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Editorial

Redefining the Era of Digital Surgery: The Role of Artificial Intelligence, Augmented Reality and Machine Learning in the Surgical Field

Redefiniendo la era de la cirugía digital: el rol de la inteligencia artificial, la realidad aumentada y el aprendizaje automático en el campo quirúrgico

Redefinindo a era da cirurgia digital: o papel da inteligência artificial, realidade aumentada e aprendizado de máquina no campo cirúrgico

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The era of digital surgery is characterized by the implementation of new technologies that have the potential to improve preoperative planning, increase the availability of therapeutic alternatives, improve surgical training in apprentices, optimize postoperative results for patients, and reduce possible adverse events (1). Although the incorporation of these technologies has the main premise of improving patients' clinical outcomes, the use of these advances has been accelerated by commercial interests and the opportunities that large companies have to generate profits worldwide (2).

The technologies that are currently having a direct impact on the surgical field are artificial intelligence (AI), augmented reality (AR), and machine learning (ML),

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without forgetting the availability of other robotic devices (3). Although digital surgery is gaining more popularity in the clinical practice, there is still a lack of knowledge about it, its benefits, and potential barriers to its adoption.

To overcome these obstacles, experts in the field have identified critical areas for institutional adoption, such as creating groups of experts in each hospital, educating the staff about the existence of such technologies, generating training and education programs that guarantee a continuous innovation process (4). Additionally, there is a need to create innovation departments where health professionals, engineers, and data scientists using a multidisciplinary approach, can integrate different types of expertise to offer personalized solutions for clinical, medical research, and organizational improvement of internal and administrative processes (5).

AI enables data automation to incorporate it into processes that will determine a better management of the surgical patient. In digital surgery, these tools, among other benefits, help to stratify preoperative patient risk, contribute to predict surgical time duration, help to identify surgeries at risk of cancellation, and help to standardize surgical techniques, translating these benefits into clinical efficiency and resource optimization. This new knowledge generated with the use of these technologies is the basis for the development of medical algorithms and new guidelines for patient management (6,7).

However, a limitation is that AI systems require a large amount of high-quality data to minimize the biases of their results. Other concerns with the implementation of AI in the surgical area are the risks of confidentiality and the loss of integrity of patient information at the time of data handling and analysis. Regarding this, the World Health Organization has made clear its ethical position on the use of AI in medicine. They emphasize the importance of implementing the use of AI based on the principles of justice, beneficence, patient autonomy, and non-maleficence. Regarding the legal framework for the use of AI in medicine, new regulations have been emerging in the most advanced health systems in the world. However, this field is still subject to evolve in the near future (1,6).

AR and virtual reality (VR) have played a fundamental role in recent years to improve teaching processes in the surgical area. These increasingly available technological advances allow medical students, residents, and fellows to be immersed in simulated and controlled scenarios, where they can acquire surgical skills and abilities necessary in their training processes. Among the advantages of AR and VR are the reduction of the learning curve time, the reduction of possible surgical complications by not exposing real patients for learning purposes, and the use of previously established and validated courses (8). Similarly, these teaching models have the potential to be adapted in environments where other surgical teaching methods are not available, such as animal models and cadaveric models.

ML is a branch of AI and is defined by the development of new advanced techniques for modeling data beyond traditional statistical models. Unlike traditional data analysis models, ML tries to find different patterns in the behavior of data and does so in an automated and autonomous way. These mathematical models allow the development of complex algorithms and their use is becoming more frequent in the daily surgical practice. These models have allowed an improved performance compared to traditional statistical analysis and have been mainly evaluated in identifying prognostic factors for the prevention of surgical complications and for selection of patients for high-complexity surgical procedures (9). As with any new technique or technology, a basic understanding of its principles, applications, and limitations is essential for its appropriate implementation in clinical practice.

In the same way as it has happened throughout the history of medicine and its numerous advances, trying to innovate has not been an easy mission and there have been barriers to overcome in the process. In the case of digital surgery, its most important limitations have been to implement systems respecting ethical principles, the high costs to acquire these technologies, the availability of data necessary to perform advanced statistical analysis, and the need to adjust administrative processes which represent a great commitment of additional work and resources for the institutions that adopt them. From the perspective of surgeons and medical personnel, the most frequent barriers are the lack of knowledge and education about these technologies, the presence of skepticism regarding their usefulness, and the existence of biases when determining the use of these tools (10).

For the implementation of these technologies, the formation of interdisciplinary groups for their use, the development of guidelines for their management and the standardization of surgical practices are suggested. In the same way, it is recommended to educate the stakeholders involved in the care of the surgical patients in these technologies, to establish inter-institutional collaborations to share experiences and knowledge, and to initiate digital surgery programs with the “trial and error” philosophy, which it has allowed great advances in the surgical world (6,8).

This special edition of MedUNAB focused on surgical innovation, new technologies, and future approaches to digital surgery, provides an academic space for reflection on the impact of these scientific advances in modern clinical practice and calls us to be prepared for this new era of digital medicine. This special issue presents experiences from research groups and experts who are betting on making innovation in the surgical field a reality. These initiatives,

both at the Latin American and international levels, have as their fundamental principle to revolutionize this area of medicine from the base of teaching, multidisciplinary participation, and medical research.

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