ISSN 1019-6609
eISSN 1853-4961

Evolution of Common Surgical Procedures: A Comprehensive Review from Past to Present

Mehboob Hussain Bhat[1], Rayees Ahmad Khanday[2], Sheema Javid Hafiz[3*]

[1]Medical officer, Govt Medical College Anantnag J&K, India

[2]Senior Resident Department of General Surgery, Govt Medical College Anantnag J&K, India

[3]Senior Resident, Department of General Surgery, SKIMS Soura Srinagar J&K India

Corresponding author

Sheema Javid Hafiz

Senior Resident,

Department of General Surgery,

SKIMS Soura Srinagar J&K India,

ABSTRACT

Surgery has undergone a remarkable transformation from rudimentary operative techniques to highly advanced, technology-driven procedures that define modern clinical practice. This comprehensive review explores the historical evolution of common surgical procedures, tracing major milestones that have shaped contemporary surgery. The shift from open to minimally invasive and robotic-assisted techniques has significantly reduced patient morbidity, enhanced recovery, and improved outcomes. Developments in anesthesia, asepsis, and perioperative care have further revolutionized surgical safety and precision. The review also examines innovations in surgical oncology, trauma management, transplantation, and reconstructive procedures, alongside the integration of emerging technologies such as artificial intelligence, virtual reality, and telemedicine. Additionally, the role of simulation-based education and personalized approaches in shaping the next generation of surgeons is discussed. By bridging historical insights with modern advancements, this review underscores the continuous pursuit of excellence that defines surgical evolution and its impact on patient-centered care.

KEYWORDS

General surgery, Minimally invasive surgery, Surgical innovation, Robotic-assisted procedures, Surgical education

Introduction

General surgery, a dynamic and continuously advancing discipline, plays a vital role in the diagnosis, treatment, and management of a wide range of surgical conditions [1]. Ongoing innovations in surgical techniques, technology, and perioperative care have markedly improved both patient outcomes and clinical practices. To ensure evidence-based decision-making and remain informed about current advancements, it is crucial for surgeons, researchers, and healthcare professionals to stay updated with contemporary findings in the field [2].

ISSN 1019-6609
eISSN 1853-4961

This review critically examines recent literature to provide a comprehensive understanding of key developments and emerging trends that influence clinical practice, guide future research, and foster innovation in surgical care. It offers a historical perspective on the evolution of general surgery—from traditional open techniques to minimally invasive and robotic-assisted procedures. The review also explores vital areas such as surgical oncology, trauma management, and strategies for preventing and managing surgical site infections and postoperative complications [3].

Furthermore, it highlights the integration of emerging technologies, including artificial intelligence, virtual reality, and telemedicine, which are revolutionizing surgical precision and patient care. Advancements in surgical education, particularly simulation-based training and quality improvement initiatives, are also discussed as essential components for sustaining surgical excellence. Finally, the review outlines future directions, emphasizing the role of personalized and precision surgery in bridging the gap between evidence and practice to support informed, patient-centered decision-making [4].

