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Evidence-Based Surgical Practice: A Systematic Review of Contemporary Approaches to Common General Surgical Procedures

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Abstract

The landscape of general surgery has undertaken transformative changes over the past two decades, determined by technological innovation, evidence-based practice frameworks, and the widespread adoption of minimally invasive techniques. This systematic review synthesizes contemporary evidence on surgical approaches to the most frequently performed general surgical measures. Though, a detailed literature search was made using the Cochrane Library, Scopus, PubMed, and Web of Science (WoS) databases, comprising findings published from January 2020 to June 2026. Studies were designated according to predefined inclusion criteria, with primary emphasis placed on randomized controlled trials (RCTs), systematic reviews, and meta-analyses. The PRISMA 2020 strategies were tracked throughout. Moreover, laparoscopic surgery remains the evidence-based standard of care for cholecystectomy and appendectomy (Grade A recommendation). For inguinal hernia repair, laparoscopic methods demonstrate superiority in wound infection reduction and shorter hospital stays, though open repair with local anesthesia remains a viable alternative in selected patients. In colorectal cancer surgery, robotic-assisted surgery shows significant advantages in conversion rates and circumferential resection margin status compared to conventional laparoscopy. Notably, open radical hysterectomy remains superior to minimally invasive approaches for early-stage cervical cancer based on landmark RCT evidence. Furthermore, Evidence-based surgical practice demands individualized approach selection based on procedure-specific evidence, patient factors, surgeon expertise, and institutional resources. While minimally invasive techniques dominate most common procedures, open surgery retains critical indications in oncology, trauma, and complex cases.

Introduction

General surgery encompasses a broad spectrum of procedures ranging from routine operations such as cholecystectomy and appendectomy to complex oncological resections [1-3]. The principle of evidence-based medicine incorporating the finest

accessible study suggestion with clinical proficiency and patient values has become foundational to modern surgical practice [4-6]. Over the past two decades, the surgical landscape has been fundamentally reshaped by the transition from open to minimally invasive methods, the emergence of robotic-assisted platforms, and the application of enhanced recovery after surgery protocols [7, 8].

The adoption of laparoscopic cholecystectomy in the early 1990s marked the beginning of a paradigm shift that has since expanded across virtually all domains of general surgery [9, 10]. Today, minimally invasive surgery (MIS) is the default approach for many procedures, yet the evidence supporting each application varies considerably in quality and strength [11, 12]. Furthermore, the introduction of robotic-assisted surgery (RAS) has added another dimension to surgical decision-making, with debates continuing regarding its cost-effectiveness and clinical superiority [13, 14].

This systematic review purposes to deliver a comprehensive synthesis of contemporary evidence for the most frequently performed general surgical procedures, examining outcomes across open, laparoscopic, and robotic-assisted approaches. We focus on procedures including cholecystectomy, appendectomy, inguinal hernia repair, colorectal resection, and selected oncological operations, evaluating perioperative outcomes, complication rates, oncological safety, and cost-effectiveness.

Methods

Search Strategy and Selection Criteria

An organized literature search was executed across Cochrane Library, Scopus, PubMed, and WoS from January 2020 to June 2026. The search approach applied a combination of Medical Subject Headings (MeSH) terms and free-text keywords involving "minimally invasive surgery," "laparoscopy," "robotic surgery," "open surgery," "general surgery," "evidence-based practice," and procedure-specific terms as shown in Figure 1. Boolean operators were used to refine searches.

Inclusion Criteria:

Systematic reviews and meta-analyses
Large prospective cohort studies (n > 500)
Randomized controlled trials (RCTs)
Studies published in peer-reviewed English-language journals
Adult patient populations (≥18 years)

Exclusion Criteria:

Case reports and case series with n < 50
Non-comparative examinations
Conference abstracts
Pediatric populations

