated within fixed parameters, LLMs offer dynamic, flexible, and context-aware interactions, with significant implications for integration in medical education.

Newer AI models possess the ability to tailor explanations according to a learner's level of training, provide immediate access to clinical information, and simulate patient encounters for educational purposes. Moreover, LLMs can support educators by automating pedagogical tasks such as generating learning objectives, synthesizing clinical cases, and providing feedback on learner performance, thereby addressing longstanding challenges inherent to clinical teaching.⁴ These advances are particularly relevant in today's clinical learning environments, where clinical teaching remains a highly valued, yet increasingly strained educational modality. AI models, specifically LLMs, offer an opportunity to extend the reach and enhance the impact of clinical teaching without replacing the human elements central to medical learning.

As LLMs become more accessible and user-friendly, their integration into clinical teaching environments is not only feasible but potentially transformative. This paper explores the role of AI, with a focus on LLMs, in supporting four key domains of clinical education: generating clear and competency-aligned goals and objectives, augmenting bedside teaching, modeling appropriate use in clinical care, and delivering timely and actionable feedback. By highlighting practical examples and thoughtful applications, this paper aims to guide educators, especially those new to AI, in understanding and applying these tools to enrich the learning experience and address barriers inherent to clinical teaching. Furthermore, the ethical considerations and important limitations of such technologies will be discussed.

Using AI to Generate Learner Goals on Shift

The use of AI for setting goals and objectives for clinical shifts offers a productive and personalized way to enhance learning in the clinical environment. In conjunction with AI, educators can help learners leverage AI to generate individualized goals that reflect their strengths, weaknesses, and preferred learning styles. AI can also assist in tailoring goals based on

120 the type of clinical shift (high-acuity, low-acuity, trauma, fast track, etc.). This may be
 121 particularly useful when educators have had limited prior contact with a learner and lack baseline
 122 insight; a learner struggles to identify an area of focus; or to help focus or narrow down the goals
 123 for the shift.
 124

Generating Learner Goals on Shift (Table 1)

Educational Scenario: *You are beginning a shift with a junior resident, Resident M, whom you haven't worked with before. You ask Resident M what he'd like to work on today, and he hesitates, noting he's not sure what to focus on.*

Text to Input into ChatGPT:

"Provide areas to focus on for a junior emergency medicine resident on a moderate acuity pod shift."

ChatGPT Output:

"On a moderate acuity pod shift, junior EM residents should focus on developing foundational skills while managing increased responsibility. Here are key areas to focus on:

1. Patient assessment and data gathering
2. Differential diagnosis development
3. Diagnostic stewardship
4. Reassessments & Task Switching
5. ED Flow & Disposition Planning
6. Documentation efficiency
7. Communication & Teamwork
8. Time Management"

You ask Resident M to choose areas of focus from the list provided by ChatGPT. Resident M decides that he has been struggling with task switching and communication with other members of the care team, specifically nursing. However, Resident M is unable to come up with a measurable goal related to this for his shift.

Text to Input into ChatGPT:

"Generate a single measurable goal that addresses both task switching and communication for a junior emergency medicine resident on shift."

ChatGPT Output:

"Goal: By the end of the shift, the resident will demonstrate effective task switching by initiating follow-up or re-evaluation on at least 80% of patients within 15 minutes of receiving a critical lab, imaging result, or consultation recommendation, and will communicate the updated plan to the nursing staff in a timely, closed-loop manner."

You decide that this goal is somewhat unrealistic given the clinical constraints of the ED.

Text to Input into ChatGPT:

"Make the goal less ambitious."

ChatGPT Output:

“Goal: Over the course of the shift, the resident will identify and follow up on at least 3 patients within 20 minutes of receiving a key result and will communicate the updated plan to the bedside nurse using closed-loop communication”

You recognize that, as the sole attending covering multiple residents, your ability to follow up on this goal may be challenging.

Text to Input into ChatGPT:

“Remove the time frame for the goal and change to something that can be completed by the end of the shift.”

ChatGPT Output:

“Goal: By the end of the shift, the resident will demonstrate task switching and communication skills by identifying at least 3 patients who required follow-up after key results and discuss how these results were communicated to nursing using closed loop communication.”