Historical Overview Of General Surgery

General surgery has a rich history that has evolved through centuries of medical advancements and surgical innovations. Understanding the historical developments in this field provides a valuable context for appreciating the current state of general surgery and its continued progress.The origins of surgery can be traced back to ancient civilizations, where early surgical procedures were primarily performed for wound management, bone setting, and basic surgical interventions. Ancient Egyptians, Greeks, and Romans made significant contributions to surgical knowledge, documenting their techniques and observations. During the Middle Ages, surgical practices faced numerous challenges due to limited knowledge of anatomy, infection control, and anesthesia. However, notable surgeons such as Guy de Chauliac and Ambroise Paré laid the foundation for modern surgical techniques and principles. Paré's introduction of ligatures instead of cauterization for wound closure revolutionized surgical practice and reduced postoperative complications [5]. The 19th century witnessed remarkable advancements in general surgery. The introduction of anesthesia, pioneered by William Morton and Crawford Long, enabled surgeons to perform longer and more complex procedures with reduced patient discomfort and improved outcomes [6]. In addition, the discoveries of Louis Pasteur and Joseph Lister on the principles of antisepsis and asepsis significantly reduced surgical site infections and improved surgical safety. The field of general surgery experienced a major breakthrough in the 19th century with the introduction of anesthesia, enabling surgeons to perform more complex procedures. The use of ether and chloroform as anesthetics revolutionized surgical practice and expanded the scope of surgical interventions [5].The advent of the 20th century brought remarkable advancements in surgical techniques and technologies. The development of sterilization methods, such as steam auto- A comprehensive review of the literature in general surgery J Fac Med Or,Vol 8, n°1.p.961-1020., juin 2024 1001 claves, facilitated safer surgical procedures [6]. Surgeons like William Halsted, Harvey Cushing, and William Mayo made significant contributions to the fields of surgical oncology, neurosurgery, and specialized surgical techniques. The mid-20th century saw the emergence of minimally invasive surgery. The introduction of laparoscopy and its subsequent refinement by gynecologists and general surgeons marked a significant shift in surgical approaches. Laparoscopic procedures offered benefits such as reduced postoperative pain, shorter hospital stays, and faster recovery.Further advancements in surgical techniques and technologies continued into the 21st century. Robotic-assisted surgery, pioneered by Intuitive Surgical's da Vinci system, allowed for enhanced precision, dexterity, and

ISSN 1019-6609
eISSN 1853-4961

visualization during surgical procedures [7]. The integration of advanced imaging modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI), enabled surgeons to accurately diagnose and plan complex surgical interventions.

SURGICAL TECHNIQUES

A vast array of surgical procedures that have developed throughout time and each have unique benefits, drawbacks, and results are included in general surgery. The three surgical methods that are often used in general surgery—open surgery, laparoscopic surgery, and robotic surgery—are reviewed and discussed in this section. To reach the operative site, open surgery—also referred to as traditional or conventional surgery—involves opening a sizable incision. This method helps the surgeon perform accurate surgical procedures by giving them tactile input and direct vision. In many challenging instances, including large abdominal operations, trauma surgeries, and cases needing considerable tissue manipulation, it continues to be the preferred method and has been the gold standard for many surgical procedures [8]. Excellent exposure of the operative field, adaptability in managing different anatomical features, and the capacity to execute many treatments or interventions at once are some benefits of open surgery. It also makes it possible to effectively manage difficulties during the surgery and directly control hemorrhage [9]. General surgery has undergone a revolution thanks to laparoscopic surgery, also referred to as keyhole surgery or minimally invasive surgery. It entails making tiny incisions to reach the surgery site. To offer a magnified image of the surgical field on a monitor, a laparoscope—a tiny tube equipped with a camera and light source—is inserted. Additional tiny incisions are then made to introduce the surgical tools, enabling the physician to complete the process with the least amount of tissue damage. Compared to open surgery, laparoscopic surgery has a number of benefits, such as less discomfort after surgery, shorter hospital stays, quicker recovery, and better cosmetic results [10]. For several operations, including bariatric surgeries, appendicectomies, and cholecystectomy, it has emerged as the recommended method. Single-incision laparoscopic surgery (SILS) and natural orifice transluminal endoscopic surgery (NOTES) are two further developments in laparoscopic surgery. SILS improves cosmetic results and may lessen postoperative discomfort by completing the whole treatment with a single incision, often in the umbilicus [11]. By entering the operative site via natural openings like the mouth, anus, or vagina, NOTES goes beyond minimally invasive surgery and completely removes apparent external scars [12]. These cutting-edge methods are still developing, and research is being done to improve their uses and solve technical problems. One important technical development in general surgery is robotic surgery. It combines the advantages of laparoscopic surgery with the improved control, accuracy, and dexterity offered by robotically assisted devices. Using robotic arms that hold and handle surgical equipment, the surgeon controls the robotic console. Increased range of motion and enhanced tool stability are provided by the robotic system, which converts the surgeon's motions into accurate surgical actions. Certain surgeries, including hysterectomy and prostatectomy, have been transformed by this technology, which enables better surgical results, less blood loss, and quicker recovery periods [13]. However, the need for expensive technology, specific training, and a committed surgical team may prevent robotic surgery from being widely used.

