Open access Editorial

Recent Advancements in General Surgery

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The landscape of general surgery is undergoing a profound transformation in recent years. Today's operating room is no longer of resemblance to that of a decade ago. The ongoing expansion of the volume and complexity of surgical procedures based on the WHO Surgical Safety Checklist which is now a cornerstone of preoperative safety accelerates a new wave of technological integration is fundamentally reshaping how surgeons plan, execute, and follow up on operations. This editorial emphasizes key recent advancements, focusing on the maturation of robotic systems, the rise of artificial intelligence (AI), innovations in minimally invasive techniques, and the evolution of perioperative care.

Robot-assisted surgery (RAS): From Emergency to Essential

Robot-assisted surgery (RAS) has incorporated from an experimental adjunct to a standard-of-care tool across multiple subspecialties of general surgery. Robust data demonstrates that RAS minimizes surgical invasiveness through smaller incisions, minimal intraoperative blood loss, and accelerates patient recovery. The introduction of the da Vinci Surgical System which enhanced three-dimensional visualization, tremor filtration, and ergonomic superiority have already been well-documented advantages in complex colorectal resections, pancreaticoduodenectomies, and hernia repairs.[1]

However, the most important recent development is the expansion of RAS beyond the elective setting into emergency general surgery (EGS). Previously, it was considered that, the robotic platforms was not suitable for acute settings due to time constraints and logistical hurdles. But, recent national-level analyses from the United States indicate that the proportion of minimally invasive EGS procedures performed robotically has dramatically increased from 2008 to 2020, with the largest growth observed in robot-assisted large bowel resections and perforated ulcer repairs.[2] Robot-assisted approaches in EGS have been associated with significantly reduced odds of perioperative blood transfusion (for cholecystectomy: aOR 0.66; for large bowel resection: aOR 0.73) compared to traditional laparoscopy. While costs remain higher- by increments of up to $4,900—the safety and feasibility of RAS in the acute setting are now well-established.[2] Concurrently, a diverse array of new robotic platforms, including the Senhance and Versius systems, are entering the market, promising increased competition, lower costs, and specialized capabilities that may further democratize access to RAS.[1]

Artificial Intelligence: Augmenting surgeon's mind

If robotics has extended the surgeon's hands, artificial intelligence is augmenting the surgeon's mind. AI is no longer a futuristic concept but a tangible tool enhancing decision-making across the entire surgical continuum. Preoperatively, machine learning models are improving cancer detection and refining surgical risk stratification.[3] Intraoperatively, systematic reviews now confirm AI's capacity to track hand movements, identify anatomical landmarks, and even predict the next operative steps in real time.[4]

The emergence of foundation model architectures and multimodal AI- systems capable of processing diverse types of data (video, images, text, sensor data) simultaneously- is poised to drive the next leap forward.[5] These models hold immense potential to reduce variability in surgical technique, provide real-time decision support, and

accelerate the learning curve for trainees. But there are significant challenges e.g. data unavailability, lack of robust validation tools, and unresolved ethical concerns regarding autonomy and accountability.[4]

Refining Minimally Invasive Techniques and Enhanced Recovery

The continual drive of refinement of core surgical principles is progressing beyond the introduction of high-tech platforms. Natural Orifice Specimen Extraction (NOSE) surgery has emerged as a compelling option for colorectal procedures, offering superior cosmetic outcomes by avoiding abdominal incisions for specimen retrieval. NOSE compromise oncologic safety or increase postoperative complications compared to conventional laparoscopy despitelonger operative time.[6]

The principles of Enhanced Recovery After Surgery (ERAS) are being successfully adapted to increasingly challenging clinical contexts. A randomized controlled trial published in 2024 demonstrated that a modified Enhanced Recovery After Surgery (ERAS) protocol is not only safe but significantly effective in trauma patients undergoing emergency laparotomy. The ERAS group experienced a reduced median length of stay (6 vs. 8 days), earlier recovery of bowel function, and lower rates of deep surgical site infections compared to conventional care.[7] This represents a paradigm shift, extending the benefits of structured perioperative optimization from elective oncology patients to the most acute and vulnerable surgical populations.

The integration of AI, robotics, and 3D printing into unified, patient-specific workflows heralds an era of truly personalized surgery. Custom 3D-printed anatomical models are already enabling surgeons to rehearse complex procedures before entering the operating room, while bioprinting and smart implants remain on the horizon.[3] The challenge for the surgical community will be to critically evaluate these innovations through further researches, ensuring that the pursuit of technological novelty never supersedes the fundamental goals of safety, efficacy, and patient-centered care.

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