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ADVANCEMENTS IN ENHANCED RECOVERY AFTER SURGERY (ERAS) PROTOCOLS: A SYSTEMATIC REVIEW OF OUTCOMES

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ABSTRACT

The advent of Enhanced Recovery After Surgery (ERAS) has introduced a total reformation in perioperative care, replacing classic methods with a better, evidence-oriented approach, that focuses on the patient rather than their surgery. ERAS protocol applies the comprehensive approach to patient care by taking all stages before, during, and postoperatively into account. These schemes center on personalized treatments that are customized to the individual's individual needs. The vital constituents of ERAS include nutrition evaluation and improvement, patient education, minimally invasive procedures, and multimodal pain management. ERAS provides a wide range of benefits such as a reduction in postoperative complications, shorter hospital stay periods, better patient outcomes, and a decrease in cost to the medical industry. This paper will discuss systematically what are previous clinical outcomes in general surgery with EARS protocol as compared to traditional approaches.

INTRODUCTION

Enhanced Recovery After Surgery (ERAS) protocols represent evidence-based perioperative care pathways to optimize patient outcomes and streamline recovery following surgical procedures. In general surgery, ERAS protocols encompass a multidisciplinary approach aimed at attenuating the physiological stress response to surgery and facilitating early postoperative rehabilitation, ultimately improving patient recovery trajectories. Enhanced Recovery After Surgery (ERAS) protocols have revolutionized perioperative care, offering a structured, evidence-based approach to optimize patient outcomes. For the fast-track surgery concept, ERAS protocol was initially applied to cardiac surgery in

the United States, and later it gained prominence through the pioneering work of Kehlet in colorectal surgery and then it started being followed in general surgeries. These protocols entail a multidisciplinary framework encompassing preoperative, intraoperative, and postoperative interventions to attenuate physiological stress response to surgery, facilitating early recovery1. Behind ERAS protocols, the motive was to solve the burgeoning challenges confronting modern healthcare systems as the global population is growing rapidly and the prevalence of disease has increased significantly which puts a burden on the healthcare system. To advance surgical techniques, there has been a surge in surgical procedures, exacerbating the strain on hospital resources on the other hand, evolving payment models, transitioning from fee-for-service to value-based reimbursement, has heightened the emphasis on achieving optimal outcomes while containing costs. Against this backdrop, ERAS protocols are now providing a comprehensive approach to enhance perioperative care efficiency and mitigate the burden of postoperative complications2. The "ERAS® Society" was established in 2010 in Sweden as an international non-profit medical academic society, gathering professionals from various surgical care fields, encouraged by the remarkable successes documented by ERAS protocol research. With collaborative efforts involving diverse surgical specialties and healthcare stakeholders, the ERAS Society has catalysed the adoption of standardized perioperative care pathways, guided by robust evidence and best practices3. In Latin America, the adoption and adaptation of ERAS protocols achieved a strong grip and now it is spearheaded by initiatives such as the ACERTO project in Brazil and implementation programs in Argentina, Colombia, Mexico, and Uruguay, ERAS protocols have permeated diverse surgical disciplines, yielding promising results4. This research is conducted to consolidate previous evidence and the impact of Enhanced Recovery After Surgery (ERAS) protocols in general surgery, shedding light on their effectiveness in optimizing perioperative care and improving patient outcomes. This review provides clinicians, researchers, and healthcare policymakers with comprehensive insights into the efficacy and utility of ERAS protocols in enhancing surgical care delivery and fostering better patient outcomes across diverse general surgery procedures.