Advances In Minimally Invasive Surgery

By providing patients with less intrusive alternatives to open surgery, minimally invasive surgery has completely transformed the area of general surgery. The most recent developments in minimally invasive surgery are examined in this section, with particular attention on laparoscopic and endoscopic

ISSN 1019-6609
eISSN 1853-4961

techniques and their effects on patient outcomes, recovery after surgery, and general surgical practice. Laparoscopic surgery, also referred to as keyhole or minimally invasive surgery, uses tiny incisions to reach the operating site. By using laparoscopes, which are made up of a camera and a light source, surgeons can see and precisely traverse the inside organs thanks to the high-definition pictures of the surgical area they provide. In a number of areas, such as bariatric surgery, gynecology, urology, and gastrointestinal surgery, laparoscopic treatments have grown in popularity [14]. Reduced postoperative discomfort, smaller incisions, quicker healing, shorter hospital stays, and better esthetic results are some of the benefits of laparoscopic surgery over open surgery [15]. Furthermore, as compared to open surgery, laparoscopic techniques have shown equivalent or even better results in terms of perioperative morbidity and mortality. The accuracy and capability of laparoscopic treatments have been further improved by ongoing developments in laparoscopic tools, such as robotic-assisted systems and 3D imaging. Significant progress has also been made in endoscopic operations in recent years. Endoscopy enables direct vision and intervention in the body's cavities or hollow organs, including the urinary tract, respiratory system, and gastrointestinal tract.

Surgical Oncology

General surgery plays a crucial role in the multidisciplinary management of various types of cancers, including breast, colorectal, gastric, and hepatic cancers. This section discusses the advancements in surgical approaches, adjuvant therapies, and outcomes in surgical oncology. Breast cancer is one of the most common malignancies worldwide, and surgical intervention is a cornerstone of its treatment. The surgical management of breast cancer has evolved significantly, with a shift towards breast-conserving surgery, also known as lumpectomy or partial mastectomy, as an alternative to mastectomy. Breast-conserving surgery aims to remove the tumor while preserving the cosmetic appearance of the breast. Sentinel lymph node biopsy, a minimally invasive technique, has also gained prominence in evaluating the spread of breast cancer to regional lymph nodes [19]. Advances in oncoplastic surgery have allowed for simultaneous breast reconstruction during cancer resection, further improving cosmetic outcomes and patient satisfaction. Additionally, neoadjuvant therapies, such as chemotherapy and targeted therapies, are increasingly being used to downsize tumors before surgery, enabling more conservative surgical approaches and improving overall outcomes. Colorectal cancer represents a significant burden globally, and surgery plays a critical role in its management. Surgical techniques for colorectal cancer have evolved from open surgery to minimally invasive approaches, such as laparoscopic and robotic-assisted surgery. These techniques offer advantages such as reduced postoperative pain, shorter hospital stays, faster recovery, and comparable oncological outcomes to open surgery [20]. In selected cases, transanal minimally invasive surgery (TAMIS) or transanal total mesorectal excision (TaTME) techniques are employed for rectal cancer, allowing for precise dissection and sphincter preservation [21]. The utilization of enhanced recovery after surgery (ERAS) protocols, including optimized perioperative care, has further improved postoperative recovery and patient outcomes in colorectal cancer surgery. Gastric cancer is another malignancy that requires surgical intervention as a primary treatment modality. The advent of minimally invasive techniques, such as laparoscopic and robotic gastrectomy, has gained traction in the surgical management of gastric cancer. These approaches offer reduced blood loss, shorter hospital stays, and comparable oncological outcomes to open surgery [22]. Lymph node dissection is a critical component of gastric cancer surgery, and extended lymphadenectomy has shown improved survival outcomes in selected patients [23]. Neoadjuvant chemotherapy or chemoradiotherapy followed by surgery has become the standard of care for locally advanced gastric cancer, allowing for downstaging of tumors and facilitating curative resection.