Both you and Resident M agree that this is a realistic goal to work on for today’s shift that targets his self-identified areas for growth.

125

126 **AI can Augment Clinical Teaching at the Bedside**

127 Clinical teaching for educators requires managing time constraints, clinical complexities, and

128 varying student readiness levels. Adopting a learner-centered approach transforms these

129 obstacles into opportunities for collective growth ([REF](#)). Instead of viewing educators strictly as

130 providers of information, this model positions them as facilitators of reflection, reasoning, and

131 skill advancement in collaboration with learners. Incorporating AI into clinical education fosters

132 this evolving relationship by providing tools that enhance preparation and offer timely support.

133 In this way, AI empowers both learners and educators: learners take charge of applying

134 knowledge and clinical reasoning, while educators help shape professional identity,

135 communication skills, and critical thinking.

136

137 *Performance Preparation and Shared Mental Models*

138 Prior to performing procedures or preparing for a resuscitation, educators may employ mastery

139 learning checklists and prompt learners to articulate their strategies aloud.⁵ LLMs, such as

140 ChatGPT (<https://chat.openai.com>), can further support this process by generating customized
 141 checklists, anticipating common errors, and constructing “what-if” scenarios designed to prepare
 142 both learners and educators for high-pressure clinical situations. These pre-briefing activities are
 143 essential for establishing a shared mental framework, delineating responsibilities, and setting the
 144 appropriate atmosphere in preparation for stressful conditions. Research indicates that LLMs can
 145 replicate realistic clinical interactions and provide feedback that improves clinical reasoning and
 146 readiness.⁶
 147

Augmenting Clinical Teaching at The Bedside (Table 2)

Educational Scenario: *The shift is going well. Resident M. picks up a patient with septic shock, and despite managing their care very well, the patient is requiring escalating vasopressor doses. Resident M. would like to proceed with placing a central venous catheter, however, notes he has not put one in before.*

Text to Input into ChatGPT: “Prepare a checklist with the steps needed for preparation and placement of a central venous catheter in the emergency department”

ChatGPT Output:

Pre-Procedure Preparation

- ☐ Verify indication for central line (e.g., vasoactive meds, poor access, hemodynamic monitoring, frequent blood draws).
- ☐ Assess contraindications (e.g., local infection, distorted anatomy, coagulopathy—relative).
- ☐ Obtain informed consent if possible.
- ☐ Perform timeout: correct patient, site, procedure.
- ☐ Gather equipment:
 - CVC kit (introducer needle, guidewire, dilator, catheter, scalpel, syringes, flushes)
 - Sterile gown, mask, gloves, drape
 - Ultrasound machine with sterile probe cover
 - Chlorhexidine or povidone-iodine prep
 - Suture, dressing, sterile gauze, flushes

Sterile Preparation

- ☐ Perform hand hygiene.
- ☐ Don cap, mask, sterile gown, and sterile gloves.
- ☐ Prep skin with chlorhexidine (scrub for ≥ 30 seconds, allow to dry).
- ☐ Apply full sterile drape over patient.
- ☐ Place patient in Trendelenburg position (if IJ/subclavian and tolerated) to distend veins and reduce air embolism risk.
- ☐ Apply local anesthetic at insertion site.

Site Selection & Ultrasound

- ☐ Identify vein: Internal jugular (preferred with US), subclavian, or femoral.

Catheter Insertion (Seldinger Technique)

- ☐ Insert introducer needle into vein under ultrasound guidance.
- ☐ Aspirate venous blood (dark, non-pulsatile).
- ☐ Advance guidewire smoothly through needle.
- ☐ Confirm wire intraluminal position with US (if possible).
- ☐ Remove introducer needle over wire.
- ☐ Make small skin nick with scalpel.
- ☐ Advance dilator over wire, then remove.
- ☐ Advance catheter over guidewire to appropriate depth.
- ☐ Remove guidewire while aspirating and flushing all lumens.