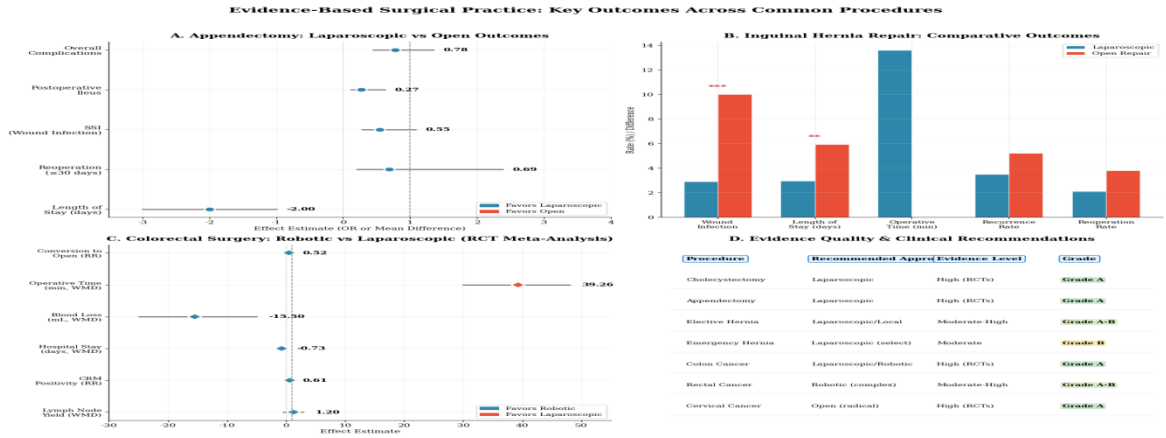

Figure 1: Evidence-based surgical practice for common general surgical procedures

Information Extraction and Quality Assessment

Information was autonomously obtained by two referees, including information on study characteristics, patient demographics, surgical techniques, and outcome measures.

The Newcastle–Ottawa Scale (NOS) was utilized to evaluate qualitative research, and the Cochrane Risk of Bias 2 (RoB 2) assessment was used to measure the scientific level of a randomized controlled trial (RCTs). The GRADE system was used to assess each result's level of evidentiary assurance. Figure 2 shows the entire process of information extraction and quality evaluation.