ISSN 1019-6609
eISSN 1853-4961

Trauma Surgery

Trauma surgery is essential for treating a variety of injuries, from blunt and penetrating trauma to polytrauma brought on by violent crimes or accidents. The examination and treatment of various injury types, resuscitation methods, surgical procedures, and results are all included in this section's overview of the most recent research on trauma surgery. A methodical strategy that places a high priority on patient stabilization, prompt therapies, and interdisciplinary teamwork is necessary for the assessment and care of trauma patients. The Advanced Trauma Life Support (ATLS) guidelines offer a standardized framework for initial evaluation, resuscitation, and decision-making in trauma treatment [25].

Surgical Infections And Complications

In the realm of surgery, surgical site infections (SSIs) and post-operative complications pose serious problems. The prevention, diagnosis, and treatment of surgical site infections (SSIs), post-operative complications, and methods to improve patient safety and lower morbidity and mortality are all covered in this area. A comprehensive strategy that takes into account a number of risk variables is needed to prevent SSIs. Optimizing patients is essential to lowering the risk of SSIs. In order to reduce the risk of infection, this involves screening for comorbidities prior to surgery, such as diabetes and obesity, and improving these conditions [30]. Furthermore, careful attention to surgical site preparation, such as using the right antiseptic solutions and hair removal methods, helps prevent microbial colonization and infection [31]. Because hypothermia might compromise the immune response, it's also critical to maintain normothermia during surgery by using warming equipment. Clinical evaluation by itself could not always provide a conclusive diagnosis for surgical site infections. Histopathological analysis and wound cultures are examples of ancillary studies that may help identify the pathogenic organisms and assess the extent of the infection [32]. Furthermore, improvements in imaging methods like magnetic resonance imaging (MRI) and ultrasound have made it easier to identify deep-seated infections and abscesses, allowing for prompt management [33]. Consistent monitoring and benchmarking of infection rates is made possible by the adoption of surveillance systems and defined criteria for surgical site infections, such as those set by the Centers for Disease Control and Prevention (CDC). Surgical site infections need a comprehensive approach to therapy. In order to manage the illness, empirical antibiotic therapy must be started early and guided by patterns of local antimicrobial resistance. Targeted antibiotic treatment may be used when the causal organism has been identified [34]. Surgical procedures like wound debridement and drainage may be required in situations of severe infection in order to remove contaminated tissues and encourage recovery. Working together with experts in infectious diseases may provide invaluable knowledge on treating complicated illnesses and customizing antibiotic treatment. The term "post-operative complications" refers to a broad category of unfavorable outcomes that might follow surgery. In order to reduce the negative effects of these consequences on patient outcomes, prompt identification and early management are essential. Early detection of problems is facilitated by structured post-operative surveillance, which includes routine evaluation of clinical indicators, laboratory results, and vital signs. Complications include bleeding, anastomotic leaks, or intra-abdominal abscesses may need immediate intervention, such as surgical exploration or interventional therapies [35]. Surgeons, intensivists, and other medical specialists work together in a multidisciplinary team to provide comprehensive treatment and the best possible results for patients Table 1.

ISSN 1019-6609
eISSN 1853-4961

Table 1 Evolution of Common Surgical Procedures from Historical Roots to Modern Practice

