How Artificial Intelligence is Shaping the Future of Gynecology Residency Education

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Abstract

The training of gynecology specialists is a complex process that requires the acquisition of extensive theoretical knowledge, refined surgical skills, proficiency in diagnostic imaging, and, above all, the ability to provide medical care within a highly intimate and personal context. Artificial Intelligence (AI) has emerged as a transformative force with the potential to revolutionize medical education by offering innovative solutions to traditional challenges in residency training.

This narrative review explores current applications of AI in gynecology residency education, analyzing its benefits, limitations, and associated ethical imperatives. The analysis encompasses the use of large language models (LLMs) for clinical decision support, advanced surgical simulation platforms, and AI-assisted diagnostic imaging training.

We conclude that, when implemented thoughtfully and ethically, AI can serve as a powerful complementary tool, personalizing learning, optimizing skill acquisition, and ultimately contributing to the development of more competent and confident gynecologists.

Keywords: Artificial Intelligence (AI); Large Language Models (LLMs); Medical Care

Introduction

Medical residency in gynecology represents an intense immersion into a highly complex specialty, characterized by a wide spectrum of pathologies, the need for advanced surgical skills, and the continuous evolution of scientific knowledge. Training programs face significant challenges, including information overload, time pressure in clinical environments, and anatomical variability that demands extensive hands-on experience.

In this context, the rise of Artificial Intelligence (AI), particularly large language models (LLMs) and machine-learning algorithms, presents an unprecedented opportunity to redefine paradigms in medical education.

The objective of this narrative review is to analyze the state of the art of AI applications in gynecology residency education. Through synthesis of recent scientific literature, we explore how these technologies are being used to support and enhance clinical decision-making, surgical skills training, and interpretation of imaging studies. Additionally, this article discusses the benefits, inherent limitations, and ethical challenges associated with integrating AI into gynecologic training, outlining future perspectives for an effective symbiosis between human and artificial intelligence in shaping the gynecologist of the future.

Methodology

This study consists of a narrative review of the scientific literature. A systematic search was conducted in academic databases including PubMed, PMC, and ScienceDirect, focusing on articles published between 2023 and 2025. Search terms included combinations of "artificial intelligence", "medical education", "gynecology", "residency training", "surgical simulation", and "machine learning".

Articles were selected if they directly addressed the application or potential use of AI in residency education, with a specific filter to exclude purely obstetric content and focus on gynecologic applications.

Applications of AI in gynecology residency education

The integration of AI into gynecologic training involves multiple dimensions, from enhancing clinical reasoning to improving technical proficiency in surgical procedures. The main areas of application are detailed below.

Large language models and clinical decision support

LLMs have proven valuable tools for diagnostic support and clinical education. A comparative cross-sectional study (PERFORM) evaluated the performance of eight LLMs and 24 obstetrics-gynecology residents across 60 standardized clinical scenarios, with findings applicable to gynecology training.

Results demonstrated higher overall diagnostic accuracy for AI systems (73.75%) compared with residents (65.35%). High-performing models such as GPT-4o and Claude 3.5 Sonnet showed less performance degradation under time pressure-an omnipresent condition in clinical practice. Importantly, the greatest benefit was observed among early-stage residents, who experienced nearly a 30% increase in diagnostic accuracy when assisted by AI.

These findings suggest that AI can function as a diagnostic support tool, helping residents expand differential diagnoses and reduce cognitive load. However, its role must remain complementary and should never replace clinical reasoning or expert supervision, particularly due to the risk of hallucinations or incorrect outputs generated by language models.

AI chatbots for educational and administrative tasks

Beyond clinical support, AI chatbots are increasingly optimizing educational and administrative tasks that consume significant faculty time. These tools can align learning objectives of gynecologic surgery modules with competencies required by accrediting bodies such as the Accreditation Council for Graduate Medical Education (ACGME).

In personalized learning, AI facilitates more efficient knowledge management and promotes active learning methodologies. Residents can use chatbots to compare different surgical approaches to specific pathologies, focusing on pathophysiology, success rates, and complications rather than memorizing procedural steps alone. This capacity to tailor content and identify knowledge gaps fosters more effective self-directed learning.

