Quick Insights

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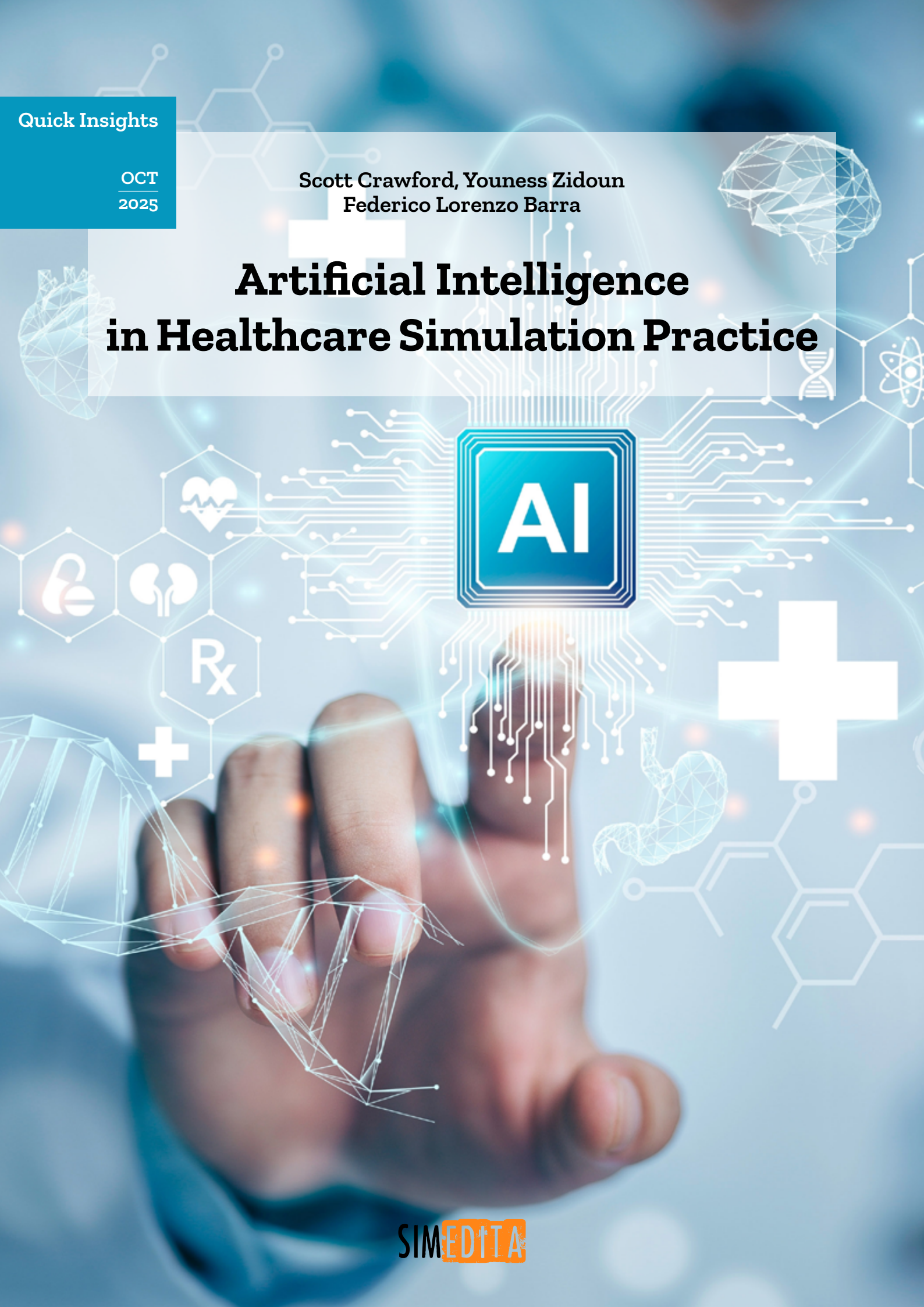
Artificial Intelligence in Healthcare Simulation Practice



SIMEDITA

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Artificial Intelligence in Healthcare Simulation Practice

Objective:
The goal of the paper is to appeal to simulation/healthcare educators to allow an understanding of the implications of AI and to enable them to use it more effectively and appropriately.

Examples are provided throughout the paper to describe potential features or identified use cases of AI. These are not meant to indicate endorsement of any company or institution over any other.

Content

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1. Background

The Dartmouth research project from the mid-20th century marked the beginning of AI as a scientific field while establishing the groundwork for future technological advancements (McCarthy et al., 2006).

Artificial intelligence (AI) refers to computer systems developed to carry out tasks that would normally require human intelligence, such as rationality, learning, vision, and language interpretation. By leveraging large volumes of data, such systems can identify patterns, make decisions, and handle problems autonomously, and usually in very short times with often outstanding precision and accuracy (Rodgers et al., 2023; What Is Artificial Intelligence?, 2025).

In other words, AI merges theoretical and practical aspects of computer science alongside linguistics and cognitive psychology, as well as other connected disciplines. Through advanced interdisciplinary integration, researchers can develop systems that successfully (Sarker, 2022) mimic the complex cognitive functions of the human brain. AI systems utilize sophisticated computational algorithms and statistical methodologies through linguistic structures to both process large data sets and adaptively learn from their environment. These systems can execute multiple complex tasks, including autonomous learning and logical reasoning, which allows artificial intelligence to serve a broader range of applications across various sectors (Sarker, 2022). As of today, AI drives everything from virtual assistants to recommendation engines to driverless cars, dramatically reshaping communities and people's lives.

Artificial intelligence can be categorized by both capability and underlying technique. In terms of ability, it includes Narrow AI (incapable of anything beyond simple control tasks), General AI (theoretically able to do any task naturally), and Superintelligent AI (capable of surpassing any human but remains a hypothetical concept at the moment) (*Types of Artificial Intelligence | IBM, 2023; What Is Artificial Intelligence?*, 2025). In terms of functionality, AI spans from memoryless reactive machines and limited memory systems (i.e., learn from data) to more advanced constructs that are still conceptual and speculative. As a subset of AI, machine learning (ML) emphasizes the creation of algorithms that enable computers to learn from data and subsequently make predictions or decisions based on that information.

OpenAI introduced ChatGPT to the world in November 2022, using multilingual text data to build a large language model (LLM) that generates humanlike contextual answers. ChatGPT functions as a combined system performing both chatbot operations and generative pre-trained transformer tasks with neural network-based natural language

processing capabilities (Brown et al., 2020). Through enhanced contextual understanding, DeepSeek uses deep learning techniques to improve both multilingual comprehension and reasoning abilities and produce sophisticated responses. A human-centered approach drives Anthropic's development of Claude, which operates as a language model dedicated to safety standards and constitutional AI principles to build user-aligned interactions while addressing bias and misinformation. Google DeepMind's Gemini model builds upon transformer systems by integrating advanced multimodal capabilities that allow efficient generation and processing of text, images, and code through improved contextual understanding.

A longstanding debate has been reignited within the scientific community over the advantages and risks of advanced AI technologies (Tai, 2020; Wogu et al., 2017). On the one hand, LLMs such as ChatGPT have been promoted for their capability to streamline writing and conversational tasks, enhancing efficiency in information processing. On the other hand, erroneous content, which can be referred to as "hallucination/confabulation", remains one of the most significant concerns, alongside the misuse of such tools, contributing, for example, to the dissemination of misinformation, which can hinder its adoption in critical domains (Deng & Lin, 2023).

One of the earliest scientific papers highlighting the potential of AI in healthcare simulation can be considered *"Artificial Intelligence: A New Frontier for Anesthesiology Education"* (Arora, 2020), published in the British Journal of Anaesthesia. While this article mentions the interesting emerging role of AI in transforming anesthesiology training and clinical practice, it does not specifically focus on its integration into simulation.