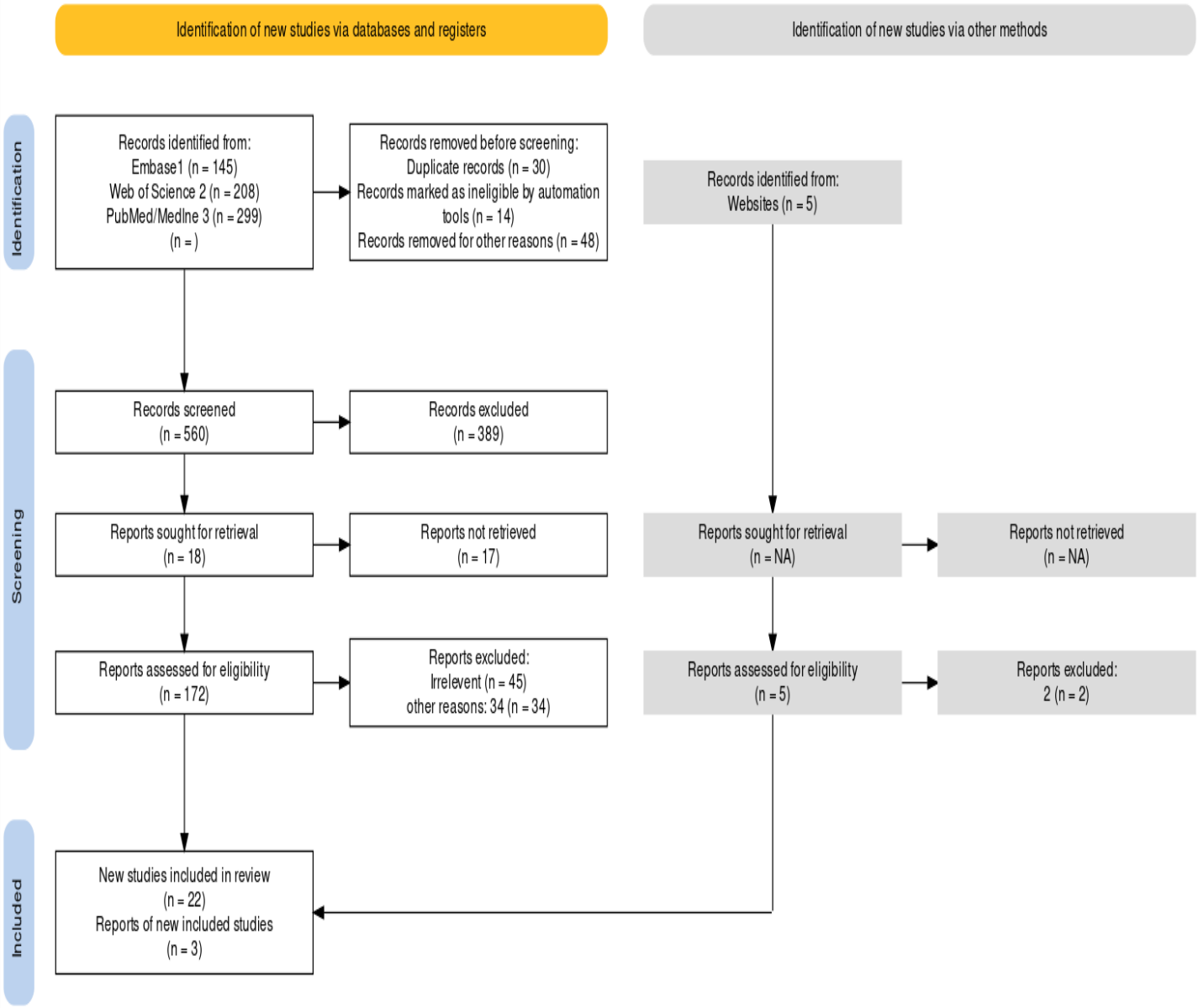
METHODOLOGY

To identify relevant literature for this systematic research on general surgery outcomes through Enhanced Recovery After Surgery (ERAS) protocols, we decided on databases such as PubMed/MEDLINE and Web of Science access to peer-reviewed articles, cohort studies, systematic reviews, and meta-analyses to search outcomes of ERAS protocols in optimizing patient outcomes and healthcare resource management. Also, we searched on Embase database to cater to biomedical and nursing research, offering valuable perspectives on surgical complications, pain management strategies, readmission rate, and patient satisfaction within the ERAS framework. Our systematic approach across database search is guided by a well-defined search strategy and specific keywords and phrases related to ERAS, perioperative care, and surgical outcomes. We carefully developed Boolean operators such as "AND" and "OR," to refine the search.