Surgical Procedure	Historical Approach (Past Era)	Modern Advancement (Present Era)	Clinical Outcome Improvement	Key References
Appendectomy	Open appendectomy via large abdominal incision; manual ligation of the appendix stump.	Laparoscopic and single-incision appendectomy using advanced visualization tools.	Reduced postoperative pain, shorter hospital stay, faster recovery.	Parker et al., 2019; Nguyen et al., 2021
Cholecystectomy	Open cholecystectomy with high risk of infection and prolonged recovery.	Laparoscopic and robotic-assisted cholecystectomy enabling minimal tissue trauma.	Lower infection rates, faster ambulation, improved cosmetic outcomes.	Strasberg et al., 2020; Bhandari et al., 2022
Hernia Repair	Tissue-based repair using simple suturing techniques (Bassini method).	Mesh-based laparoscopic or robotic hernioplasty with tension-free closure.	Decreased recurrence rates, reduced postoperative pain, early return to activity.	Simons et al., 2018; Köckerling et al., 2021
Cesarean Section	Classical vertical incision under ether/chloroform anesthesia; high maternal morbidity.	Lower segment transverse incision under regional anesthesia with enhanced asepsis.	Improved maternal survival, reduced infection and bleeding.	Betrán et al., 2021; Molina et al., 2022
Cardiac Surgery	Open-heart surgery with manual cardiopulmonary bypass systems.	Minimally invasive valve replacement, robotic CABG, and transcatheter procedures.	Shorter ICU stays, improved cardiac function, reduced mortality.	Mack et al., 2020; Falk et al., 2023
Neurosurgery	Craniotomy performed without imaging guidance; high neurological risk.	Image-guided, stereotactic, and robotic-assisted neurosurgery using 3D mapping.	Enhanced precision, minimized brain tissue	Kalkanis et al., 2017; Brown et al., 2022

ISSN 1019-6609
eISSN 1853-4961

			damage, faster recovery.	
Orthopedic Surgery	Manual fixation with metallic plates and plaster casts.	Computer-assisted navigation and joint replacement with 3D-printed implants.	Better alignment, improved mobility, reduced revision rates.	Parratte et al., 2020; Gomez et al., 2023
Transplant Surgery	Early organ grafting without immunosuppressants leading to high rejection.	Use of advanced immunosuppressive therapy and laparoscopic donor harvesting.	Increased graft survival, better postoperative quality of life.	Meier-Kriesche et al., 2019; Cooper et al., 2022
Plastic & Reconstructive Surgery	Basic skin grafts and flap rotations for trauma or burns.	Microvascular free flap surgery and 3D bioprinting for tissue regeneration.	Enhanced aesthetic outcomes, improved functionality.	Cigna et al., 2021; Shayan et al., 2023

Quality Improvement In General Surgery

In order to maximize surgical results, improve healthcare delivery, and raise patient satisfaction, general surgery must include quality improvement programs and patient safety measures. In addition to highlighting evidence-based recommendations that direct best practices, this section addresses the significance of quality improvement in general surgery. In order to provide safe, efficient, and patient-centered care, general surgery quality improvement entails the methodical evaluation and enhancement of healthcare procedures. Pain management, perioperative antibiotic prophylaxis, surgical site infection prevention, and prompt intervention for complications are only a few of its many facets. Initiatives for quality improvement seek to improve patient outcomes, lessen care disparities, and raise the standard of surgical services generally [52]. In attempts to increase quality, patient safety precautions are essential. It has been shown that implementing surgical safety checklists, such the World Health Organization's Surgical Safety Checklist, lowers surgical complications and death rates [53]. These checklists provide a uniform framework for guaranteeing that crucial safety precautions, such as site marking, intraoperative stop at crucial times, and pre-operative verification, are followed throughout surgical procedures. Additionally, using incident reporting systems to record and analyze unfavorable incidents and near-misses aids in identifying system weaknesses and putting preventative measures in place. General surgery quality improvement is based on evidence-based standards. They are created by carefully examining the research data that is currently accessible, reaching expert agreement, and taking patient preferences into account. Preoperative assessment, surgical procedures, post-operative treatment, and long-term follow-up are only a few of the areas of surgical care that are covered by guidelines [54]. They provide suggestions for risk mitigation techniques, best practices, and patient outcome-improving therapies. The Enhanced Recovery After Surgery (ERAS) protocols are one instance of evidence-based recommendations in general surgery. In order to improve patient outcomes, lower complications, and hasten recovery, these procedures provide multimodal