Most simulationists would agree that the first paper focusing on AI integration into healthcare simulation was *"Artificial Intelligence in Healthcare Simulation: Hype or Hope"* (Rodgers et al., 2023), published in the International Journal of Healthcare Simulation. In this paper, the authors discussed the rapid adoption of AI technologies like ChatGPT in healthcare professional training, questioning whether AI is a trend or a significant advancement that should be considered seriously.

Another key publication was *"Advancing Healthcare Simulation Through Artificial Intelligence and Machine Learning"* (Harder, 2023), published in Clinical Simulation in Nursing. In this article, the authors explore how AI and machine learning can contribute to the improvement of healthcare simulation by optimizing learning outcomes and improving patient care.

Additionally, "Artificial Intelligence and Simulation in Healthcare: The Shifting Landscape of Medical Education" (Hamilton, 2024), published in Cureus, contributed to understanding how AI-based tools complement and reinforce traditional simulation methods, providing insightful points about their benefits and challenges in medical education.

These essential reference papers collectively demonstrate the growing interest in leveraging AI to improve healthcare simulation and medical education.

2. AI status in Simulation

The current prevalence and specific use of AI in educational institutions, and specifically simulation centers worldwide, is difficult to quantify. This is partly because the technology has only been around for public use since the end of 2022, so no large scale studies have been published related to this topic, and often individuals may be hesitant to reveal that they are in fact using AI in any form. This hesitancy could be because of a fear of negative perception by coworkers or leadership, specific guidance forbidding or limiting its use from administration or IT departments, or uncertainty about how to appropriately cite or disclose its use in a scholarly manner.

An anonymous survey with 375 respondents compiled from live-polling during presentations regarding the origins and consideration for use of AI conducted at 8 simulation conferences across four countries (United States, New Zealand, Argentina, and Denmark) from May 2024 to January 2025 revealed that 72% (270, n=375) of respondents have "used AI for a work related activity." A smaller percentage 18.2% (58, n=317) report using AI daily in simulation or other educational activities. Hospitals, universities, and nearly every large institution are struggling to understand the impact and implications of this new technology on their current workforce, infrastructure and are rushing to provide appropriate guardrails and policies to staff, students, and faculty for if, how, and when it may be appropriate to use AI. One of the largest barriers to providing such guidance, may still be how little is understood about what it is capable of and broader societal perceptions about what it should be used for, and what it shouldn't. In the same survey, 7.3% (18, n=245) of respondents believed it would be unethical to use AI in a clinical setting and 25.8% (82, n=317) wouldn't know how to use it for simulation.

Despite these limitations and uncertainties, 87% (242, n=278) of respondents in these simulation conferences believed AI would improve our lives in the next 10 years. One of the most important ways to ensure this is the case is to guide and educate the users of this technology regarding how to use it, when it is appropriate or inappropriate to use it, and how to disclose its use.

3. Policy Considerations

Policies are a written guide for people to follow related to a specific area or facet of their work or that directs how an institution wishes to operate. Policies however are only part of the final approach that is taken in any given instance. Institutional, professional, or societal culture may often have a larger impact on how people end up acting in any given situation. Speed limits while driving are a prime example of the latter. Although the posted number is the "policy," each region and individual driver has their own approach to the final application of this number in practice. Police enforcement ends up being the mediator between culture and policy. Given how rapidly the area of AI tools is changing, it is important to have a policy that reflects not only the expected actions, but also acknowledges that areas of uncertainty may exist and provide guidance for larger goals to support individual ethical application and flexibility to adapt to a changing environment. (Personal Data Protection Commission - Singapore, 2020). Since it may not be possible to predict all uses, an overall guidance statement can help in areas of uncertainty.

"Absent a clear statement from a course instructor, use of or consultation with generative AI shall be treated analogously to assistance from another person. In particular, using generative AI tools to substantially complete an assignment or exam (e.g. by entering exam or assignment questions) is not permitted. Students should acknowledge the use of generative AI (other than incidental use) and default to disclosing such assistance when in doubt." (Generative AI Policy Guidance | Office of Community Standards - Stanford, 2023)

Some specific areas that may be important to address in an AI policy within simulation and other educational environments are:

- Use by staff and faculty in scenario creation, auxiliary materials, or live AI patient portrayal
- Use in feedback, debriefing, evaluation, or grading of learner performance
- When AI tools are (or are not) allowed by learners in educational activities
- Disclosure of use and citation/attribution of AI created content; by learners or faculty
- How or if AI detection tools should be used

- IT and security guidance for specific tools with and without institutional agreements
- Data privacy related to uploading and disclosing information in prompts or document ingestion by AI models
- Alignment with other policies and institutional practices
- AI material review and authorship attribution

While an independent AI policy will be important for individual institutions, or companies to adopt, it may be easier to refer to and rely on existing practices and policies related to its implementation. Many of the above examples are likely covered in some manner in existing policies about academic misconduct, data disclosure, and student and patient record protections. Alignment with these existing policies may provide for a smaller overall changes and understanding of expected practice and thus allow for more rapid deployment and support alignment with existing local cultural practices and institutional understanding.

One example of this approach is from Texas Tech University Health Sciences Center El Paso - "Operating Policy 56.08 - Acceptable Use of Generative Artificial Intelligence (GenAI) Tools." (Texas Tech University Health Sciences Center El Paso, 2025)

This individual institutional document, for example, highlights that AI is allowed for personal use, but only with publicly available data and should only be used in a support capacity and not to provide autonomous content creation on behalf of the institution. This policy is also explicit that "If LLMs or similar AI Tools are used to generate output that would be available for public use outside of the institutional domain, authorship must be attributed to an institutional employee or student." This later portion would thus require full review of any output and provide editing or modification before it could be allowed for distribution/use.

For a purely simulation specific interpretation of use, faculty and staff could therefore use AI to create scenarios and support materials, but would need to disclose or acknowledge its use in the creation of content and must take ownership of the material before distribution. This may not be sufficient, however, to provide protection from content sharing or duplication. AI produced materials are likely not able to be protected under copyright law unless substantial additions in the form of creative input are added on the part of the author.

Copyright

While the idea of copyright related to AI is a continuously evolving field, the U.S. government has specified that copyright protection requires "human authorship." This concept has been reiterated in the document "Copyright and Artificial Intelligence, Part 2: Copyrightability" put out by the U.S. Copyright Office in January of 2025. *(https://www.copyright.gov/ai/opyright-and-Artificial-Intelligence-Part-2-Copyrightability-Report.pdf)*. It is further clarified and supported that "No court has recognized copyright in material created by non-humans, and those that have spoken on this issue have rejected the possibility." This same guidance also reports that an author must make a "copyrightable contribution" in order to be considered a joint author and that "prompts alone do not provide sufficient human control to make users of an AI system the authors of the output."

This same report from the U.S. Copyright Office provides examples from Korea, Japan, The People's Republic of China, the United Kingdom, and the European Union. The summary paper of comments on this topic from the EU Council in Brussels "Policy question-

naire on the relationship between generative Artificial Intelligence and copyright and related rights – Revised Presidency summary of the Member States contributions" summarizes the concept in one example that copyright is available "only if the human input in [the] creative process was significant." *(https://data.consilium.europa.eu/doc/document/ST-16710-2024-REV-1/en/pdf)*

IT Security and Data Privacy

Publicly available AI systems are explicit in their terms of use that material used in prompt review and generation may be used to continue training future AI models. This may be of little concern for small or simple tasks without specialized or proprietary data input, however once student grading, health record, research data, or other potentially restricted use materials are planned for use in AI interpretation or for use with content creation, this discussion changes.

Data is commonly classified into 4 levels depending on how sensitive or protected the material is or its risks if shared. (*Palo Alto Networks*, n.d.) Other classification systems expand these categories into 5 levels by separating Confidential into High and Low risk categories.(*Harvard*, n.d.)