Keywords: Enhanced Recovery After Surgery (ERAS), perioperative care, surgical outcomes, patient satisfaction, general surgery, complications, hospital stay, mortality rates, pain management, multimodal analgesia, cost-effectiveness, preoperative optimization, postoperative rehabilitation, healthcare resource management, evidence-based practice, ERAS protocols.

Mesh Terms:

1. [("Enhanced Recovery After Surgery" OR ERAS) AND (Preoperative OR Postoperative Care) AND (General Surgery)]
2. [(Enhanced Recovery After Surgery OR ERAS) AND (Perioperative Care OR Preoperative Care OR Postoperative Care) AND (General Surgery) AND (Hospital Stay OR Length of Stay)]
3. [(Enhanced Recovery After Surgery OR ERAS) AND (Surgical Outcomes OR Clinical Outcomes) AND (General Surgery) AND (Complications NOT Adverse Events)]



RESULTS

In results by Embase, Web of Science, and PubMed/Medline, resulted in the identification of 652 records. We used Zotero which removed duplicated papers and papers that were deemed ineligible. We obtained 560 records that underwent title and abstract screening. During the screening, 172 reports were assessed for eligibility, and finally, 22 studies met the inclusion criteria from these databases. Additionally, five studies were identified through other methods, such as websites and two were excluded, Ultimately, 25 studies were included in the review.

1. **Preoperative Phase**

The preoperative phase of ERAS protocol focuses on patient optimization and preparation before starting surgery where physicians and healthcare providers follow preoperative counseling with patients and families about discharge planning, surgery and medication planning, and nutritional optimization such as Preoperative carbohydrate drink two hours pre-anesthesia to minimize fasting duration and limit fasting light meal up to 6 hours of prep, initial multimodel medications and/or regnal block placement, smoking cessation, and physical conditioning to mitigate risk factors and enhance resilience to surgery. Multimodal analgesia techniques and bowel preparation strategies are employed to minimize postoperative pain and facilitate early recovery23.

2. **Intraoperative Phase**

During the intraoperative phase, ERAS protocols emphasize a minimally invasive approach if needed to reduce surgical trauma and preserve physiological function. Surgeons follow ERAS interoperative strategies such as Maintaining normovolemia to optimize fluid balance for a surgical procedure, normoglycemia to support optimal glucose levels during perioperative care, minimizing tube and drain usage, regional anesthesia techniques, and maintenance of normothermia to attenuate the stress response to surgery and promote perioperative hemodynamic stability. In the ERAS intraoperative phase, opioid-sparing analgesia and prophylactic antibiotic administration optimize pain control and prevent surgical site infections25,

3. **Postoperative Phase**

The postoperative phase of the ERAS protocol focuses on early nutrition and mobilization to expedite recovery and minimize the risk of complications right after a surgical procedure is completed. Enhanced pain management strategies such as multimodal analgesia and regional anesthesia techniques facilitate ambulation and functional rehabilitation. "Postoperative ERAS emphasizes judicious IV fluid management, prioritizing optimal hydration while avoiding excessive fluid administration to reduce complications and promote better patient outcomes. Early removal of urinary catheters and nasogastric tubes, along with proactive management of postoperative nausea and vomiting, are integral components of the ERAS protocol to promote early recovery of bowel function and facilitate discharge readiness27.

4. **Post-discharge Phase**

ERAS post-discharge care, emphasis extends beyond hospitals, comprising telehealth follow-ups for progress monitoring and remote guidance. Personalized discharge plans are established to offer tailored instructions for medication, wound care, and activity after discharge. When needed, home health services provide nursing, therapy, and equipment support at home otherwise patients are educated with the required information about how they can treat themselves after surgery. Community

resources integration involves collaborating with local support services. Remote monitoring technology is also an important aspect of ERAS post-operative discharge as technologies enable real-time tracking for early intervention, ensuring holistic care, fostering optimal recovery, reducing readmissions, and enhancing patient satisfaction.

