

Letter to the Editor

The Dawn of a New Era in Surgery: Unleashing the Potential of Artificial Intelligence: Opportunities and Challenges

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Introduction

The emergence of the Information Age, combined with the advent of Artificial Intelligence (AI), has triggered profound transformations across all scientific disciplines, including medicine and surgery. This evolution necessitates organizational readiness across various dimensions, including technical and technological infrastructure, the empowerment of physicians and surgeons, the development of relevant policies and guidelines, and the resolution of critical issues related to insurance, reimbursement, as well as legal and ethical considerations essential for the comprehensive development of AI tools.

At the societal level, the digital landscape has exposed communities to various psychological phenomena, such as the "Fear of Missing Out" (FOMO) and "Shiny Object Syndrome" (SOS). The latter, characterized by

an excessive fixation on new concepts, often results in the dismissal of previously established ideas whenever innovations emerge, highlighting the psychological strain associated with rapid technological changes.¹ Within specialized fields like surgery, these pressures are intensified by the accelerated pace of digital advancements, leading to significant shifts in service delivery methods, including robotic surgeries, simulations for complex procedures, real-time feedback mechanisms, and advanced imaging technologies.² The contemporary surgical field faces numerous challenges, such as integrating robotics, the impact of AI on physicians' decision-making autonomy, the potential deskilling of current roles, the emergence of "digital surgeons,"³⁻⁵ and a range of legal and ethical dilemmas that may contribute to

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technophobia—an aversion to new technologies.¹ To successfully navigate this transition and foster an environment conducive to the development of AI tools in surgery, it is imperative to first identify and manage existing challenges through appropriate strategies. This letter will succinctly address four key dimensions: 1) The Role of AI in Surgery, 2) The Educational Needs of Surgeons, 3) AI's Impact on Surgeons' Clinical Autonomy, and 4) Its Social, Organizational, and Legal Implications in Surgery.

1. The Role of AI in Surgery

While technology has historically been developed to enhance societal well-being, there is a prevailing concern that AI could undermine surgeons' clinical independence, positioning humanity in opposition to machines. However, it is crucial to emphasize that humans and machines have never functioned as adversaries in any domain or era. In the Information Age, the synergy of human intelligence and AI—referred to as Augmented Intelligence—will undeniably provide a powerful capability for delivering superior patient care.⁶ The convergence of human creativity and problem-solving skills with the computational strength and extensive resources of AI holds the promise of transformative changes in healthcare. The American Medical Association explicitly states that, although AI has the potential to enhance healthcare, it will never replace the multifaceted roles of physicians for several reasons:

- The Non-Linearity of Medical Diagnosis

The processes of diagnosing and treating diseases are inherently non-linear, necessitating creativity and problem-solving skills that algorithms and robots cannot independently replicate. For example, consider a case involving a young man exhibiting symptoms of poisoning. Through extensive

differential diagnosis, the medical team ultimately discovered that he had purchased jeans from a street vendor contaminated with pesticides. Such complex diagnoses would be nearly impossible to achieve using AI tools alone.⁶

- Limitations of AI in Eliciting Empathy

While AI tools demonstrate remarkable capabilities in specific healthcare tasks, they struggle to replicate human empathy. AI is primarily designed to automate routine, repetitive tasks, such as documenting medical records and generating reports. However, certain tasks require human finesse and emotional intelligence—AI may analyze thousands of documents in seconds, but it can never perform a Heimlich maneuver. Certain responsibilities will always be executed more swiftly, reliably, or cost-effectively by humans than by technology.⁶

- The Necessity of Human Training for AI Tools

It is essential to recognize that many advanced AI tools require training guided by humans. AI systems must be trained to perform analyses that emulate human reasoning to be effectively integrated into care processes. Furthermore, the development of AI for complex decision-making should occur under human supervision, while repetitive tasks can be efficiently managed by AI.⁶

2. Training and Skill Enhancement for Surgeons

As previously indicated, the implementation of many AI tools necessitates human training, highlighting the importance of equipping surgeons with the necessary skills to use these technologies effectively.