1. Public - No risk or damage if shared (Marketing materials)
2. Internal - Minimal to no damage if shared (Course materials)
3. Confidential - Moderate damage (Student performance data)
4. Restricted - Significant damage (Research data, Health records)

AI use policies should describe in what settings each type of data can be used in prompt creation or analysis.

This type of AI policy will likely be set at an institutional level (school, hospital etc.) and not for a single program or simulation center.

4. Ethical Use & Hazards

Separate from any written guidance, and arguably more importantly, teaching users about AI and how institutions and society are being encouraged to interact with this new technology will influence its adoption and use. One of the most impactful examples to describe how to view the interaction with the text-based response from a large language model is that it is analogous to texting your most knowledgeable friend about any topic; and it appears that this interpretation was used to help provide the following guidance at Stanford about how (or if) the use of AI assistance should be disclosed.

> *"Absent a clear statement from a course instructor, use of or consultation with generative AI shall be treated analogously to assistance from another person. In particular, using generative AI tools to substantially complete an assignment or exam (e.g. by entering exam or assignment questions) is not permitted. Students should acknowledge the use of generative AI (other than incidental use) and default to disclosing such assistance when in doubt." (Stanford, 2023)*

While individual programs and organizations are trying to discover and define how, AI should be used by learners, educators, and clinicians, larger governmental and national regulatory bodies are working to support these individual-level policies by providing societal level guidance with a global perspective. The United Nations Educational, Scientific and Cultural Organization (UNESCO) produced summary guidance in 2021 to outline 10 core principles, based on a human rights approach to AI. (Ethics of Artificial Intelligence The Recommendation, n.d.).

UNESCO 10-principles:

1. Proportionality and Do No Harm
2. Safety and Security
3. Right to Privacy and Data Protection
4. Multi-stakeholder and Adaptive Governance & Collaboration
5. Responsibility and Accountability
6. Transparency and Explainability
7. Human Oversight and Determination
8. Sustainability
9. Awareness and Literacy
10. Fairness and Non-Discrimination

The greater societal and ethical considerations about the origin and creation of generative language models is being reviewed at a larger legal level. The high profile case of The New York Times vs. Open AI and financial backer Microsoft began in January of 2025.

Here the question will come down to was the use of copyrighted material used to: train this model in violation of copyright or is this covered under fair use? (Allyn, 2025) Until this question is resolved or larger regulatory guidance is provided, individuals and organizations will need to define their own ethical understanding of what is appropriate use.

One area where ethics may prevail over policy is in the use of AI detection systems and specifically enforcement of academic integrity sanctions for suspected infractions.

Some schools use AI detection systems such as Turnitin to flag material identified as potentially being partially or completely AI created. This tool reported 98% accuracy from its creator in detecting AI content when it was released in 2023, a number that seems remarkably good, but has significant concerns when expanded to match this 1 in 50 error rate with the consequences of academic dishonesty. A more recent independent evaluation of this tool suggests that it may only be able to detect AI content 91% of the time. (Perkins et al., 2024) And specifically only 54.8% of the AI content was identified. Other groups have evaluated similar tools with wide accuracy ranges from 35-79%. Potentially more concerning, however, is that human-written texts are only identified accurately with a level near 96%. (Weber-Wulff et al., 2023) This would allow actual human generated content to be flagged as AI in 1 in 25 assignments, depending on the detection tool used.

Since the risk or false positive and negative detections by these systems remains variable, generating a culture of appropriate use and attribution may be the most important step. Some schools and training sites have allowed or encouraged the use of AI, by incorporating it directly into the assignment process. By acknowledging its use and not trying to hide it, students are hoped to be more forthcoming about its use and sharing how it is being used in the creative development process, such as turning in the prompt and resultant outputs as part of the assignment.

This approach aligns with both AI UNESCO guidance and the long-standing medical concept of "first do no harm" while remaining human centered as outlined in the AI-based guidance from Singapore's Personal Data and Protection Commission. (Personal Data Protection Commission - Singapore, 2020; UNESCO, 2021)

An article in The Economist by author and historian Yuval Noah Harari describes what he views as the greatest risk of AI. His dystopian view of the end of humanity is not machines taking over the world in the form of robots, but when we cannot distinguish between human and AI generated content.

If AI continues without appropriate safeguards in place, a tool that was trained and built from the collective ingenuity of humanity, it is possible for new culture, and thoughts to be built without the mind and thoughts of a human. A further reminder that AI tools must remain human centered and with the goal of beneficence. (*"Yuval Noah Harari Argues That AI Has Hacked the Operating System of Human Civilisation,"* 2023)

Although different than the ethical use of AI, bias and hallucinations/confabulations pose a risk to the appropriate use of these tools due to the chance of sharing incorrect information or skewing the information that is produced.

"ChatGPT 'learning' quickly adapts to what you are looking for and may produce results slanted towards a view the program thinks you want, similar to a confirmation bias." (Rodgers et al., 2023) Human oversight will remain critical to help prevent negative effects of bias and hallucinations/confabulations. While AI system designers must work to minimize these effects through algorithmic processes, end-users must remain vigilant and responsible for sharing AI produced content.

4. Ethical Use & Hazards

Here in the ethics of use is one area where simulation may play a critical role in the changing landscape of healthcare education. Much in the same way that some undergraduate courses have reverted to pencil and paper assignments to ensure academic integrity and demonstration of critical thinking in writing assignments, simulation-based educational events allow for direct observation of a learner's knowledge or skill. This direct observation allows educators to see the true level of performance and provide guidance on knowledge or skill advancement. It may therefore be encouraged to decrease the reliance on written assignments where AI systems could be used by learners if detection is not reliable.

One area of proposed use that exemplifies potential issues with ethical implementation is the allowance of an AI system to portray a member of the healthcare team. It has been established as appropriate by many clinical educators to have AI systems, using pre-programmed cases, to respond to learner's questions in the role of a patient. The risk of hallucinations and bias are restricted by using a guided script to constrain responses. Could these same systems be used in the role of another healthcare team member in the same way? The World Health organization states that IPE "occurs when students from two or more professions learn about, from, and with each other." (*Framework for Action on Interprofessional Education and Collaborative Practice*, 2010)

Here is posed a practical example:

Can an AI system take on the persona of another healthcare team member?

Does an appropriately guided and trained AI model meet the standards of the WHO to support IPE education?