Securing & Confirmation

- ☐ Aspirate blood and flush all ports.
- ☐ Secure catheter with sutures or sutureless device.
- ☐ Apply sterile transparent dressing.
- ☐ Dispose sharps safely.
- ☐ Confirm placement:
 - Chest X-ray (for IJ/subclavian) to confirm tip at cavoatrial junction and rule out pneumothorax.
 - For femoral, confirmation by blood return and flush is usually sufficient.

Post-Procedure Care

- ☐ Document procedure, number of attempts, and any complications.
- ☐ Monitor patient for immediate complications (arrhythmia, hematoma, pneumothorax, arterial puncture, air embolism).
- ☐ Maintain sterile line care and daily necessity assessment.

148

149 *Simulation and Just-in-Time Training*

150 To enhance procedural memory and mental rehearsal, clinicians can utilize resources such as the

151 “Hit the Box” tool from [Taming the SRU](#). This accessible, free platform engages learners in

case-based scenarios that guide clinical decision making. When coupled with AI tools such as ChatGPT, educators can further expand these cases by introducing clinical variations or reflective prompts that stimulate discussion and promote deeper understanding, particularly during periods of clinical downtime or high patient boarding. AI does not replace clinical teaching; rather, it augments it. By supporting preparation and mental rehearsal, AI tools enable educators to deliver more intentional, learner-centered instruction, even in dynamic and high-pressure environments.

AI Use for Refining Feedback Delivery

Feedback is a crucial element of promoting learner growth, professional development, and honing clinical reasoning and skills. Coaching, a powerful technique that diminishes the typical hierarchy that is prevalent in medical education, focuses on developing a partnership between educator and learner that facilitates rich feedback discussion in a safe space. Several coaching frameworks exist to help learners integrate feedback into their development, with two models (ADAPT and R2C2) demonstrating effective use in real-time clinical environments and longitudinal coaching opportunities, respectively. While coaching can elevate feedback conversations with learners, there remain several complexities with feedback delivery that continue to make this a challenging, and ever-evolving, process in medical education.

In-the-Moment Feedback Delivery

Learners may reject feedback that doesn't align with their self-perception or that feels like a personal attack rather than constructive discussion. This may be amplified based on the emotional and behavioral state of the learner under pressure or in a stressful situation. As such, faculty need to consider the way feedback is delivered, and not just the medical knowledge or skills content, to optimize learner acceptance and use. AI models can assist clinicians in crafting

psychologically safe and inclusive language for effective real-time feedback. For instance, educators can request AI models to generate phrases based on non-violent communication principles (such as “I noticed... I feel... I need...”) or to role-play responses to challenging learner behaviors like disengagement or overconfidence. Faculty can also utilize AI to review and refine feedback language, eliminating bias and assumptions, thereby promoting equity-focused practices. This preparation enables educators to respond calmly and deliberately in emotionally charged, time-sensitive situations, improving their effectiveness and presence at the bedside.^{7,8} Reflecting after procedures or difficult patient encounters can reinforce learning. Frameworks such as the ADAPT model mentioned above provide a coaching-oriented structure for feedback that highlights observation, collaborative reflection, and actionable planning (REF). AI can assist by creating customized debrief prompts suited to the learner’s level, the complexity of the procedure, and the desired tone. For instance, by inputting “debrief questions after first intubation using the ADAPT model,” one receives valuable prompts suitable for development. These reflections serve to normalize challenges, bolster essential concepts, and transform even minor achievements into significant learning experiences.

Gathering Data to Inform Feedback Delivery and Longitudinal Coaching

Future directions can leverage AI to enhance data gathering to better inform feedback discussions. This includes expanding the number of direct observations available for each learner and offering real-time feedback on a much larger dataset. For example, AI has been used to analyze video recordings of urology residents performing a variety of surgical procedures and provide personalized and annotated feedback on both anatomical approaches and real-time problem-solving skills. This allows learners to have higher quantities of direct and specific data to reflect on and discuss. AI systems may also be used to screen the number of patients seen, the

number of procedures performed, the acuity of patients managed, etc., to tailor clinical experiences and ensure each learner is adequately prepared for practice after training.