Like any innovative tool, AI requires appropriate training to ensure its successful implementation. A lack of self-efficacy regarding new technologies can result in

technophobia and, consequently, resistance among physicians and surgeons toward their adoption. Therefore, many accrediting organizations in the United States emphasize the importance of ongoing education and training for healthcare professionals to mitigate these challenges and promote a collaborative environment for AI integration. In conclusion, while AI has the potential to revolutionize surgical practices, it is imperative to preserve the human touch in patient care. The collaborative interplay between human intelligence and AI can significantly advance the field of surgery. However, to fully harness AI's potential in surgical practice, it is essential to implement proper training, develop effective policies, and adopt a proactive approach to addressing the challenges of this transformative era.⁷

3. AI and the Clinical Decision-Making Autonomy of Surgeons

Numerous studies have underscored the potential threat that AI may pose to the individual and professional independence of surgeons. Clinical decision-making independence is defined as a physician's ability to make choices free from external constraints or influences.⁸ Although concerns regarding this issue have not been definitively established, they warrant thorough examination.⁹ In addition to physicians' independence, the autonomy of AI systems has become a significant consideration. At the highest level of autonomy—referred to as Level 5—robots can make decisions without any human oversight. This advanced capability necessitates a comprehensive reevaluation of surgeons' legal responsibilities before the widespread implementation of AI technologies in surgical practice.¹

4. Social, Organizational, and Legal Challenges in Implementing AI in Surgery

The integration of AI into the healthcare ecosystem presents a multifaceted challenge

that requires comprehensive organizational readiness. This readiness includes the preparation of infrastructure, the establishment of regulatory and legal frameworks,¹⁰ and the consideration of ethical implications.

- Managing Change in Healthcare Institutions for AI Adoption

As AI impacts numerous stakeholders within the healthcare system, its application may conflict with existing regulations, processes, and institutional cultures. Therefore, implementing change management strategies is essential to facilitate this transition within healthcare organizations.¹⁰

- Medical Liability in the Context of AI

Medical liability encompasses the legal, judicial, and ethical responsibilities of physicians concerning patient care. The integration of AI tools into surgical practices introduces novel dimensions to this liability:¹¹

1) Medical Malpractice: Surgeries performed based on AI recommendations that result in adverse patient outcomes may expose surgeons to malpractice claims. It is essential to establish clear guidelines for assessing such cases before the widespread adoption of AI technologies.

2) Product Liability: As AI-driven surgical tools and algorithms become increasingly prevalent, designers and manufacturers will be held legally accountable for any damages resulting from design deficiencies, inadequate safety warnings, or defects. Therefore, it is essential to establish clear laws and regulations that explicitly define these responsibilities.¹¹

- Quality Information Management for AI Implementation

The efficacy of AI tools depends significantly on the availability of high-quality data. Currently, clinical data related to patients

is primarily collected manually through medical records, which presents challenges in utilizing this information for clinical recommendations, pattern recognition, and predictive modeling. Therefore, enhancing data quality, transitioning to electronic health records (EHR), and ensuring the confidentiality of patient information are critical steps that must be taken before implementing AI tools in surgical settings.¹⁰

Conclusion

The integration of AI tools into surgical practice presents a complex organizational challenge that requires careful consideration of various technical, clinical, organizational, social, and legal factors. To establish a robust

foundation for organizational readiness, it is essential to comprehensively address all influencing elements—including technological infrastructure, workforce development, regulatory policies, and the ethical implications of AI use—while actively engaging relevant stakeholders such as the Ministry of Health, medical system organizations, forensic medicine bodies, insurance and reimbursement institutions, and professional associations. By fostering collaboration and dialogue among these entities, we can promote the responsible and effective adoption of AI in surgery, ultimately enhancing patient care and outcomes.

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