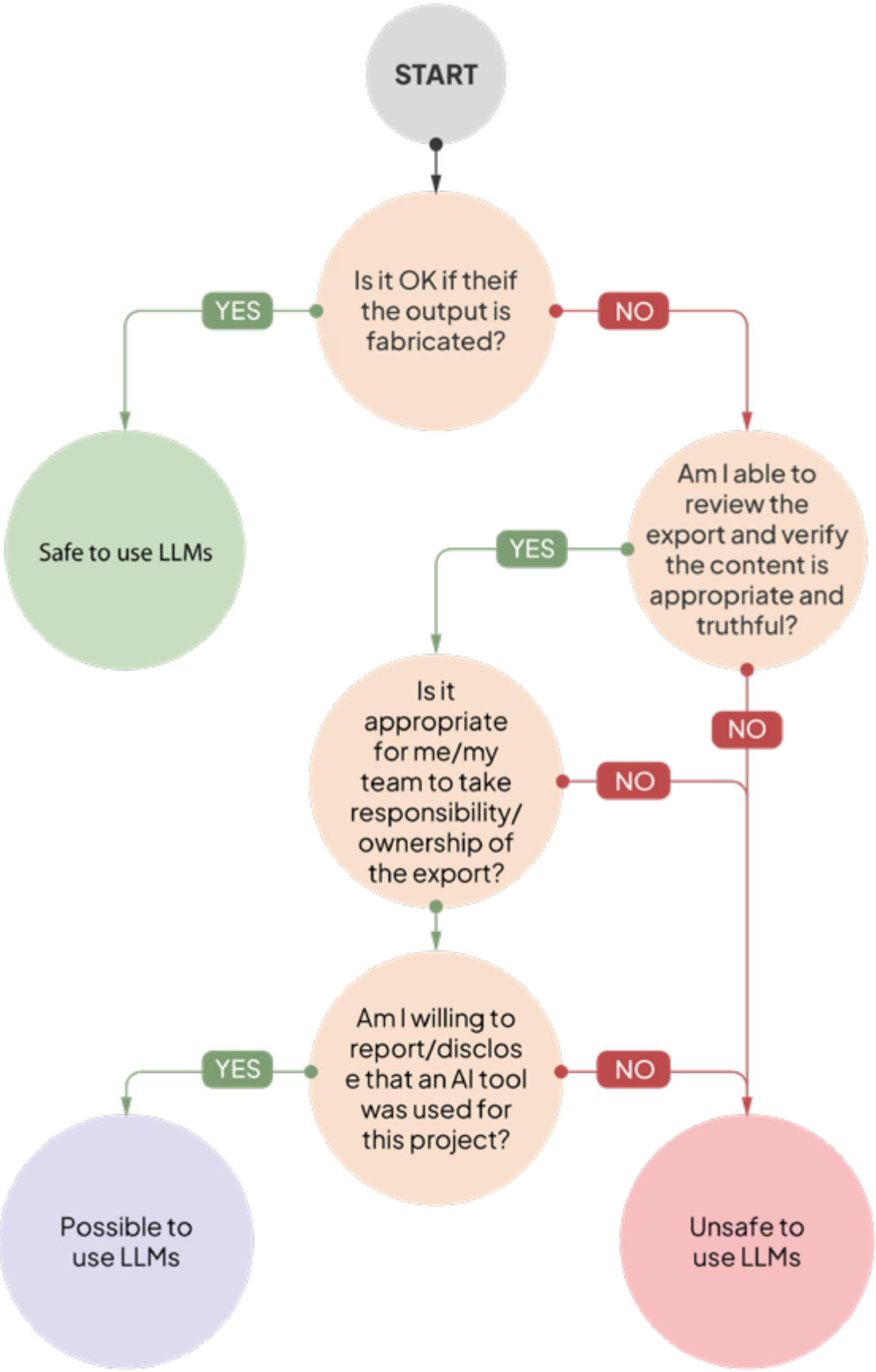
As suggested previously, relying on existing guidelines such as the Healthcare Simulationist Code of Ethics that was crafted by a working group of global contributors. (Code of Ethics Working Group, 2018) could meet the requirements for ethical implementation if it aligns with the six guiding principles.

I. Integrity
II. Transparency
III. Mutual Respect
IV. Professionalism
V. Accountability
VI. Results Orientation

This hypothetical use of AI in IPE training could therefore be considered under this existing ethical framework for simulation as long as it:

1. Discloses the origin and intention of its design.
2. Is not produced to deceive the responses and interactions as being anything other than AI in origin and describe its expected purpose within the simulation activity.
3. Is open to critique and cognisant of potential issues with psychological safety or bias in responses from the system.
4. Is assessed to ensure it is advancing the culture of simulation and the professions it is supporting.
5. Provides attribution to the AI tool or system that is being used.
6. Seeks feedback for improvement regarding its use

4. Ethical Use & Hazards



5. AI and Simulation-Based Education Standards

Artificial intelligence (AI) is rapidly emerging as a transformative force in healthcare simulation-based education. Educators are exploring how AI-driven tools, from intelligent virtual patients to data-crunching algorithms, might enhance learning experiences. Because simulation training is already intertwined with advanced technology, it offers a practical testbed for new AI applications. (Hamilton, 2024)

Used thoughtfully, AI can help scale up training opportunities, personalize learning, and provide rich feedback for learners.

Crucially, however, any integration of AI must uphold the core values and proven methods that make Simulation a safe and effective learning modality. Simulation best practice frameworks, such as the ASPiH Standards (Association for Simulated Practice in Healthcare) and INACSL Healthcare Simulation Standards of Best Practice™, serve as essential guardrails. (*ASPiH Standards 2023* – ASPiH, n.d.; Healthcare Simulation Standards of Best Practice, 2021)

Recognition of existing standards and guiding frameworks will help ensure appropriate implementation of AI tools either based on general pedagogical approaches and educational frameworks, or reference and review within the context of Ethical frameworks by individual professionals and those specific to healthcare simulation.

(Code of Ethics Working Group, 2018)

This chapter uses these standards as a guiding framework. We will first explore how AI can support, and not substitute, the pedagogy of Simulation across key dimensions like curriculum integration, scenario design, facilitation, debriefing, and assessment. Then, we will explore specific AI applications currently changing the field, categorized broadly into Planning, Managing, and Reviewing simulation activities. We will address the ethical and practical considerations for keeping AI's use in sync with the "spirit and letter" of established best practices.

Aligning AI with Core Simulation Principles

Before diving into specific tools, let's consider how AI can potentially reinforce the foundational principles of effective simulation education, as outlined by leading standards.

- **Integrating Simulation into the Curriculum:** Effective simulation-based education is not an isolated event; it is integrated into the broader curriculum

with specific learning objectives. Both ASPiH and INACSL emphasize that every simulation activity should be driven by educational needs and intended outcomes. AI can assist educators by analyzing curricula and learner performance data to identify gaps and suggest targeted simulation topics. For instance, if data shows consistent struggles with recognizing sepsis, AI could prompt faculty to develop a relevant scenario, reinforcing the standard that outcomes must align with learning needs. AI tools like large language models can also act as assistants, drafting scenario outlines tied to objectives, significantly reducing development time while allowing educators to focus on refinement and ensuring accuracy. The human educator remains essential for vetting and finalizing content. (Sumpter, 2024)

- **Key Point:** AI can help map curriculum gaps and accelerate content creation that is aligned with objectives, but educators must ensure the final product meets standards and learner needs.

- **Scenario Design and Fidelity: "As Real as Necessary":** Scenario design starts with objectives, which then dictate the appropriate modality and fidelity. Realism serves the learning goal, not just the "wow" factor. AI can generate complex case details rapidly, drawing on vast medical knowledge to add lifelike elements like evolving symptoms or subtle vital sign changes. This frees educators to focus on ensuring quality and relevance, core ASPiH values. AI can also enhance fidelity dynamically. AI algorithms in manikins can adjust physiological responses based on learner actions (e.g., simulating an adverse drug reaction), creating more authentic, responsive scenarios that are hard to script manually, all while following educator-set parameters. AI-driven virtual patients offer another avenue, mimicking human conversation and behavior to practice communication skills, potentially increasing access when standardized patients are unavailable. (Hamilton, 2024; Liaw et al., 2023) The crucial point remains: fidelity must serve the learning outcomes. Educators direct the AI, ensuring realism enhances, rather than distracts from, the educational purpose.
  - **Key Point:** AI can assist scenario creation and enhance fidelity with realistic, dynamic elements, but human educators must curate the design to ensure fidelity serves the learning objectives.

- **Facilitation: AI as Co-Pilot, Not Autopilot:** Skilled facilitation involves guiding learners, managing the scenario, and maintaining psychological safety. AI can act as a co-pilot, handling specific tasks. AI agents can play ancillary roles (like virtual consultants) and free instructors from workload. Studies suggest AI characters can perform comparably to human-controlled ones in specific contexts, potentially making training more scalable. (Liaw et al., 2023)
  AI might also offer real-time decision support, prompting facilitators about scenario events or using voice recognition to adjust simulator parameters automatically. However, the human touch such as empathy, adaptability, establishing psychological safety, remains irreplaceable and beyond current AI capabilities. Facilitators need training in simulation pedagogy and potentially in managing AI tools effectively. AI supports, but the human facilitator pilots the learning journey.
  - **Key Point:** AI can automate roles and tasks, freeing human facilitators to focus on learners and making simulations more scalable. However, the facilitator's expertise in guiding the

experience and ensuring safety is paramount.