ISSN 1019-6609
eISSN 1853-4961

perioperative care routes. ERAS protocols encompass interventions such as preoperative patient education, preoperative fasting optimization, goal-directed fluid therapy, minimally invasive surgical techniques, early mobilization, and enhanced pain management strategies. Improved patient satisfaction, shorter hospital stays, and fewer problems have all been linked to the use of ERAS procedures. Another key aspect of quality improvement in general surgery is the use of performance metrics and quality indicators. These metrics provide unbiased information for evaluating and tracking the quality of surgical treatment. Examples of performance metrics include surgical site infection rates, readmission rates, surgical complication rates, and compliance with evidence-based practices. Frequent tracking of these indicators makes it possible to pinpoint problem areas and carry out focused treatments.

Future Directions, Challenges, And Conclusion

The field of general surgery is constantly developing in response to new developments in research, technology, and healthcare demands. Current issues, potential paths forward, and the significance of multidisciplinary teamwork in influencing general surgery's future are all highlighted in this section. Personalized medicine is one of the newer subspecialties of general surgery. Developments in molecular diagnostics, proteomics, and genomics provide prospects for customized treatment plans based on a person's genetic profile, enabling accurate prognostication, targeted therapy selection, and detection of genetic predispositions. In surgical practice, personalized medicine has the potential to increase treatment effectiveness, minimize complications, and maximize patient outcomes. However, issues like standardizing testing procedures, integrating genetic data into clinical decision-making, and addressing ethical concerns about permission and data privacy are all obstacles that must be overcome. Robotic surgery, image-guided treatments, and minimally invasive procedures are all examples of precision surgery that is always developing. By combining cutting-edge imaging techniques like intraoperative magnetic resonance imaging (MRI) with fluorescence-guided surgery, anatomical features and disease targets may be precisely identified and seen in real time, increasing surgical precision. Computer-assisted technology and robotics improve surgical dexterity, improve vision, and make difficult operations less invasive. To guarantee fair adoption and the best results, issues including cost, technology accessibility, and training needs must be taken into account as precision surgery develops. In general surgery, interdisciplinary teamwork is becoming more and more crucial. Working together with experts in a variety of disciplines, including as radiology, oncology, pathology, and genetics, promotes a multidisciplinary approach, makes complete patient management easier, and guarantees the provision of excellent, patient-centered care. Multidisciplinary tumor boards have emerged as a key component of cancer therapy, bringing together specialists from several fields to analyze complex cases and create integrated treatment strategies. Furthermore, using big data, AI, and predictive analytics to improve surgical decision-making, optimize resource allocation, and improve patient outcomes requires cooperation between data scientists, bioengineers, and informaticians. There are still difficulties in the area of general surgery. Globally, access to surgical treatment is still a problem, especially in underprivileged areas. Innovative approaches, such as telemedicine, task shifting, and surgical capacity development programs, are necessary to address healthcare inequities and provide fair access to surgical services. Furthermore, it might be difficult to retain competency, stay up with changing surgical procedures, and integrate new technology into clinical practice due to the quick speed of technological improvements. To overcome these obstacles, standardized training frameworks, lifelong learning, and ongoing professional development are crucial.

ISSN 1019-6609
eISSN 1853-4961

Conclusion

The evolution of general surgery from traditional open techniques to minimally invasive and robotic-assisted procedures represents one of the most remarkable advancements in modern medicine. Continuous innovations in surgical technology, anesthesia, and perioperative care have greatly enhanced safety, precision, and patient recovery. The integration of artificial intelligence, virtual reality, and telemedicine is reshaping surgical planning, education, and real-time decision-making. Furthermore, the emphasis on evidence-based practice, simulation-based training, and personalized approaches continues to elevate surgical standards worldwide. By understanding the historical foundations and embracing modern innovations, surgeons can ensure the delivery of safer, more effective, and patient-centered surgical care, paving the way for future breakthroughs in precision and outcomes.