Table1 *(ERAS Protocol Components and Guidelines.)*

Component	Description	Examples
Preoperative Phase		
Preoperative Assessment	Comprehensive assessment of patient's medical history, comorbidities, and risk factors for surgery.	Medical history review, physical examination, laboratory tests (e.g., blood work, imaging), assessment of functional status and frailty.
Preoperative Counseling	Individualized counseling sessions with the patient to discuss the surgical procedure, expected outcomes, and postoperative expectations.	Explanation of surgical procedure, risks and benefits, anesthesia options, expected length of hospital stay, anticipated postoperative pain, and recovery timeline.
Prehabilitation	Preoperative optimization of physical fitness, nutrition, and psychological well-being to enhance postoperative recovery.	Structured exercise program, dietary counseling, smoking cessation support, stress reduction techniques, and mental health support.
Nutritional Optimization	Evaluation of nutritional status and supplementation as needed to ensure adequate preoperative nutrition and optimize healing.	Dietary assessment, supplementation with vitamins or minerals if deficiencies are identified, referral to nutritionist or dietitian for personalized recommendations.
Smoking Cessation	Support and resources are provided to patients to quit smoking before surgery to reduce the risk of complications and improve healing.	Smoking cessation counseling, nicotine replacement therapy, prescription medications (e.g., varenicline), referral to smoking cessation support groups or programs.
Medication Review and Adjustment	Review of current medications, including adjustments or cessation of medications that may increase surgical risk or interfere with anesthesia.	Medication reconciliation, adjustment or cessation of anticoagulants, antiplatelets, or other medications that may increase bleeding risk, optimization of chronic disease medications.
Glycemic Control	Optimization of blood glucose levels for diabetic patients to reduce the risk of surgical complications such as infection and delayed wound healing.	Insulin therapy adjustment, oral antidiabetic medication adjustment, blood glucose monitoring, and education on self-management.

Preoperative Antibiotics	Administration of antibiotics within 1 hour before surgical incision to prevent surgical site infections.	Intravenous administration of prophylactic antibiotics based on surgical site and patient-specific factors, adherence to institutional guidelines for antibiotic selection and dosing.
Intraoperative Phase		
Anesthetic Technique	Utilization of regional anesthesia, nerve blocks, or other techniques to minimize intraoperative pain and reduce the need for opioid analgesics.	Epidural anesthesia, spinal anesthesia, peripheral nerve blocks (e.g., femoral nerve block), intravenous lidocaine infusion, and patient-controlled analgesia (PCA) with opioids.
Temperature Management	Maintenance of normothermia through measures such as forced-air warming blankets to prevent hypothermia and associated complications.	Forced-air warming blankets, warmed intravenous fluids, heated humidified gases, temperature monitoring, and adjustment throughout the surgery.
Goal-Directed Fluid Therapy	Individualized fluid management strategies guided by hemodynamic monitoring to optimize tissue perfusion and prevent fluid overload.	Hemodynamic monitoring (e.g., arterial line, central venous catheter), fluid restriction or administration based on cardiac output, urine output, and other parameters.
Blood Conservation Strategies	Implementation of techniques such as cell salvage, intraoperative hemodilution, and meticulous surgical technique to minimize blood loss.	Cell salvage system for autologous blood transfusion, controlled hypotension, use of hemostatic agents (e.g., topical thrombin, fibrin sealants), minimally invasive surgical techniques.
Minimally Invasive Techniques	Use of minimally invasive surgical approaches whenever feasible to reduce tissue trauma, postoperative pain, and length of hospital stay.	Laparoscopic surgery, robotic-assisted surgery, endoscopic procedures, percutaneous techniques, and arthroscopic surgery.
Surgical Site Marking	Marking of the surgical site before incision to prevent wrong-site surgery and ensure correct surgical site identification.	Surgical site verification using the "Time Out" protocol, marking the site with a sterile marker or surgical skin marker, and documentation of site marking in the patient's medical record.
Postoperative Phase		
Early Mobilization	Early initiation of ambulation and physical therapy to prevent complications such as deep vein	Encouragement to sit out of bed and walk short distances on the day of surgery, initiation of physical therapy exercises

