EDITORIAL

Innovative medical and surgical breakthroughs: Transforming healthcare

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We are living in a dynamic world where scientific and technological changes constantly and rapidly transform and reshape our lives. Similar to other domains, medicine and surgery are bound to undergo a profound transformation. Innovations in healthcare focus on providing more convenient, effective, and less expensive treatments. They also focus on enhancing treatment precision and outcomes, providing better patient experience, and expanding healthcare accessibility. Healthcare deals with humans and their lives. Therefore, unlike other domains, innovations in healthcare go through stringent barriers – medical, legal, and regulatory. That's why not all innovations make it to the market [1]. In order to understand their potential impact on the future of healthcare, it is crucial to explore the innovations that have reshaped or will reshape the field of medicine and surgery.

Innovations in medicine challenge the current practice and practice patterns. Clinicians are no longer reliant merely on natural and synthetic drugs. As if it were a scenario from science fiction, clinicians can now treat genetic or inherited disorders that were once considered untreatable. The emergence of biologics, immunotherapies, and cell and gene therapies is likely to transform medicines. The safety and efficacy of human, humanized, and specifically tailored monoclonal antibodies and biologicals have already been established. Regulatory bodies have endorsed and approved several treatments, and these treatments have seamlessly integrated into medical practice. Technologies such as Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-Cas9 gene-editing, Transcription Activator-Like Effector Nucleases (TALEN), and Zinc Finger Nucleases (ZFN) could potentially transform how rare diseases and cancer are treated [2]. The COVID-19 pandemic triggered research into mRNA vaccines. While some immunotherapies and cancer vaccines are already approved, ongoing research promises bright prospects for more candidates. Technological changes are transforming administrative tasks in medical practice. Advanced computing and Artificial Intelligence (AI) have the potential to simplify, declutter, and automate capturing and managing patient data and medical records.

AI has disrupted various industries globally, and the healthcare sector is no exception. Integrating AI in healthcare could enhance diagnostic accuracy, optimize treatment strategies, and propel toward precision medicine. AI-based tools are being studied to detect early signs of cancer, diabetes, cardiac, hepatic, neurological, and skin disorders. Compared with traditional methods, AI tools provide fast and accurate results at lower costs and reduce/eliminate human errors. AI is being incorporated into medical devices and smart gadgets that continuously monitor vital parameters (e.g., blood

pressure, oxygen levels, glucose levels, etc.). These devices continuously track data and identify and flag irregularities/patterns. Healthcare providers can monitor data remotely and act swiftly when they sense critical signs/conditions. The potential limitations of using AI include legal and ethical complications, availability of quality data, and risks pertaining to data privacy, safety, and security [3-5]. There is a need for proper regulations to control and govern the use of AI and the resulting outputs/data before integrating it into the healthcare systems. Moreover, there's a need for human medical expertise to utilize and channel the power of AI.

Augmented Reality (AR) and Virtual Reality (VR) are immersive technologies. They are applied to various avenues in healthcare, including dentistry, surgical procedures, radiology, patient rehabilitation, and medical training. Simulated VR surgeries create real-life scenarios and complications that enable students to learn and enhance their surgical skills without risking a patient's life. Thus, AR/VR will become an indispensable tool in medical education and training. AR overlays could provide real-time data on diagnostics and preexisting conditions to the surgeon which enhances accuracy and minimizes intraoperative complications. AR/VR could enable healthcare providers to remotely assess diagnostic data, collaborate, consult, and plan treatments and surgeries. The use of AR/VR in tandem with AI and robotic surgeries could enable surgeons to plan, manage, guide, and perform surgeries, even remotely [6-7]. AR/VR technology has garnered interest even from the US FDA and is recognized as integral medical devices [8]. AR/VR technology will need further enhancements. In its current form, AR/VR technology is resource-heavy and requires specialized equipment and integration into existing systems. Data management and confidentiality pose concerns as well [6-7].

The shortfall of healthcare facilities and well-trained healthcare professionals remains a global challenge [9]. The population living in rural and remote areas faces this problem prominently as they struggle to access basic healthcare facilities. Telemedicine has emerged as a promising solution that could provide cost-effective quality healthcare that caters to the needs of the underprivileged population. The COVID-19 pandemic validated the possibility of providing effective healthcare to remote locations. Telemedicine platforms enable virtual consultations and remote monitoring devices to continuously track vital parameters (e.g., blood pressure, glucose levels, oxygen levels, etc.). As a result, the need for frequent in-person visits is reduced. This benefits patients, caregivers, and healthcare service providers equally [10]. Ultimately, it reduces the overall burden on the healthcare system. The advent and integration of AI, AR/VR, and robotic techniques into telemedicine promises to revolutionize it even further. However, to unleash the full potential/impact of telemedicine, there is a need for enhanced infrastructure, skilled/trained manpower, and complete integration into the existing healthcare systems.

The field of surgery has evolved through the ages and has witnessed various breakthroughs. Erstwhile, surgeries were considered as the last resort and had many safety concerns. Over time, surgical tools and techniques have undergone significant enhancement and sophistication, and surgical procedures have been standardized and streamlined. The changes in government policies,

increased number of qualified surgeons, better facilities, and insurance coverage have helped to break the old perceptions. Globally, surgeons undertake more than 300 million surgeries yearly [11]. Advancements such as robotic, laser, and minimally invasive surgeries are transforming surgery. The introduction of robots in surgery has drastically changed surgeries. The processes and procedures for robotic surgeries are more stream-lined. The use of robots promises to ease the workload of surgeons and nurses. Robot-assisted minimally invasive surgery requires small or no incisions, enhances precision and control, reduces recovery times, and leads to improved patient outcomes [12]. The reduction in pre- and post-hospitalization time and post-surgical compli-cations reduces the burden on the healthcare system. AI finds its application in pre-, intra-, and post-surgical procedures. AI could guide/ recom-mend the surgeon in screening, diagnosis, risk stratification, deciding and planning the surgery, and patient follow-ups. These innovative techno-logies provide real-time analysis and feedback during surgeries that help surgeons execute decisions faster and reduce the probability of human errors [13].

The World Health Organization (WHO) defines a sustainable healthcare system as "a system that improves, maintains or restores health, while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it, to the benefit of the health and well-being of current and future generations" [14].

Healthcare facilities consume a significant amount of energy and produce waste that raises environmental concerns. Adopting environment-friendly energy-efficient approaches, increasing energy efficiency, and using renewable energy sources will help to reduce operational costs and minimize environmental impact. Waste reduction, digitization, and reducing carbon footprint will help in building sustainability in the healthcare framework. Practices such as reducing waste gene-ration, use of reusable medical supplies, recycling resources where possible, and proper waste segre-gation and disposal should be promoted and implemented across the healthcare landscape.

To summarize, the field of medicine and surgery is evolving, and technological innovations are bound to transform the practice patterns and revolutionize the healthcare landscape. Based on these transfor-mations, we can envision enhanced treatment precision and efficacy, improved patient care and outcomes, reduced burden on the healthcare system, and more accessible and affordable treat-ments. Healthcare facilities need to follow sustain-able green practices to minimize environmental impact. As technology evolves, it is pertinent that healthcare professionals will have to update/ upgrade themselves and enhance their skills. It is important to remember that one cannot substitute the need for human intelligence and expertise in healthcare. Despite all the innovation and trans-formation, physicians and healthcare professionals will continue to play a central role in providing patient care.

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