- **Debriefing: Enhancing Reflection with AI Support:** Debriefing, the reflective discussion post-scenario, is critical for consolidating learning. (Healthcare Simulation Standards of Best Practice, 2021) Its goal is to turn experience into insight. AI must support, not undermine, this reflective process. Encouragingly, the standards acknowledge AI's potential role in guiding debriefing. AI can provide objective data (e.g., timing of actions, communication patterns) that facilitators might miss, enriching discussion. This data could be presented non-judgmentally and fuels reflection ("Let's look at the timeline..."). AI can also standardize feedback on technical skills (e.g., reporting intubation success rate) or even enable AI co-debriefers (chatbots) for supplemental, personalized reflection. However, debriefing is sensitive; the facilitator must manage AI feedback carefully to maintain psychological safety. The human connection, empathy, and mentorship in debriefing remain vital. AI provides data and prompts; the facilitator guides the meaning-making.
  - **Key Point:** AI can bolster debriefing with objective data and feedback, enhancing reflection, but the human facilitator remains the anchor, ensuring insights are used tactfully within a safe, supportive environment.

- **Learner Assessment and Feedback: Towards Personalized Evaluation**: Simulation serves formative (improvement-focused) and summative (competence-evaluating) assessments. Standards require rigor, fairness, validity, reliability, and psychological safety in assessment. AI can offer rich, real-time formative feedback, acting like a personalized coach available 24/7, supporting deliberate practice. For summative assessment, AI can consistently enhance reliability by applying scoring criteria, reducing human rater variability. However, vigilance against AI bias is crucial. Systems must be trained on diverse data and validated to ensure equity. Transparency about AI's role and faculty oversight are key. AI assessment should be one tool, among others, interpreted within a human mentoring context. AI's ability to analyze multimodal data (video, audio, sensors) offers the potential for more granular assessment, always aimed at learner growth.
  - **Key Point:** AI can provide personalized feedback and consistent scoring, supporting learning and potentially improving assessment fairness, but validity, reliability, equity, and psychological safety must be paramount, with human educators guiding interpretation.

Epistemological and Methodological Considerations

Integrating AI into Simulation requires careful attention to how knowledge is constructed (epistemology), and sound methodology guided by ASPiH and INACSL principles.

- **Safety (Physical and Psychological):** AI systems must uphold simulation's safety imperative. This means rigorous testing of AI-controlled equipment and ensuring AI interactions (e.g., avatar speech, feedback) maintain a respectful, supportive environment. Programming boundaries and facilitator overrides are essential. Learner data privacy and confidentiality must be paramount.

- **Equity, Diversity, and Inclusion (EDI):** AI bias is a known risk. We must ensure AI tools treat all learners fairly and rep-

resent diversity appropriately in scenarios. This involves diverse training data, bias checks, and the conscious use of AI to create more inclusive cases. Validation of diverse user groups and ensuring accessibility (e.g., language support) are crucial.

- **Transparency and Integrity:** Honesty about AI use builds trust. Learners and faculty should know when AI is involved (e.g., controlling an avatar and generating feedback). Educators must acknowledge AI limitations and retain final judgment, ensuring human oversight upholds ethical standards. Research involving AI must adhere to ethical guidelines like informed consent.

- **Epistemological Alignment:** AI should support experiential learning (learning by doing and reflecting). AI tools should prompt critical thinking, not just provide answers. Simulation offers a space to teach AI literacy: having learners interact with and critique AI tools and understanding their strengths and weaknesses.

- **Methodological Rigor:** Implement AI with a continuous improvement mindset (Plan-Do-Study-Act). Evaluate whether AI integration genuinely improves outcomes. Involve stakeholders in testing and developing clear protocols for using AI tools, ensuring quality and excellence. AI might support sustainability goals by increasing efficiency and enabling remote options.

By addressing these considerations, we ensure AI integration reinforces, rather than undermines, the quality and values of simulation education.

Specific AI Use Cases in the Simulation Workflow

Having established the importance of aligning AI with pedagogical standards, let's explore how AI is applied across the simulation workflow, categorized broadly into Planning, Managing, and Reviewing simulation activities.

1. CASE CREATION (Planning):

AI is revolutionizing clinical scenario development, moving us from static scripts towards dynamic, adaptive, and personalized learning experiences (*AI Medical Scenario Creator | ASTEC - Arizona Simulation Technology and Education Center*, n.d.; Theros, 2023). Creating realistic and varied patient cases traditionally demanded significant time and expertise from senior educators. Adapting scenarios for different learner levels, updating guidelines, or including rare conditions was often resource-intensive.

Generative AI systems, trained on vast datasets, can generate diverse patient cases on demand tailored to specific learning objectives and learner needs ("Case Study," 2024). These algorithms synthesize information from diagnostic criteria, treatment protocols, demographic data, and real-time clinical feeds to build realistic clinical situations (Zheng et al., 2024). AI can be trained on guidelines (like USMLE/NCLEX), past exams, or EHR data to create detailed patient histories mirroring real-world complexity, fostering critical thinking and clinical reasoning.

This flexibility allows simulation programs to adapt to changing curricula, emerging health challenges (like new infectious diseases), or specific learner performance gaps. Educators can feed AI models parameters like:

- Target learner level (e.g., novice vs. expert)
- Clinical competencies to address (e.g., diagnostic accuracy, communication)
- Pathophysiology complexity

- Equipment constraints

Reports indicate AI can produce fully-formed scenarios with differential diagnoses and complication branches in under 15 minutes. Pilot programs, like one at the University of Toronto, showed significant reductions in development time while maintaining adequate clinical accuracy compared to human authors (Barra, 2025; Sumpter, 2024).

AI also facilitates standardizing scenarios by importing and converting existing cases into digital platform templates, like those offered by iRIS, ensuring consistency (*iRIS - The Intuitive, Collaborative,Simulation Authoring Platform*, n.d.).

Furthermore, AI enables personalization by dynamically adjusting case difficulty or complexity based on real-time learner performance. As learners progress, AI can generate progressively challenging scenarios. Finally, AI excels at incorporating unpredictability – introducing unexpected complications or atypical presentations – preparing learners for the ambiguity of real practice and building resilience.

2. AVATAR PORTRAYAL

(Managing, Planning):

AI-powered Avatars, or Virtual Patients (VPs), blend artificial intelligence with immersive technologies (VR, AR, or screen-based) to create realistic, adaptive training environments (Anderer & Hswen, 2024; Lewis et al., 2017). They address the limitations of traditional methods: standardized patients can be costly and variable, while mannequins lack natural language interaction. VPs offer interactivity, scalability, and cost-effectiveness.

Large language models (LLMs) are the engine behind these avatars, enabling realistic animations, expressions, and dynamic responses to learner communication. This fosters immersion, which is crucial for developing interpersonal skills like empathy (*Create AI Characters For Your VR Games And Simulations | Convai, n.d.; HeyGen - AI Spokesperson Video Creator*, n.d.). While LLM performance varies (e.g., response lag, language support), smaller, faster multilingual models are emerging.

Without risk, learners can safely practice communication skills, such as active listening, delivering difficult news, and shared decision-making. VPs can simulate diverse patient demographics (age, ethnicity, background) and communication challenges (health literacy, language barriers, sensory impairments), promoting culturally competent care (*SimX For Physicians, Clinicians, and Students*, n.d.).

Systems like Coventry University use custom-trained LLMs for fluid, unscripted conversations (*PCS Spark*, n.d.).

Advanced voice processing allows avatars to recognize and respond to tonal variations (Barra et al., 2024; Callwood, 2025). Systems like Hyperspace's simulate emotionally intelligent interactions, providing feedback on empathy (Stefanic, 2025). Reinforcement learning allows continuous improvement; the University of Florida's system evaluates nursing students' questioning and empathy, offering immediate suggestions (*AI-Powered Avatars Transform Training for Nurse Practitioners and Dentists " College of Nursing " University of Florida*, n.d.).