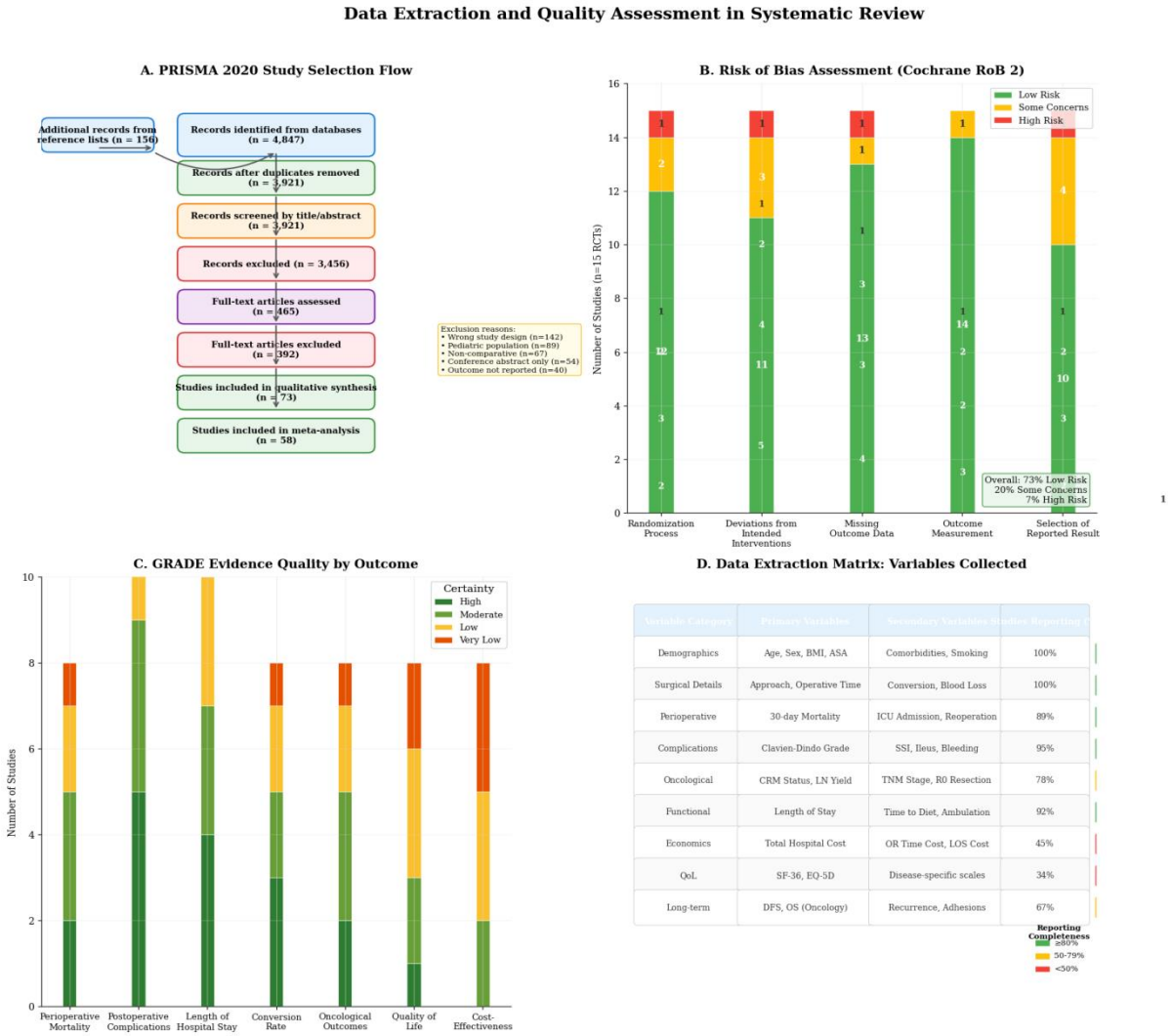

Figure 2: **Information Extraction and Quality Assessment**

Outcome Measures

Primary outcomes included:

Perioperative mortality (30-day)

Postoperative complications

Conversion rates (for minimally invasive approaches)

Oncological outcomes (for cancer surgery)

Secondary results involved:

Operative time

Blood loss and transfusion requirements

Quality of life measures

Cost-effectiveness

Long-term functional outcomes

Results

Cholecystectomy

Laparoscopic cholecystectomy has been recognized as the gold standard for symptomatic gallstone disease since the early 1990s. Contemporary evidence continues to support this recommendation across diverse patient populations.

A qualified organized review of laparoscopic surgery results confirmed that patients undergoing laparoscopic cholecystectomy experience no substantial difference in morbidity and mortality associated to open surgery, with the additional benefits of faster recovery and shorter hospital stay. Importantly, laparoscopic cholecystectomy demonstrates advantage over open surgery in elderly patients concerning cardiac and respiratory complications. Among patients with Child–Pugh class A or B cirrhosis, laparoscopic cholecystectomy has been associated with outcomes that are comparable to or better than those of open cholecystectomy. It is also linked to a lower risk of postoperative complications, including reduced intraoperative blood loss and decreased bacterial contamination of ascitic fluid [15].

Regarding intraoperative cholangiography, the routine on-table usage demonstrations no advantage in preventing common bile duct injuries or retained stones, and significantly prolongs operative time [15].

Appendectomy

Acute appendicitis remains one of the most frequently encountered surgical emergencies globally. The role of laparoscopic appendectomy has evolved from an elective option to the preferred approach in most clinical scenarios.

A recent retrospective cohort study comparing laparoscopic versus open appendectomy in 282 adult patients demonstrated favorable outcomes for the laparoscopic approach. The frequency of postoperative ileus was considerably greater following open appendectomy than laparoscopic appendectomy (14.7% versus 4.0%; $p = 0.020$). Patients who underwent the laparoscopic procedure also experienced a considerably shorter median hospital stay (4 vs. 6 days; $p < 0.001$). Among cases of complicated appendicitis, the laparoscopic approach demonstrated superior outcomes, with a lower rate of postoperative ileus (7.1% vs. 26.3%; $p = 0.025$) and a reduced length of hospitalization (5 vs. 7 days; $p < 0.001$) compared with the open technique [16].

These findings align with accumulating evidence from meta-analyses demonstrating that laparoscopy is safe and effective even in advanced disease. Researcher found no significant difference in intra-abdominal abscess between laparoscopic and open approaches (3.8% vs. 4.5%), while hospital stay was shorter in the laparoscopic group (4.5 vs. 6.0 days). A 2023 meta-analysis of perforated appendicitis confirmed reduced wound infections and overall complications with laparoscopy, along with a pooled mean reduction in hospital stay of 1.3 days [16, 17].