Additional areas for AI use in feedback are around more subjective and nebulous topics, such as communication skills. Virtual patient conversations have been previously used to assist learners not only with practicing communication skills in difficult clinical scenarios or with interprofessional challenges, also to analyze communication performance to inform learners of areas for continued growth.^{9,10} Future AI use may be expanded to develop scenarios that are particularly challenging for a learner to continue to practice in a low-stakes environment, and to screen for more nuanced tone, complexity, microaggression, and bias to continue to refine communication skills in areas that are otherwise difficult to provide feedback around.

If this objective data is made easily accessible, much of a learner's self-monitoring and reflection can be done privately and with increasing frequency. This allows the learner to not only self-monitor and improve in-between coaching sessions but empower them to better prepare for collaborative discussions when they meet with their coach. AI is essentially creating more "safe space" opportunities for self-reflection and behavior adaptation, allowing the time spent with a coach to be focused on the most complex situations or challenges.

Lastly, AI models may be utilized to glean themes or signals for each learner that may otherwise be subtle or missed amongst large data reservoirs. Predictive modeling can also be particularly useful when identifying learners who may require additional support early on.¹¹

As AI can be useful in generating goals at the beginning of shift, it can additionally be helpful in creating future specific goals at the end of shift after receiving feedback.

Giving Feedback on Shift (Table 3)

Educational Scenario: *While Resident M. prepared for the CVC beautifully, he had difficulty visualizing his needle tip under ultrasound guidance and his initial attempt to access the vein was unsuccessful. He was notably frustrated which made subsequent attempts challenging even with your coaching. Ultimately, you made the last attempt which was successful.*

Text to Input into ChatGPT:

“Provide supportive, but constructive verbal feedback to a resident who was unsuccessful in placing a central venous catheter. Mention that they subsequently became frustrated and include how this likely negatively impacted subsequent attempts.”

ChatGPT Output:

“Hey [Resident’s Name]. Can we take a minute to talk about the central line attempt earlier? I really appreciate your willingness to step up and try a technically challenging procedure—it’s clear you care about doing things well, and that matters a lot in this environment.”

“I noticed that after the first attempt didn’t go as planned, you seemed visibly frustrated. That’s a completely normal reaction, and it’s tough when things don’t go the way you want. But I also noticed that the frustration may have started to impact your focus during the next attempts.”

“One of the things that separates a good proceduralist from a great one isn’t just technical skill—it’s the ability to reset mentally after a setback. We all miss each other. What matters most is how we recover. I’ve had to learn that myself, and it’s still a work in progress.”

“Next time, I’d encourage you to take a brief pause after a tough attempt—even just 10 seconds to breathe, reassess your landmarks or positioning, and reframe your mindset. I think that could help you bring your best focus back to the next step.”

“You’ve got the drive, the fundamentals, and the situational awareness. If we can work on managing the emotional side in the moment, your performance will only keep improving. I’m happy to support you however you need—whether it’s more practice, talking through the steps, or taking a moment to reset with you during procedures.”

Your shift is nearing the end, and Resident M. asks you if there is any feedback you have for him based on his goals at the beginning of the shift and his performance overall. Resident M. has demonstrated a strong performance today; however, you noted there were areas in which he could improve.

Text to Input into ChatGPT:

“Construct verbal feedback for a resident at the end of their ED shift whose goal was to work on task switching and closed-loop communication with nurses. Allow them to reflect at the beginning before providing feedback.”

ChatGPT Output:

“Hey [Resident’s Name], before we wrap up, let’s take a few minutes to debrief the shift. I know you were working on prioritizing tasks and improving communication with the nursing team—how do you think that went today?”

(Let them reflect. Listen actively. Ask a follow-up question if needed, like: “Can you think of a moment where that went well or where it was challenging?”)

“Thanks for sharing that. From my perspective, I saw some good progress, especially when you [mention a specific moment they did well]. That showed real intention.”

“One opportunity I’d highlight is continuing to loop back with nurses after giving instructions. I noticed a couple of moments where plans were made, but confirmation was missing—closed-loop communication helps prevent things from slipping through.”