Virti is an immersive learning platform that leverages extended reality (XR), virtual reality (VR), and artificial intelligence (AI) to provide engaging training experiences. Their platform includes AI-powered virtual patients that interact with trainees, testing skills in areas such as empathy and communication. Virti's technology has been used globally, including by organizations like the NHS and Cedars-Sinai Hospital, to train healthcare professionals in various skills. (*The AI Role-Play and Video Training Platform for Upskilling*, 2025)

ClinCaseQuest provides an AI-driven patient simulator aimed at enhancing clinical training. Their platform offers intelligent, interactive, and adaptive clinical training experiences, allowing learners to engage in realistic patient encounters. ClinCaseQuest's

simulator is designed to support the development of clinical reasoning and decision-making skills. ("Get Early Access AI-Driven Patient Simulator," 2025)

However, ethical considerations arise. If not carefully managed, biases in LLM training data could perpetuate healthcare disparities. Patient data privacy requires strict anonymization. Over-reliance on scripted elements, even within AI, risks oversimplifying complex interactions. Balancing standardization with realistic variability remains a challenge.

3. SUPPORT DOCUMENT CREATION

(Managing):

Generating realistic simulation support materials – patient charts, lab results, imaging reports – is traditionally time-consuming administrative work for educators. This detracts from teaching and limits scalability. AI offers automated workflows to create accurate, context-aware medical documentation.

Manual creation involves populating EHR templates, generating consistent lab values, writing imaging reports, and ensuring internal consistency across all documents. This complexity increases for longitudinal scenarios. A 2023 study found anesthesiology educators spent significant prep time on documentation, often duplicating efforts (Gershov et al., 2023). Manual methods also risk inaccuracies if the results don't align with the clinical picture.

AI addresses this through:

- **Context-Aware Content Generation:** Natural Language Process (NLP) models trained on clinical data produce synthetic records matching specified criteria.
- **Dynamic Data Synthesis:** Machine Learning (ML) algorithms create interdependent values (labs, vitals) reflecting disease progression (e.g., trending lactate in a sepsis simulation).
- **Scenario Adaptation:** Systems can modify records based on learner actions (e.g., generating antibiotic susceptibility results if inappropriate drugs are ordered).

AI can also structure free-text notes and translate complex medical jargon into plain language, which is helpful for simulated patient education materials. This automation saves educators time for observation, facilitation, and debriefing.

4. MANIKINS AS INTELLIGENT PATIENTS

(Managing)

Modern human patient simulators are evolving from static manikins into responsive, AI-driven "patients" that mimic real human behavior. Simulation manufacturers and researchers have begun integrating artificial intelligence to enhance realism in medical training. These AI-enabled simulators can speak and understand language, show emotions, adapt their physiology, and even help create new training scenarios. The result is a more lifelike and immersive learning experience for healthcare trainees, bridging the gap between classroom practice and real clinical encounters. (Ayoub Ait Lahcen, 2025)

One of the most visible impacts of AI is in giving simulators the ability to carry on realistic conversations. Natural language processing (NLP) lets patient simulators understand spoken questions and respond with human-like dialogue. For example, Gaumard's advanced HAL models (such as the HAL S5201/S5301 series) feature "conversational speech enhanced by artificial intelligence." These simulators can listen to a trainee's questions (like asking about medical history or symptoms) and automatically answer in real time with a natural-sounding voice. HAL can follow voice commands and "learn" from interactions over time to improve its responses. Other commercial simulators offer similar AI-driven communication. (*HAL® S5301*, n.d.)

The ALEX patient simulator (developed by Nasco Healthcare) is a full-body manikin that uses cloud-based speech recognition and AI to engage with learners in multiple languages. ALEX can speak and understand English, Spanish, French, and German, providing patient-specific answers on hundreds of topics. This allows nursing and medical students to practice taking histories or delivering instructions to a "patient" who talks back in their own language. (Gore, 2023)

AI voice technology also adds emotional realism. For instance, Laerdal Medical has created an AI voice library with voices that sound empathetic, fearful, or in pain, so that virtual or manikin patients can express emotion in their tone. All of these advances make interactions feel more genuine. Trainees must communicate effectively, show empathy, and build rapport with the simulator as if it were a live patient, which hones their bedside manner and communication skills. (*AI Voices. A New Level of Realism in Healthcare Education.*, n.d.)

5. AUTOMATED PERFORMANCE GRADING AND FEEDBACK

(Reviewing, Managing):

AI is transforming assessment in Simulation by enabling automated, objective, and scalable evaluation of clinical competencies using algorithms, NLP, and computer vision. This tackles traditional methods' challenges like human bias, resource intensity, and delayed feedback.

- **OSCE and Transcript Analysis:** At UT Southwestern, GPT-4 evaluated OSCE history summarization transcripts, showing good agreement with human graders but drastically reducing turnaround time (*Large Language Models for Medical OSCE Assessment: A Novel Approach to Transcript Analysis*, n.d.). Open-source LLMs fine-tuned on local data offer privacy-preserving alternatives.

- **Clinical Note Analysis:** The University of Minnesota uses NLP to process SOAP notes from standardized patient encounters, providing immediate feedback on diagnostic reasoning and documentation quality, replacing a month-long manual grading process (Brianna Vitands, 2021). Systems evaluate completeness, clarity, and accuracy against guidelines.

- **Communication Competence:** The UK's Automated Interactive Evaluation (AIE) framework uses AI-powered simulators (SAPS) to assess not just medical content but also communication skills like empathy and active listening through linguistic cues, aligning with GMC standards (Liao et al., 2024).

- **Psychomotor Skill Assessment:** AI analyzes video recordings of procedural skills (suturing, laparoscopy, ultrasound). Depth sensors capture precise kinematic data (instrument path length, tremor) (Jin et al., 2018). Algorithms provide quantitative metrics (time, errors) and qualitative feedback (visual overlays highlighting technique deviations). This allows asynchronous review and personalized feedback (*How Generative AI Is Transforming Medical Education | Harvard Medicine Magazine*, n.d.).

- **Nonverbal Communication Analysis:** Depth-sensor video analysis, initially for ICU monitoring, assesses procedural communication cues like gaze patterns and posture, providing quantifiable metrics for skills often graded subjectively (*A Computer Vision System for Deep Learning-Based Detection of Patient Mobilization Activities in the ICU | Npj Digital Medicine*, n.d.).

AI tracks progress over time, enabling longitudinal assessment and personalized remediation plans. This objective, detailed feedback motivates learners and informs instruction.

6. AI SUPPORT FOR DEBRIEFING AND FACILITATOR DEVELOPMENT

(Reviewing):

Debriefing is crucial for learning consolidation. AI can enhance its quality and effectiveness by analyzing debriefing sessions and providing objective feedback on facilitation techniques, fostering continuous improvement.

AI systems can record and analyze audio/video of debriefings using NLP and video analysis (Brutschi et al., 2024). They assess facilitator performance against best practices, examining:

- Question types (open vs. closed)
- Balance of facilitator talk vs. learner reflection
- Creation of psychological safety
- Effectiveness in promoting critical thinking
- Overall tone, pacing, and structure
- Learner engagement (verbal/nonverbal cues)

AI-generated feedback can highlight strengths and weaknesses, offering concrete examples (e.g., identifying missed opportunities to probe deeper or address emotions) (Benfatah et al., 2024). This allows facilitators to refine their skills and guide reflection more effectively.

AI can also promote consistency by providing a structured framework for debriefing across different facilitators. These data-driven insights empower instructors to enhance their skills, contributing to a culture of continuous improvement and ultimately improving patient safety through better training.

Future Directions: AI Agents and Automated Workflows

While the applications discussed above represent significant advancements, the next wave of AI integration in Simulation likely involves more sophisticated, autonomous systems known as **AI agents** operating within **automated workflows**. An AI agent, in this context, is more than just a chatbot; it's an autonomous system that can perceive requirements, make decisions, and execute sequences of actions across multiple tools (like databases, document creators, and different AI models) to achieve a goal, such as generating a complete simulation scenario.