Acknowledgement

I want to show my gratitude to my co-author for helping me complete the review.

Conflict of interest

No Conflict of interest

References

[1] Cuschieri A. Laparoscopic surgery—current status, issues, and future developments. Surg Technol Int. 2018;33:17-23.
[2] Anderson BO, Yip CH, Smith RA, et al. Guideline implementation for breast healthcare in low-income and middle-income countries: overview of the Breast Health Global Initiative Global Summit 2007. Cancer. 2008;113(8 Suppl):2221-2243.
[3] Paré A. The Apologie and Treatise of Ambroise Paré. Thomas Cotes; 1634.
[4] Bigelow HJ. Insensibility during surgical operations produced by inhalation. Boston Med Surg J. 1846;35(16):309-317.
[5] Lawrence GH. A Brief Historical Review of the Development of Sterilization Methods. Surg Gynecol Obstet. 1919;29(5):434-444.
[6] Intuitive Surgical. da Vinci Surgical System. Accessed June 30, 2023. https://www.intuitive.com/en-us/products-and-services/ da-vinci
[7] Bass E, Clark M, Amaral JF. The impact of laparoscopic surgery on major abdominal surgery for cancer. Surg Endosc. 2004;18(2):334-337.
[8] Arulampalam THA, Costa ML, Visvalingam N, et al. A systematic review of laparoscopic versus open abdominal incisional hernia repair, with meta-analysis of randomized controlled trials. Int J Surg. 2012;10(10):553-560.
[9] Antoniou SA, Antoniou GA, Koch OO, et al. Meta-analysis of laparoscopic vs open repair of paraesophageal hernia. Surg Endosc. 2012;26(8):2144-2155.
[10] Bucher P, Pugin F, Buchs NC, Ostermann S, Morel P. Single-port access laparoscopic cholecystectomy: A systematic review. Surg Endosc. 2011;25(2):367-377.
[11] Rattner D, Kalloo A, ASGE/SAGES Working Group on Natural Orifice Translumenal Endoscopic Surgery. ASGE/SAGES working group on natural orifice translumenal endoscopic surgery. Surg Endosc. 2006;20(2):329-333.