“As for task switching, your awareness was solid, and with a bit more proactive delegation—especially during busier stretches—I think you’ll feel less mentally overloaded. That comes with time and reps, and you’re already on the right track.”

“Overall, I appreciated your focus on growing in these areas. Keep building on what went well today and stay intentional about your goals.”

Resident M. openly receives your feedback openly receives the feedback you have given and is interested in additional resources to garner a deeper understanding for procedural approach; he hopes to be better prepared for next time.

Text to Input into ChatGPT:

“What are some resources an emergency medicine resident wanting to learn more about central venous access could use?”

ChatGPT Output:

Textbooks:

- Roberts and Hedges’ Clinical Procedures in Emergency Medicine and Acute Care
- Tintinalli’s Emergency Medicine
- Ma and Mateer’s Emergency Ultrasound - key for US guided procedures

Online & Video Resources:

- EM:RAP
- Core EM
- LITFL
- 5 Minute Sono

After finishing verbal feedback with Resident M, but prior to leaving your shift, you decide that you want to complete the written evaluation now so that it is timely and complete.

Text to Input into ChatGPT:

“Take the verbal feedback above and turn it into written feedback”

ChatGPT Output:

Resident M. identified task switching and closed-loop communication as goals for this shift and reflected thoughtfully on their performance.

They showed good progress in task switching during high-acuity periods—for example, pausing to reassess and set clear plans when multiple patients needed attention. Communication with nursing was generally clear, though there were a few missed opportunities to confirm task completion. Continuing to close the loop consistently will help avoid missteps and build stronger team coordination.

Proactive delegation during busy times will also be an area for growth, but overall, [Resident's Name] demonstrated solid awareness and forward momentum toward their goals

225

226

227 **Modeling AI Use in Clinical Care**

228 As educators, we have a responsibility to model the appropriate and effective use of clinical tools
229 for our learners. Role modeling is a well-established strategy in medical education that has been
230 shown to effectively transfer skills and can be used in both formal and informal contexts.^{12,13}

231 With the advent of novel technologies such as AI, learners will inevitably look to us for guidance
232 in adopting safe and appropriate applications for use in the clinical environment. While this may
233 initially seem daunting, requiring educators to develop their own familiarity and understanding
234 of these tools, the practice of modeling clinical diagnostic tool use, particularly with novel
235 technology, is already part of our teaching skill set. For example, when teaching a novice learner
236 about risk stratification in patients presenting with chest pain, we may already choose to navigate
237 to the MD Calc website and put in a patient's data into the HEART score calculator. Or when a
238 learner asks a clinical question about the safety of using full strength aspirin in patients with
239 ACS who are already on a DOAC, we may choose to show them how to perform an evidence-
240 based search for literature on this topic. These behaviors can easily be transitioned to
241 demonstrating to learners the appropriate uses of AI on shift.

242

243 There are also opportunities to model the use of AI tools for improving provider efficiency.

244 Aside from LLMs, another use for AI involves novel technology to ambiently listen to

245 conversation and dictate in real time. This has recently been used to assist with real-time
246 documentation of notes, such as the use of DAX-CoPilot software, to decrease documentation
247 burden for physicians. This can be a valuable resource in clinical settings that lack the resources
248 or support for alternative dictation services (handheld Dictaphone applications, scribes, etc.).
249 However, it is important to emphasize to learners that these transcripts require thorough review
250 and editing to ensure accuracy, preserve individual style, and meet institution-specific needs.

251
252 AI can also assist with patient-facing aspects of clinical care. As we know, writing clear
253 discharge instructions is critical to ensuring that patients understand subsequent steps in their
254 care and recognize appropriate return precautions. However, tailoring instructions to the needs of
255 the individual patients is often complex and time-intensive for providers. This challenge presents
256 an opportunity to introduce learners to the use of LLMs for generating patient-specific
257 educational materials. For instance, educators may demonstrate how an LLM can be prompted to
258 adapt discharge instructions to a 7th-grade reading level (e.g., “Reword these discharge
259 instructions to a 7th-grade reading level”) to enhance patient comprehension. Educators should
260 stress to learners that these outputs necessitate rigorous review and thoughtful refinement to
261 maintain clinical accuracy and clarity for the patients.