These agents work together using specific techniques like:

- **Decomposition:** Dividing the primary goal (e.g., scenario creation) into focused tasks such as generating objectives, defining patient states, create briefing notes.
- **Prompt Chaining:** Passing information sequentially, where the output of one agent informs the input of the next, ensuring context and coherence.
- **Retrieval-Augmented Generation (RAG):** Allowing agents to access external knowledge (like medical literature via PubMed, textbooks, or guidelines) to enhance the accuracy and relevance of AI context.
- **Tool Use:** Integrating with other software, Model Context Protocol (MCP) Servers and APIs to perform specific actions (e.g., querying sources, formatting documents).

These new concepts do not strictly require specialized AI engineers. Using open-source tools, a simulation educator with basic coding skills could develop these agents and agentic workflows. This highlights a key future direction: democratizing **AI tools** and making powerful automation accessible to simulation centers without large technical teams. By strategically using a mix of different AI models (some free, some paid, and po-

tentially even locally hosted models), centers can balance privacy, performance, capability, and cost-effectiveness.

The potential benefits are substantial. Such systems can free up invaluable educator time for focusing on facilitation, debriefing, and direct learner interaction. They can also ensure consistent alignment with standards, support multilingual outputs, and facilitate the rapid creation of scenario variations for diverse learners and settings. (Barra et al., 2025)

However, this future is not without challenges. The potential for factual inaccuracies or biases in AI outputs remains a primary concern, reinforcing the absolute necessity of rigorous review by human subject matter experts before any AI-generated scenario is used. Technical hurdles, the initial learning curve for setting up workflows, and managing costs (API access or hardware for local models) are also practical considerations.

Ultimately, the rise of AI agents and automated workflows represents a powerful evolution in simulation technology. These systems can significantly enhance efficiency, consistency, and capability in scenario design and other simulation management tasks. When implemented thoughtfully, with robust human oversight and a clear understanding of their limitations, these agentic systems can become powerful allies for simulation educators, further augmenting their ability to deliver high-quality, impactful learning experiences.

Conclusion: Augmentation Over Replacement

Artificial intelligence holds immense promise for advancing healthcare simulation. Yet, its true power is realized only when aligned with the core principles of impactful simulation learning, as embodied in the ASPiH and INACSL standards. These standards are not obstacles but scaffolding for building meaningful, learner-centered AI applications.

The key is viewing AI as a tool to augment educators and learners, not replace them. AI might handle scenario setup, but educators ensure relevance. AI might run an avatar, but instructors foster empathy. AI might crunch data, but faculty guides insight and growth. Used this way, AI amplifies best practices, aiding fidelity, facilitation, debriefing, and assessment within the guardrails of educational integrity and safety.

As simulationists, we should explore AI's possibilities while confidently rejecting uses that conflict with our pedagogical values. The path forward involves continuous dialogue between technology and pedagogy, refining standards, and sharing experiences. By anchoring these explorations in our best practice frameworks, we can ensure learners benefit from innovation without losing simulation education's fundamental quality and humanity. The future is not AI versus instructor but AI and instructor working together, leveraging each other's strengths for optimal learning and, ultimately, better patient outcomes.

Bibliography

(1. Background)

Arora, A. (2020). Artificial intelligence: A new frontier for anaesthesiology training. British Journal of Anaesthesia, 125(5), e407–e408. https://doi.org/10.1016/j.bja.2020.06.049

Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J. D., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D., Wu, J., Winter, C., … Amodei, D. (2020). Language Models are Few-Shot Learners. Advances in Neural Information Processing Systems, 33, 1877–1901. https://proceedings.neurips.cc/paper/2020/hash/1457c0d6bfcb4967418bfb8ac142f64a-Abstract.html

Deng, J., & Lin, Y. (2023). The Benefits and Challenges of ChatGPT: An Overview. Frontiers in Computing and Intelligent Systems, 2(2), 81–83. https://doi.org/10.54097/fcis.v2i2.4465

Hamilton, A. (2024). Artificial Intelligence and Healthcare Simulation: The Shifting Landscape of Medical Education. Cureus. https://doi.org/10.7759/cureus.59747

Harder, N. (2023). Advancing Healthcare Simulation Through Artificial Intelligence and Machine Learning: Exploring Innovations. Clinical Simulation In Nursing, 83. https://doi.org/10.1016/j.ecns.2023.101456

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence, August 31, 1955. AI Magazine, 27(4), Article 4. https://doi.org/10.1609/aimag.v27i4.1904

Rodgers, D., Ahmed, R. A., & Misra, A. (2023). Artificial intelligence in healthcare simulation: Hype or hope. International Journal of Healthcare Simulation, nzqf1198. https://doi.org/10.54531/nzqf1198

Sarker, I. H. (2022). AI-Based Modeling: Techniques, Applications and Research Issues Towards Automation, Intelligent and Smart Systems. SN Computer Science, 3(2), 158. https://doi.org/10.1007/s42979-022-01043-x

Tai, M. C.-T. (2020). The impact of artificial intelligence on human society and bioethics. Tzu Chi Medical Journal, 32(4), 339. https://doi.org/10.4103/tcmj.tcmj_71_20

Types of Artificial Intelligence | IBM. (2023, October 12). https://www.ibm.com/think/topics/artificial-intelligence-types

What Is Artificial Intelligence? Definition, Uses, and Types. (2025, May 23). Coursera. https://www.coursera.org/articles/what-is-artificial-intelligence

Wogu, I. A. P., Olu-Owolabi, F. E., Assibong, P. A., Agoha, B. C., Sholarin, M., Elegbeleye, A., Igbokwe, D., & Apeh, H. A. (2017). Artificial intelligence, alienation and ontological problems of other minds: A critical investigation into the future of man and machines. 2017 International Conference on Computing Networking and Informatics (ICCNI), 1–10. https://doi.org/10.1109/ICCNI.2017.8123792

Hatem, R., Simmons, B., & Thornton, J. E. (2023). Chatbot confabulations are not hallucinations. JAMA Internal Medicine, 183(10), 1177-1177.
(https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2808091)

(3. Policy Considerations)

Generative AI Guidelines. (Initial Guidelines for the Use of Generative AI Tools at Harvard, n.d.) (Chan, 2023) "Initial Guidelines for the Use of Generative AI Tools at Harvard." Accessed February 3, 2025. https://huit.harvard.edu/ai/guidelines Chan, Cecilia Ka Yuk. "A Comprehensive AI Policy Education Framework for University Teaching and Learning." International Journal of Educational Technology in Higher Education 20, no. 1 (July 7, 2023): 38. https://doi.org/10.1186/s41239-023-00408-3.

