



Concept

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

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Intro to AI for Clinical Teaching in the ED

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

2 Department

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

5

6 **Abstract**

7 **Introduction:**

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

12

13 **Methods:**

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

21

22 **Considerations:**

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

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

29

30 **Conclusion:**

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

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46 **Introduction**

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

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

58

59 **Methods**

60 This author group consisted of academic emergency medicine (EM) physicians from multiple
61 institutions who facilitated the “Be the Best Teacher: Clinical Teaching Educational Bootcamp”
62 at the 2025 Society for Academic Emergency Medicine (SAEM) pre-conference day on May 13,
63 2025. The curriculum addressed a range of core domains in clinical teaching, including strategies
64 for maximizing instruction in time-constrained environments, applications of cognitive load
65 theory, frameworks for delivering feedback as a structured process, and best practices for
66 navigating challenging learner interactions in the clinical setting.

67

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

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

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78 **Defining Artificial Intelligence and Its Use in Healthcare and Medical Education**

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

83

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

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

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

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

115 **Using AI to Generate Learner Goals on Shift**

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

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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.

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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

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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:

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 **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.

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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

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

159

160 **AI Use for Refining Feedback Delivery**

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

170 *In-the-Moment Feedback Delivery*

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

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176 psychologically safe and inclusive language for effective real-time feedback. For instance,
177 educators can request AI models to generate phrases based on non-violent communication
178 principles (such as “I noticed... I feel... I need...”) or to role-play responses to challenging learner
179 behaviors like disengagement or overconfidence. Faculty can also utilize AI to review and refine
180 feedback language, eliminating bias and assumptions, thereby promoting equity-focused
181 practices. This preparation enables educators to respond calmly and deliberately in emotionally
182 charged, time-sensitive situations, improving their effectiveness and presence at the bedside.^{7,8}

183 Reflecting after procedures or difficult patient encounters can reinforce learning. Frameworks
184 such as the ADAPT model mentioned above provide a coaching-oriented structure for feedback
185 that highlights observation, collaborative reflection, and actionable planning (REF). AI can assist
186 by creating customized debrief prompts suited to the learner’s level, the complexity of the
187 procedure, and the desired tone. For instance, by inputting “debrief questions after first
188 intubation using the ADAPT model,” one receives valuable prompts suitable for development.

189 These reflections serve to normalize challenges, bolster essential concepts, and transform even
190 minor achievements into significant learning experiences.

191

192 *Gathering Data to Inform Feedback Delivery and Longitudinal Coaching*

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

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200 number of procedures performed, the acuity of patients managed, etc., to tailor clinical
201 experiences and ensure each learner is adequately prepared for practice after training.
202

203 Additional areas for AI use in feedback are around more subjective and nebulous topics, such as
204 communication skills. Virtual patient conversations have been previously used to assist learners
205 not only with practicing communication skills in difficult clinical scenarios or with
206 interprofessional challenges, also to analyze communication performance to inform learners of
207 areas for continued growth.^{9,10} Future AI use may be expanded to develop scenarios that are
208 particularly challenging for a learner to continue to practice in a low-stakes environment, and to
209 screen for more nuanced tone, complexity, microaggression, and bias to continue to refine
210 communication skills in areas that are otherwise difficult to provide feedback around.
211

212 If this objective data is made easily accessible, much of a learner's self-monitoring and reflection
213 can be done privately and with increasing frequency. This allows the learner to not only self-
214 monitor and improve in-between coaching sessions but empower them to better prepare for
215 collaborative discussions when they meet with their coach. AI is essentially creating more "safe
216 space" opportunities for self-reflection and behavior adaptation, allowing the time spent with a
217 coach to be focused on the most complex situations or challenges.
218 Lastly, AI models may be utilized to glean themes or signals for each learner that may otherwise
219 be subtle or missed amongst large data reservoirs. Predictive modeling can also be particularly
220 useful when identifying learners who may require additional support early on.¹¹
221

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

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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:

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"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.

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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

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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

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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

263 **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

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

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

278

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

287

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

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

295
296 **Considerations and Risks when Using AI in the Clinical Environment**

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

305

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

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

325

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

335

336 **Future Directions for AI Use in Medical Education**

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

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

349

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

353 Conclusion

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

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

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

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

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

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