262 **Ethics of AI Use in Clinical Teaching**

264 Despite these advantages, we need to be prepared to answer learner (and faculty) questions about
265 potentially inappropriate or harmful uses of AI. A primary concern when using AI for clinical
266 teaching is patient privacy and HIPAA violations. Commercial AI platforms such as ChatGPT
267 and Gemini train their models in part by using input from users, often utilizing protected health
268 information for queries, which cannot be done without violating laws and ethical principles

around the sharing of this data.¹⁴ However, novice users may be unaware of this constraint, which is often buried deep in the legal agreements for use of these models, creating a significant risk of misuse.

Additionally, the use of AI may exacerbate bias issues in medical education. AI outputs are dependent on the training data, much of which contains nonrepresentative, missing, or racially skewed information. For example, estimating cardiac risk based on Framingham Risk Score data systematically underestimates risk in minority populations.¹⁵ As AI outputs can oftentimes be presented as confident and exacting, this can increase the risk that these biases go unrecognized and unchecked and are therefore perpetuated.

An additional significant concern of widespread AI adoption is the idea of losing critical thinking skills. Medicine requires the ability to rapidly assess, synthesize, and critique a large amount of data on an ongoing basis. Because AI also has this ability, there is concern that this “cognitive offloading” of learners could hinder development of their own critical thinking skills at a crucial point in their training. While this criticism has been leveled at other “new” technology in the past, with television being previously blamed for declining test scores and illiteracy, this nonetheless remains a significant potential concern given the importance of critical thinking for our specialty.

Finally, a significant concern about the increasing use of AI for medical education is the environmental impact. AI requires significant computing resources to both train the initial models and generate its responses. One study suggested that training just one AI model has an equivalent carbon footprint to driving 242,231 miles in an average gas-powered vehicle.¹⁶ While healthcare has historically had a known environmental impact, the widespread adoption of AI in

medical education has the potential to significantly worsen this impact and raises questions of sustainability as climate change continues to warm the planet.

Considerations and Risks when Using AI in the Clinical Environment

It is important to note the many limitations of AI use in the clinical environment. Most critically, educators must be vigilant about verifying statements generated by AI. The natural “tone” adopted in its responses can often sound authoritative, but AI lacks any inherent check on whether its responses are right or wrong, and ‘hallucinations,’ or confabulated facts, are well-known to occur. A hasty educator could easily be tricked into teaching incorrect or outdated information. It is especially important to double check literature that is cited as a source, as ChatGPT currently tends to invent citations that look plausible but are incorrect or simply do not exist.¹⁷

Similarly, it is also important to remember that AI does not have “judgment” of any kind.¹⁸ Instead, it offers a collection of words that frequently appear together, resulting in plausible sounding, but sometimes unwise, recommendations. For example, when asked how to perform an appendectomy in the ED, the AI may generate the steps for an appendectomy based on the surgical literature it has been trained on. It can ignore the fact that the ED context is different and that performing an appendectomy there would be unsafe and unwise under almost all circumstances. This sensitivity also highlights the importance of framing effects when utilizing AI - utilizing prompt engineering to ask it to generate responses, as a trained expert may generate higher quality responses than asking the same question without that clarifier.¹⁹ Educators wishing to impart clinical reasoning skills should likely consider alternative routes for teaching these important skills.

Although AI is generally lauded for its ability to synthesize large amounts of data, it is also important to use caution when asking LLMs to provide best practice recommendations. Critical subtleties can be overlooked, such as misinterpreting research findings as their opposite (“effective” vs. “not effective”) or overgeneralizing specific research findings.²⁰ Additionally, educators should be cautioned that even a correct synthesis of the best available evidence and practice recommendations may not line up with local practice patterns, provider preferences, or a medicolegally conservative approach.