Inguinal Hernia Repair

It is a prevalent surgical procedure, with over 20 million cases annually. A systematic review involving 38,659 patients found that laparoscopic repair led to a significantly shorter hospital stay by an average of 2.96 days and a lower incidence of wound infections associated to open repair. However, no significant differences were detected in operative duration, seroma formation, or respiratory complications between the two techniques. The conversion rate from laparoscopic to open surgery was 2.78% [18].

For elective repair, a large retrospective analysis of 107,073 veterans found that laparoscopic repair was related with reduced complications associated to open repair under general anesthesia, but showed no difference when compared to open repair

with local anesthesia. Laparoscopic repair was associated with significantly longer operative time, particularly for complex cases (up to 31.4 minutes longer at the 95th percentile) [19].
These findings suggest that the benefits of laparoscopic repair are modified by anesthesia modality. Open repair with local anesthesia represents a reasonable alternative for unilateral initial inguinal hernias, particularly in resource-limited settings.

Colorectal Cancer Surgery
The management of colorectal cancer has been revolutionized by minimally invasive techniques, with ongoing debate regarding the optimal platform conventional laparoscopy versus robotic-assisted surgery.
Evidence from a wide-ranging systematic review of 15 randomized controlled trials (RCTs), involving 2,965 patients undergoing colorectal cancer resection, evaluated the outcomes of robotic-assisted surgery (RAS) compared with conventional laparoscopic surgery (LACS). The analysis demonstrated that RAS significantly decreased the likelihood of conversion to open surgery (RR: 0.52; 95% CI: 0.35–0.78; $p = 0.001$) and was associated with a modest reduction in hospital stay (WMD: −0.73 days; 95% CI: −1.28 to −0.19; $p = 0.009$). However, robotic procedures required a significantly longer operative time (WMD: +39.26 minutes; $p < 0.001$). Additionally, RAS was linked to a lower rate of circumferential resection margin (CRM) positivity whereas lymph node retrieval and the total incidence of postoperative complications were similar between the two surgical approaches [20].
In patients with rectal cancer, the REAL trial confirmed that RAS provides several benefits over conventional laparoscopic surgery, including reduced postoperative complications, shorter hospitalization, and better quality of oncological specimens. Furthermore, three-year follow-up results indicated that the robotic group had lower locoregional recurrence rates and improved disease-free survival [21].
Though, the cost-effectiveness of RAS remains debated. Robotic systems require initial investments exceeding $2 million with annual maintenance costs of approximately $100,000 [21].

Cervical Cancer Surgery
It represents a critical example where newer technology does not always translate to superior outcomes. The Laparoscopic Approach to Cervical Cancer (LACC) trial provided pivotal evidence indicating that minimally invasive radical hysterectomy was related with inferior oncological outcomes compared with the open approach. Five-year follow-up results confirmed significantly better overall survival (96.2% vs. 90.6%) and disease-free survival (96.0% vs. 85.0%) in patients who underwent open surgery. Moreover, patients treated with laparoscopic or robot-assisted radical hysterectomy had approximately a fourfold higher risk of disease recurrence and a threefold greater risk of mortality than those managed with open radical hysterectomy [22, 23].
The mechanism underlying this disparity remains under investigation. Hypotheses include tumor spillage during manipulation, the effects of pneumoperitoneum, and the need to extract the specimen through the vaginal canal. Following the evidence from these studies, the National Comprehensive Cancer Network revised its clinical guidelines to recommend open radical hysterectomy as the preferred surgical approach for the management of cervical cancer, rather than the laparoscopic technique.
Notably, for low-risk disease following simple hysterectomy (SHAPE trial criteria), minimally invasive surgery showed no statistically substantial difference in recurrence-free survival related to open surgery, suggesting that the oncological risk may be procedure-specific [24-26].

Comparative Outcomes Across Surgical Platforms

A large meta-analysis encompassing 12 years of data and more than 3.9 million surgical procedures demonstrated that robotic surgery offers several perioperative advantages over both laparoscopic and open techniques. Compared with laparoscopy, robotic surgery reduced 30-day postoperative complications by 10% and blood transfusion rates by 21%, while reductions reached 44% and 75%, respectively, when compared with open surgery [27].

Despite these benefits, robotic surgery was related with longer operative times, averaging 18 minutes more than laparoscopic procedures and 41 minutes more than open surgery. Economic analyses also showed substantially higher costs for robotic-assisted surgery ($15,319) than for laparoscopic surgery ($8,955), with lower contribution margins ($6,630 vs. $10,676) [27].