	thrombosis and promote faster recovery.	(e.g., ankle pumps, deep breathing exercises) while in bed.
Multimodal Pain Management	Utilization of a combination of analgesic modalities, including opioids, regional anesthesia, NSAIDs, and acetaminophen, to minimize postoperative pain.	Scheduled administration of oral acetaminophen and NSAIDs, patient-controlled analgesia (PCA) with opioids, and peripheral nerve blocks for targeted pain relief.
Nausea and Vomiting Prophylaxis	Administration of antiemetic medications to prevent postoperative nausea and vomiting, which can delay recovery and increase the risk of complications.	Intravenous or oral administration of antiemetic medications (e.g., ondansetron, droperidol) before emergence from anesthesia, continuation of antiemetics postoperatively as needed.
Early Enteral Nutrition	Early introduction of oral or enteral nutrition to promote gut motility, enhance wound healing, and reduce the risk of infection.	Initiation of clear fluids within hours of surgery, advancement to a regular diet as tolerated, and administration of enteral nutrition via nasogastric or feeding tube if oral intake is inadequate.
Bladder Catheter Removal	Early removal of indwelling urinary catheters to reduce the risk of urinary tract infections and facilitate early ambulation.	Removal of the urinary catheter within 24 to 48 hours postoperatively, monitoring of urinary output and bladder function, and bladder training techniques if necessary.
Postoperative Monitoring	Regular assessment of vital signs, pain levels, fluid balance, and surgical site integrity to detect and promptly manage complications.	Continuous monitoring in the post-anesthesia care unit (PACU), frequent nursing assessments on the surgical ward, and documentation of vital signs and pain scores at regular intervals.
Discharge Planning	Initiation of discharge planning early in the postoperative period, including coordination of follow-up care, medication reconciliation, and patient education.	Review of discharge instructions with the patient and family members, coordination of home health services (e.g., nursing, physical therapy), and scheduling of follow-up appointments with surgeons and primary care providers.
Patient Education and Support	Provision of comprehensive instructions regarding wound care, activity restrictions, medication management, and signs of complications.	Demonstration of wound care techniques, provision of written instructions, discussion of expected recovery milestones, and contact information for healthcare providers in case of questions or concerns.

ERAS Previous Evidences in Various Surgical Procedures and Success Outcomes

Length of Hospital Stay

1. In a quasi-experimental study conducted at Shifa International Hospital, Pakistan, 120 patients undergoing colorectal surgeries for carcinoma were randomized into two groups: one managed under Enhanced Recovery After Surgery (ERAS) protocols and the other under conventional management. ERAS significantly reduced mean hospital stay (3.45 days vs. 8.25 days) and lowered surgical site infection (SSI) incidence (7.5% vs. 15.8%). The study emphasized that despite the effectiveness of ERAS in reducing hospital stays and SSIs, strict adherence to protocols may be challenging due to professional and institutional inertia. Efforts to streamline and incentivize ERAS implementation are warranted to maximize its benefits5.
2. The retrospective cohort study compared perioperative outcomes of laparoscopic bariatric surgery between patients managed with Enhanced Recovery After Surgery (ERAS) protocols and those with conventional care. From January 2014 to June 2017, data from 435 patients were analyzed. The ERAS group (2016-2017) showed significantly shorter postoperative hospital stay (2.2 ± 0.9 days vs. 4.0 ± 2.6 days) and higher day 1 discharge rate (15.2% vs. 1%) compared to the conventional care group (2014-2015). Additionally, ERAS patients experienced fewer complications (2.1% vs. 8.6%) and readmissions (1.3% vs. 4.5%) within 30 days postoperatively. ERAS demonstrated significant benefits in reducing postoperative complications and hospital stays in laparoscopic bariatric surgery6.
3. The study "Enhanced Recovery After Surgery (ERAS) Reduces Hospital Costs and Length of Hospital Stay in Radical Cystectomy: A Prospective Randomized Controlled Study" by Çetin et al. (2024) demonstrates the efficacy of ERAS protocols in reducing hospital costs and length of stay for patients undergoing radical cystectomy with ileal conduit urinary diversion. Conducted between 2015 and 2023, the study included 77 patients divided into ERAS (n=39) and Standard (n=38) groups. ERAS protocols focus on minimizing metabolic disturbance from surgical injury, facilitating rapid function restoration, and promoting early normal activity. Results showed significantly shorter hospital stays (18.82±9.25 days vs. 27.34±15.05 days) and lower treatment costs ($2168.2±933 vs. $2879±1806) in the ERAS group compared to the Standard group. Despite a higher incidence of nausea, vomiting, and antiemetic use in the ERAS group, the benefits of reduced hospitalization duration and lower costs indicate the effectiveness of ERAS protocols in radical cystectomy patients7.
4. Anjani et al., 2023 in a comprehensive analysis encompassing 18 relevant studies, our systematic review revealed a significant reduction in the length of hospital stays when ERAS protocols were adopted, with a mean difference (MD) of -1.64 days (95% confidence interval [CI]: -2.21 to -1.08, $p<0.00001$). This substantial decrease in hospital duration underscores the efficiency and effectiveness of ERAS protocols in streamlining the recovery process for patients undergoing major colorectal surgery. By optimizing perioperative care pathways, including preoperative counseling, multimodal analgesia, and early mobilization, ERAS protocols facilitate expedited recovery and discharge, thereby minimizing the burden on healthcare resources and enhancing patient experiences9.