(5. AI and Simulation-Based Education Standards)

A computer vision system for deep learning-based detection of patient mobilization activities in the ICU | npj Digital Medicine. (n.d.). Retrieved February 15, 2025, from https://www.nature.com/articles/s41746-019-0087-z

AI Medical Scenario Creator | ASTEC - Arizona Simulation Technology and Education Center. (n.d.). Retrieved February 12, 2025, from https://astec.arizona.edu/aidset-AIMSC

AI Voices. A new level of realism in healthcare education. (n.d.). Laerdal Medical. Retrieved May 12, 2025, from https://laerdal.com/us/information/laerdal-ai-voice-service/

Bibliography

AI-Powered Avatars Transform Training for Nurse Practitioners and Dentists " College of Nursing " University of Florida. (n.d.). Retrieved February 15, 2025, from https://nursing.ufl.edu/2024/12/18/ai-powered-avatars-transform-training-for-nurse-practitioners-and-dentists/

Anderer, S., & Hswen, Y. (2024). Digital Avatars and Personalized Voices—How AI Is Helping to Restore Speech to Patients. JAMA, 331(15), 1259–1261. https://doi.org/10.1001/jama.2023.23556

ASPiH Standards 2023 – ASPiH. (n.d.). Retrieved March 9, 2025, from https://aspih.org.uk/standards-2/

Ayoub Ait Lahcen. (2025, January 8). Artificial Intelligence in Healthcare Simulation: When Virtual Meets Reality. SIMZINE. https://simzine.news/tech-en/artificial-intelligence-in-healthcare-simulation-when-virtual-meets-reality/

Barra, F. L. (2025, January 8). ChatGPT and Clinical Simulation: A practical guide. SIMZINE. https://simzine.news/tech-en/chatgpt-and-clinical-simulation-a-practical-guide/

Barra, F. L., Costa, A., Rodella, G., Semeraro, F., & Carenzo, L. (2024). Shaping the future of simulator interactions: The role of ChatGPT's Advanced Voice Mode. Resuscitation, 110452. https://doi.org/10.1016/j.resuscitation.2024.110452

Barra, F. L., Rodella, G., Costa, A., Scalogna, A., Carenzo, L., Monzani, A., & Corte, F. D. (2025). From prompt to platform: An agentic AI workflow for healthcare simulation scenario design. Advances in Simulation, 10(1), 29. https://doi.org/10.1186/s41077-025-00357-z

Benfatah, M., Youlyouz-Marfak, I., Saad, E., Hilali, A., Nejjari, C., & Marfak, A. (2024). Impact of artificial intelligence-enhanced debriefing on clinical skills development in nursing students: A comparative study. Teaching and Learning in Nursing, 19(3), e574–e579. https://doi.org/10.1016/j.teln.2024.04.007

Brianna Vitands. (2021, September 8). Artificial Intelligence Behind Improved Clinical Skills Assessment and Teaching [Text]. Medical School. https://med.umn.edu/news/artificial-intelligence-behind-improved-clinical-skills-assessment-and-teaching

Brutschi, R., Wang, R., Kolbe, M., Weiss, K., Lohmeyer, Q., & Meboldt, M. (2024). Speech recognition technology for assessing team debriefing communication and interaction patterns: An algorithmic toolkit for healthcare simulation educators. Advances in Simulation, 9(1), 42. https://doi.org/10.1186/s41077-024-00315-1

Callwood, K. (2025, January 24). AI-Based Empathy Training Modules for Employee Development. Hyperspace-mv - the Metaverse for Business Platform. https://hyperspace.mv/ai-based-empathy-training-modules-for-employee-development/

Case Study: Creating Healthcare Simulation Training with AI. (2024, June 6). Sonata Learning. https://sonatalearning.com/sonata-notes/healthcare-simulation-case-study/

Create AI Characters For Your VR Games And Simulations | Convai. (n.d.). Retrieved February 15, 2025, from https://convai.com/blog/create-ai-characters-vr-games-simulations

Gershov, S., Braunold, D., Spektor, R., Ioscovich, A., Raz, A., & Laufer, S. (2023). Automating medical simulations. Journal of Biomedical Informatics, 144, 104446. https://doi.org/10.1016/j.jbi.2023.104446

Get Early Access AI-Driven Patient Simulator. (2025, April 4). ClinCaseQuest. https://clincasequest.hospital/get-early-access-ai-driven-patient-simulator/

Gore, T. (2023, October 23). Nasco Healthcare Simulator Alex Trains Clinical Communication with AI | HealthySimulation.com. https://www.healthysimulation.com/nasco-healthcare-alex-ai-communication-simulator/

HAL® S5301. (n.d.). Gaumard.Com. Retrieved May 12, 2025, from https://www.gaumard.com/hal-s5301

Hamilton, A. (2024). Artificial Intelligence and Healthcare Simulation: The Shifting Landscape of Medical Education. Cureus. https://doi.org/10.7759/cureus.59747

HeyGen—AI Spokesperson Video Creator. (n.d.). HeyGen. Retrieved April 16, 2025, from https://app.heygen.com

How Generative AI Is Transforming Medical Education | Harvard Medicine Magazine. (n.d.). Retrieved February 21, 2025, from https://magazine.hms.harvard.edu/articles/how-generative-ai-transforming-medical-education

INACSL Standards Committee, Watts, P. I., McDermott, D. S., Alinier, G., Charnetski, M., Ludlow, J., Horsley, E., ... & Nawathe, P. A. (2021). Healthcare simulation standards of best practiceTM simulation design. Clinical Simulation in Nursing, 58, 14-21.

INACSL Standards Committee, Decker, S., Alinier, G., Crawford, S. B., Gordon, R. M., Jenkins, D., & Wilson, C. (2021). Healthcare simulation standards of best practiceTM the debriefing process. Clinical simulation in nursing, 58, 27-32.

iRIS – The Intuitive, Collaborative,Simulation Authoring Platform. (n.d.). Retrieved February 15, 2025, from https://irissimulationauthoring.com/

Jin, A., Yeung, S., Jopling, J., Krause, J., Azagury, D., Milstein, A., & Fei-Fei, L. (2018). Tool Detection and Opera-

Bibliography

tive Skill Assessment in Surgical Videos Using Region-Based Convolutional Neural Networks. 2018 IEEE Winter Conference on Applications of Computer Vision (WACV), 691–699. https://doi.org/10.1109/WACV.2018.00081

Large Language Models for Medical OSCE Assessment: A Novel Approach to Transcript Analysis. (n.d.). Retrieved February 15, 2025, from https://arxiv.org/html/2410.12858v1

Lewis, K. L., Bohnert, C. A., Gammon, W. L., Hölzer, H., Lyman, L., Smith, C., Thompson, T. M., Wallace, A., & Gliva-McConvey, G. (2017). The Association of Standardized Patient Educators (ASPE) Standards of Best Practice (SOBP). Advances in Simulation, 2(1), 10. https://doi.org/10.1186/s41077-017-0043-4

Liao, Y., Meng, Y., Wang, Y., Liu, H., Wang, Y., & Wang, Y. (2024). Automatic Interactive Evaluation for Large Language Models with State Aware Patient Simulator (No. arXiv:2403.08495; Version 2). arXiv. https://doi.org/10.48550/arXiv.2403.08495

Liaw, S. Y., Tan, J. Z., Rusli, K. D. B., Ratan, R., Zhou, W., Lim, S., Lau, T. C., Seah, B., & Chua, W. L. (2023). Artificial Intelligence Versus Human-Controlled Doctor in Virtual Reality Simulation for Sepsis Team Training: Randomized Controlled Study. Journal of Medical Internet Research, 25(1), e47748. https://doi.org/10.2196/47748

PCS Spark. (n.d.). Retrieved February 15, 2025, from https://www.pcs.ai/spark

SimX For Physicians, Clinicians, and Students. (n.d.). Virtual Reality Medical Simulation | SimX. Retrieved February 15, 2025, from https://www.simxvr.com/simx-for-physicians-clinicians-and-students/

Stefanic, D. (2025, January 2). AI-driven simulations for practical skill training. Hyperspacemv - the Metaverse for Business Platform. https://hyperspace.mv/ai-driven-simulations-for-practical-skill-training/

Sumpter, S. (2024). Automated Generation of High-Quality Medical Simulation Scenarios Through Integration of Semi-Structured Data and Large Language Models (No. arXiv:2404.19713). arXiv. https://doi.org/10.48550/arXiv.2404.19713

The AI role-play and video training platform for upskilling. (2025, February 24). Virti. https://www.virti.com/

Theros, J. (2023, July 7). AI-Based Medical Simulation: Rethinking Case-Based Learning. Dendritic Health AI. https://www.dendritichealth.com/post/ai-based-medical-simulation-rethinking-case-based-learning

Zheng, K., Shen, Z., Chen, Z., Che, C., & Zhu, H. (2024). Application of AI-empowered scenario-based simulation teaching mode in cardiovascular disease education. BMC Medical Education, 24(1), 1003. https://doi.org/10.1186/s12909-024-05977-z

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