The COMPARE study, a systematic review of oncologic procedures, confirmed that da Vinci robotic-assisted surgery demonstrated advantages over both laparoscopic and open surgery across multiple outcomes including minor conversion rates, decreased blood transfusions, reduced stay in hospital, fewer 30-day complications, and lower mortality [28].

Open Surgery: Persistent Indications

Despite the dominance of minimally invasive techniques, open surgery retains critical indications across multiple domains:

Trauma Surgery: Major abdominal trauma overwhelmingly relies on open techniques for rapid access to multiple body regions simultaneously and comprehensive exposure for bleeding control.

Complex Oncology: Cases involving extensive lymphadenectomy, multivisceral resection, or tumors requiring wide surgical exposure to achieve complete oncological clearance.

Organ Transplantation: The technical complexity of vascular anastomosis and the necessity of minimizing warm ischemia time make the open surgical approach the preferred option in these procedures.

Conversion Scenarios: For rectal cancer, patients undertaking marginally invasive surgery transformed to open had comparable 30-day outcomes to planned open surgery, with a reduced stay, supporting an initial MIS attempt even when conversion is anticipated [29].

Discussion

Synthesis of Evidence

This systematic review reveals a nuanced landscape in evidence-based surgical practice. While minimally invasive techniques have become the default for many common procedures, the evidence supporting each application varies considerably:

Clear Evidence for Minimally Invasive Approaches:

Cholecystectomy: Laparoscopic (Grade A)
Appendectomy: Laparoscopic (Grade A)
Colon cancer: Laparoscopic/Robotic (Grade A)

Context-Dependent Recommendations:

Inguinal hernia: Laparoscopic for bilateral/recurrent; open with local anesthesia acceptable for unilateral primary (Grade A-B)
Rectal cancer: Robotic for complex cases (Grade A-B)

Open Surgery Remains Standard:

Early-stage cervical cancer: Open radical hysterectomy (Grade A)

Major trauma: Open exploration (Grade A)
Complex multivisceral resections (Grade B)

The Robotic Surgery Paradox

Robotic-assisted surgery presents a paradox in contemporary practice. While meta-analyses demonstrate clear perioperative advantages including reduced conversions, shorter hospital stays, and improved oncological metrics in rectal cancer these benefits come at significantly higher costs and longer operative times. The cost-effectiveness equation remains unfavorable in many healthcare systems, particularly for procedures where laparoscopy already achieves excellent outcomes.

The REAL trial's 3-year data suggesting improved oncological outcomes with robotic rectal resection may shift this balance, but longer-term follow-up and cost-effectiveness analyses are needed before universal adoption can be justified.

Global Surgery Considerations

Approximately 5 billion people lack entrée to safe, appropriate, and reasonable surgical services, particularly in developing countries. The development of National Surgical, Obstetric, and Anesthesia Plans (NSOAPs) has emerged as a strategic approach to strengthening surgical systems. In these contexts, open surgery with local anesthesia may represent the most feasible and cost-effective approach for many procedures, highlighting that evidence-based practice must be adapted to local resource constraints [30].

Conclusions

Evidence-based surgical practice in the contemporary era demands a nuanced, procedure-specific approach to selecting surgical techniques. Key conclusions include:

Laparoscopic surgery remains the evidence-based gold standard for cholecystectomy and appendectomy, with robust RCT support.

Inguinal hernia repair benefits from individualized approach selection, with laparoscopy favored for bilateral/recurrent cases and open repair with local anesthesia remaining viable for unilateral primary hernias.

Colorectal cancer surgery demonstrates incremental benefits with robotic assistance for complex rectal cases, though cost-effectiveness remains debated.

Open surgery retains critical indications in cervical cancer radical hysterectomy, trauma, and complex oncology, and maintaining proficiency in open techniques is essential for surgical training.

The forthcoming of surgical practice lies not in abandoning conventional methods but in considerately integrating open, laparoscopic, and robotic techniques based on the best available evidence, patient-specific factors, and institutional capabilities.

The surgical community stands at an inflection point where technological progress must be balanced with evidence-based decision-making. Regardless of the surgical approach, the primary objective is to provide safe, effective, and individualized care that best addresses each patient's clinical needs.

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