In addition to maintaining awareness of the caveats of AI, it is also critical for educators to actively instill a healthy skepticism in their learners as well, given the above limitations. Evidence is clear that despite AI’s imperfections, medical learners of all levels are already using these tools for clinical tasks as diverse as generating discharge instructions, preparing for presentations, checking medication interactions and side effects, and understanding complex topics.²¹ Although many faculty may not feel immediately facile with these tools, without guidance from those with more clinical experience, learners may be at risk for inadvertently causing patient harm. Fortunately, progress has already begun on designing curricula to prepare learners for these complex new tools.²²

Future Directions for AI Use in Medical Education

Future, data-driven applications of AI hold considerable promise for advancing individualized medical education. AI systems may be leveraged to identify knowledge and skills gaps by analyzing multiple data sets, including in-service examination performance, simulation outcomes, and both narrative and quantitative feedback. Such insights may further inform the development of target learning goals and individualized training plans. Moreover, AI platforms

may be applied to longitudinally monitor resident clinical exposure, such as the number of patients seen, procedures performed, and acuity of cases managed, to ensure that each learner achieves the breadth and depth of experience necessary for readiness to practice independently. Beyond quantitative metrics, AI models possess the capacity to extract themes and subtle performance patterns from large and complex datasets that might otherwise escape detection. Predictive modeling may enable early identification of learners at risk of difficulty, allowing for timely, tailored interventions and support.

Collectively, these future directions suggest that AI could serve not only as an adjunct to individualized learning but also as a mechanism for advancing program-level oversight, equity, and accountability in medical education.

Conclusion

In an era where clinical educators are increasingly asked to do more with less, AI, particularly LLMs, offer a meaningful opportunity to enhance clinical teaching without replacing its human core. From augmenting bedside interactions to generating tailored learning goals and improving feedback processes, AI can support educators in delivering more intentional, equitable, and learner-centered teaching. These tools can help address longstanding challenges to clinical education such as limited faculty time, variability in teaching skills, and competing clinical demands, while also expanding access to just-in-time resources and reflective learning practices.

Importantly, effective use of AI in clinical education requires thoughtful integration. Educators must remain aware of the limitations and risks, including ethical concerns and the potential for overreliance and cognitive offloading. AI is not a substitute for clinical judgement or experience.

Rather, it is a tool that, when used deliberately and transparently, can help both learners and teachers focus more deeply on critical thinking and high-quality patient care.

As AI tools become increasingly accessible and integrated into healthcare, educators have a responsibility to model their safe and appropriate use. Learners are already engaging with these technologies—our role is to guide their application, mitigate potential harms, and ensure alignment with educational goals and clinical standards.

By leveraging AI thoughtfully, clinical educators can continue to uphold the values of clinical teaching while adapting to the realities of modern clinical practice. Used well, these tools can help us not only preserve but strengthen the educational mission at the heart of medicine.

References

1. Zhai C, Wibowo S, Li LD. The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review. *Smart Learning Environments*. 2024;11(1):28. doi:10.1186/s40561-024-00316-7
2. Jiang F, Jiang Y, Zhi H, et al. Artificial intelligence in healthcare: past, present and future. *Stroke Vasc Neurol*. 2017;2(4):230-243. doi:10.1136/svn-2017-000101
3. Nagi F, Salih R, Alzubaidi M, et al. Applications of Artificial Intelligence (AI) in Medical Education: A Scoping Review. *Stud Health Technol Inform*. 2023;305:648-651. doi:10.3233/SHTI230581
4. Xu X, Chen Y, Miao J. Opportunities, challenges, and future directions of large language models, including ChatGPT in medical education: a systematic scoping review. *J Educ Eval Health Prof*. 2024;21:6. doi:10.3352/jeehp.2024.21.6