ISSN 1019-6609
eISSN 1853-4961

[12] Nambiar A, Sundaram V, Kaouk JH, et al. Robotic radical prostatectomy: A review of outcomes compared with laparoscopic and open approaches. Urology. 2007;70(5):948-954.
[13] Silva JP, Rosa SC, Ramos P, et al. Intraoperative ultrasound in liver surgery: systematic review. GE Port J Gastroenterol. 2021;28(2):106-116.
[14] ASGE Technology Committee, Kantsevoy SV, Adler DG, Conway JD, et al. Endoscopic mucosal resection and endoscopic submucosal dissection. Gastrointest Endosc. 2008;68(1):11-18.
[15] Tsai FC, Ho KS, Chen PH, et al. Confocal endomicroscopy in the evaluation of colonic mucosal barrier in irritable bowel syndrome. Surg Endosc. 2012;26(4):1184-1189. [16]
[16] Vigneswaran Y, Prachand VN, Posner MC, et al. The National Cancer Data Base report on esophageal carcinoma. Cancer. 2006;113(3):347-357.
[17] Veronesi U, Paganelli G, Viale G, et al. Sentinel-lymph-node biopsy as a staging procedure in breast cancer: update of a randomised controlled study. Lancet Oncol. 2006;7(12):983-990.
[18] Green BL, Marshall HC, Collinson F, et al. Long-term follow-up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. Br J Surg. 2013;100(1):75-82.
[19] Marks JH, Myers EA, Zeger EL, et al. Long-term outcomes by a transanal approach to total mesorectal excision for rectal cancer. Surg Endosc. 2017;31(12):5248-5257.
[20] Huscher CG, Mingoli A, Sgarzini G, et al. Laparoscopic versus open subtotal gastrectomy for distal gastric cancer: five-year results of a randomized prospective trial. Ann Surg. 2005;241(2):232- 237.
[21] Degiuli M, Sasako M, Ponti A, et al. Randomized clinical trial comparing survival after D1 or D2 gastrectomy for gastric cancer. Br J Surg. 2014;101(2):23-31.
[22] Abdalla EK, Vauthey JN, Ellis LM, et al. Recurrence and outcomes following hepatic resection, radiofrequency ablation, and combined resection/ablation for colorectal liver metastases. Ann Surg. 2004;239(6):818-825.
[23] American College of Surgeons Committee on Trauma. Advanced Trauma Life Support (ATLS): Student Course Manual. 10th ed. American College of Surgeons; 2018.
[24] Duchesne JC, McSwain NE, Cotton BA, et al. Damage control resuscitation: the new face of damage control. J Trauma. 2010;69(4):976-990.
[25] CRASH-2 trial collaborators, Shakur H, Roberts I, et al. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial. Lancet. 2010;376(9734):23-32.
[26] Inaba K, Aksoy H, Seamon MJ, et al. Multicenter evaluation of temporary intravascular shunt use in vascular trauma. J Trauma Acute Care Surg. 2016;80(3):359-365.
[27] Rotondo MF, Schwab CW, McGonigal MD, et al. 'Damage control': an approach for improved survival in exsanguinating penetrating abdominal injury. J Trauma. 1993;35(3):375-382.
[28] Tanner J, Padley W, Assadian O, et al. Do surgical care bundles reduce the riskof surgical site infections in patients undergoing colorectal surgery? A systematic review and cohort meta-analysis of 8,515 patients. Surgery. 2015;158(1):66-77.
[29] Webster J, Osborne S. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database Syst Rev. 2015;(2):CD004985.
[30] Mangram AJ, Horan TC, Pearson ML, et al. Guideline for prevention of surgical site infection, 1999. Centers for Disease Control and Prevention (CDC) Hospital Infection Control Practices Advisory Committee. Am J Infect Control. 1999;27(2):97-132.
[31] Bassiouny M, Chong WK, Mohan H, et al. Magnetic resonance imaging in the management of surgical site infections: a cost-effectiveness analysis. J Hosp Infect. 2013;85(4):269-276. [32] Bratzler DW,

ISSN 1019-6609
eISSN 1853-4961

Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Surg Infect (Larchmt). 2013;14(1):73-156.

[32] Ingraham AM, Cohen ME, Bilimoria KY, et al. Association of surgical care improvement project infection-related process measure compliance with risk-adjusted outcomes: implications for quality measurement. J Am Coll Surg. 2010;211(6):705-714.

[33] Greif R, Egger L, Basciani RM, et al. Monitoring the quality of airway management with the anaesthesia patient safety foundation guidelines: a two-center observational study in patients at increased risk of difficult airway. Anesthesiology. 2017;126(4):608- 618.

[34] Litjens G, Kooi T, Bejnordi BE, et al. A survey on deep learning in medical image analysis. Med Image Anal. 2017;42:60-88. World Health Organization COVID-19 (COVID-19) Situation report, availableathttps://in.reuters.com/article/uk-health-coronavirus-tech- research/white-house-urges-researchers-touse-ai-toanalyse-29000 coronavirus-papers-idINKBN2133VM.

[35] Ng KS, Goh YL, Wong ASW. The present and future of artificial intelligence in surgery: a systematic review. Int J Med Robot. 2019;15(4):e1985.

[36] Seymour NE, Gallagher AG, Roman SA, et al. Virtual reality training improves operating room performance: results of a randomized, double-blinded study. Ann Surg. 2002;236(4):458-464.

[37] Sanchez-Gonzalez P, Pla-Gil I, García-Vázquez V, et al. The use of augmented reality and virtual reality in oral and maxillofacial surgery. A systematic review. J Clin Med. 2020;9(4):929.

[38] Chen JH, Chien LN, Huang JW. Telemedicine and dermatology: current scenario and future prospects. Ann Dermatol. 2018;30(4):426-432