Additionally, automation of administrative tasks-such as creating educational materials, organizing evaluations, and summarizing feedback-helps reduce faculty workload, allowing educators to dedicate more time to individualized teaching and mentorship.

Simulation and surgical skills training

Surgical training represents one of the most promising areas for AI application in gynecology. AI-based simulation platforms allow residents to practice complex procedures-such as laparoscopic hysterectomy, myomectomy, deep endometriosis surgery, mid-urethral slings, and abdominal sacrocolpopexy-in a safe, repeatable environment without risk to patients.

The distinguishing feature of these platforms is their ability to provide objective assessment and real-time feedback. AI algorithms analyze instrument movements, gesture efficiency, and time spent on each procedural phase, offering performance metrics that are difficult for human preceptors to quantify with comparable precision.

For example, a resident struggling with laparoscopic suturing can be directed to targeted training modules designed to improve dexterity and precision, creating a truly personalized learning pathway.

Training in gynecologic and functional diagnostic imaging

Similar to surgery, diagnostic imaging in gynecology-such as ultrasound and magnetic resonance imaging-requires high technical and interpretive proficiency. AI is increasingly being used to accelerate the learning curve of residents.

Algorithms trained on thousands of images can assist in identifying pathologies such as uterine fibroids, ovarian cysts, and endometrial lesions, acting as an instantaneous "second reader" for trainees. Intelligent systems can also provide real-time feedback on image acquisition quality during ultrasound examinations, ensuring correct anatomical planes are captured-an essential component of accurate diagnosis.

Additionally, AI-driven applications are being developed to enhance symptom perception related to pain and urinary dysfunction, as well as to support research tools for structured data collection and database development.

AI tools for exam preparation and clinical question-based learning

The use of AI tools for studying clinical questions and medical examinations should be approached with caution. Accuracy rates are moderate when comparing earlier versions such as ChatGPT-3 with more advanced models like ChatGPT-4.

In 2022, AI demonstrated good performance in the Brazilian Medical Diploma Revalidation Exam (REVALIDA). However, when evaluated using Brazilian residency entrance examination questions, AI tools showed variable performance, highlighting the need for cautious and critical use of these technologies in exam preparation.

Challenges and ethical considerations

The integration of AI into medical education presents significant ethical and operational challenges.

Algorithmic bias and equity

AI systems are trained on existing datasets that may contain historical and social biases. If training data disproportionately represent certain ethnic groups, performance may be inferior in others, potentially perpetuating disparities in gynecologic healthcare. Curating diverse and representative datasets is therefore an ethical imperative.

Privacy and data security

The use of patient data to train AI models raises serious concerns regarding privacy and security. All data must be rigorously anonymized, and institutional policies must comply with regulations such as Brazil's General Data Protection Law (LGPD), in alignment with Research Ethics Committees and Plataforma Brasil for scientific development and integration.

Transparency and accountability

Many AI models function as "black boxes", making it difficult for clinicians to understand the rationale behind recommendations. The development of explainable AI (XAI) is critical to building trust. Furthermore, responsibility in cases of AI-related errors-whether attributed to developers, institutions, or physicians-remains a legal and regulatory gray area requiring clearer frameworks.

Impact on learning

There is concern that excessive reliance on AI may lead to erosion of critical thinking and fundamental clinical reasoning. Educators must ensure that AI augments cognition rather than replaces it, consistently encouraging questioning and validation of AI outputs.

Future perspectives

The future of gynecology education will most likely adopt a hybrid model. Effective implementation requires formal incorporation of AI literacy into residency curricula, enabling future gynecologists to use these tools critically and ethically.

Ongoing research is essential to validate the long-term impact of AI on resident performance and, most importantly, patient outcomes. The evolution toward more transparent algorithms and the establishment of clear guidelines for safe AI use in education will be fundamental for its consolidation.

Conclusion

Artificial Intelligence holds immense potential to enhance gynecology residency education by making it more personalized, efficient, and safe. From LLM-based clinical decision support to advanced surgical simulation, applications are vast and promising.

However, integration must proceed with prudence, proactively addressing ethical and technical challenges. A balanced approach-viewing AI as a tool to augment, not replace, human expertise and preceptor supervision-will be key to training a new generation of gynecologists prepared for the challenges of 21st-century medicine [1-5].

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