- 392 5. Ahn J, Yashar MD, Novack J, et al. Mastery Learning of Video Laryngoscopy Using the
393 Glidescope in the Emergency Department. *Simul Healthc*. 2016;11(5):309-315.
394 doi:10.1097/SIH.000000000000164
- 395 6. Hill J, Frederick M, Santen SA, Urbanowicz O. Turning lemons into lemonade: Teaching
396 strategies in boarded emergency departments. *AEM Educ Train*. 2023;7(5):e10914.
397 doi:10.1002/aet2.10914
- 398 7. Shofer SL, Gagliardi JP, Bryant S, et al. Championing Civility in the Clinical Learning
399 Environment: Evaluation of a Novel Training Program. *Acad Med*. 2024;99(12S Suppl
400 1):S48-S55. doi:10.1097/ACM.0000000000005866
- 401 8. Museux AC, Dumont S, Careau E, Milot É. Improving interprofessional collaboration: The
402 effect of training in nonviolent communication. *Soc Work Health Care*. 2016;55(6):427-439.
403 doi:10.1080/00981389.2016.1164270
- 404 9. Stamer T, Steinhäuser J, Flägel K. Artificial Intelligence Supporting the Training of
405 Communication Skills in the Education of Health Care Professions: Scoping Review. *J Med
406 Internet Res*. 2023;25:e43311. doi:10.2196/43311
- 407 10. Waldron P. Medical students use AI to practice communication skills | Cornell Chronicle.
408 Cornell Chronicle. March 25, 2025. Accessed August 31, 2025.
409 [https://news.cornell.edu/stories/2025/03/medical-students-use-ai-practice-communication-](https://news.cornell.edu/stories/2025/03/medical-students-use-ai-practice-communication-skills)
410 [skills](https://news.cornell.edu/stories/2025/03/medical-students-use-ai-practice-communication-skills)
- 411 11. jhuang. The Role of AI in Assessing Student Progress and Providing Feedback.
412 21stCenturyEd. July 19, 2024. Accessed August 31, 2025. [https://21stcented.com/the-role-](https://21stcented.com/the-role-of-ai-in-assessing-student-progress-and-providing-feedback/)
413 [of-ai-in-assessing-student-progress-and-providing-feedback/](https://21stcented.com/the-role-of-ai-in-assessing-student-progress-and-providing-feedback/)
- 414 12. Hafferty FW. Beyond curriculum reform: confronting medicine's hidden curriculum. *Acad
415 Med*. 1998;73(4):403-407. doi:10.1097/00001888-199804000-00013
- 416 13. Irby DM. Clinical teaching and the clinical teacher. *J Med Educ*. 1986;61(9 Pt 2):35-45.
417 doi:10.1097/00001888-198609000-00005
- 418 14. Marks M, Haupt CE. AI Chatbots, Health Privacy, and Challenges to HIPAA Compliance.
419 *JAMA*. 2023;330(4):309-310. doi:10.1001/jama.2023.9458
- 420 15. Parikh RB, Teeple S, Navathe AS. Addressing Bias in Artificial Intelligence in Health Care.
421 *JAMA*. 2019;322(24):2377-2378. doi:10.1001/jama.2019.18058
- 422 16. Wu CJ, Raghavendra R, Gupta U, et al. Sustainable AI: Environmental Implications,
423 Challenges and Opportunities. *arXiv*. Preprint posted online January 9, 2022.
424 doi:10.48550/arXiv.2111.00364
- 425 17. Salvagno M, Taccone FS, Gerli AG. Artificial intelligence hallucinations. *Crit Care*.
426 2023;27(1):180. doi:10.1186/s13054-023-04473-y
- 427 18. Pamuk Z. Artificial Intelligence and the Problem of Judgment. *Ethics int aff*.
428 2023;37(2):232-243. doi:10.1017/S089267942300014X

19. Meskó B. Prompt Engineering as an Important Emerging Skill for Medical Professionals: Tutorial. *J Med Internet Res*. 2023;25:e50638. doi:10.2196/50638
20. Peters U, Chin-Yee B. Generalization bias in large language model summarization of scientific research. *R Soc Open Sci*. 2025;12(4):241776. doi:10.1098/rsos.241776
21. Sami A, Tanveer F, Sajwani K, et al. Medical students' attitudes toward AI in education: perception, effectiveness, and its credibility. *BMC Med Educ*. 2025;25(1):82. doi:10.1186/s12909-025-06704-y
22. Theros J, Soetikno A, Liebovitz D. Foundations of AI for future physicians: A practical, accessible curriculum. *Med Teach*. Published online February 12, 2025:1-3. doi:10.1080/0142159X.2025.2463492