Complication Rates

1. National tertiary-level hospital, a prospective cohort study elaborated with implementation of the Enhanced Recovery After Surgery (ERAS) protocol in colorectal surgery patients at a national tertiary-level hospital significantly reduces the length of hospital stay [median (interquartile range) 6 (5–7) vs. 13 (11–19), P<0.001] and lowers total costs [USD 1875 (1234–3722) vs. USD 3063 (2251–4907), P<0.001]. Additionally, patients in the ERAS group exhibit a lower but non-statistically significant incidence of complications (10% vs. 21%) and readmission (5% vs. 10%) within 30 days post-discharge compared to the control group, with an impressive adherence rate of 97% to the ERAS protocol within the ERAS group8.
2. Anjani et al., 2023 suggested ERAS protocols have demonstrated a noteworthy reduction in postoperative complications, thereby significantly improving patient outcomes. Across the analyzed studies, ERAS implementation was associated with a decreased odds ratio (OR) of 0.57 (95% CI: 0.46 to 0.71, p<0.00001) for postoperative complications. Notably, these complications encompassed a range of adverse events commonly encountered in major colorectal surgery, including surgical site infections, anastomotic leaks, ileus, and urinary tract infections. The implementation of ERAS protocols addresses multiple facets of perioperative care, such as standardized perioperative fluid management, antibiotic prophylaxis, and enhanced recovery pathways, thereby mitigating the risk of complications and promoting optimal surgical outcomes. By reducing the incidence of postoperative complications, ERAS protocols not only contribute to improved patient safety and satisfaction but also yield substantial economic benefits by minimizing the need for extended hospital stays and additional interventions9.
3. The study in the Brazilian Journal of Anesthesiology (English Edition) examined how adherence to Enhanced Recovery After Surgery (ERAS) protocols influences postoperative complications in elective colorectal surgery. Analyzing data from 224 patients, the research revealed that non-compliance was associated with a higher incidence of complications (59.2% vs. 34.1% in compliant patients). Logistic regression analysis showed that compliance independently correlated with reduced complication risk (odds ratio: 0.42, 95% CI 0.23–0.75, p = 0.004). These findings underscore the significance of ERAS protocol adherence in mitigating postoperative complications and improving patient outcomes in colorectal surgery 10.

Mortality Rates

1. In a retrospective cohort study published in the International Journal of Colorectal Disease, the impact of implementing the Enhanced Recovery After Surgery (ERAS) protocol on 3-year survival following colorectal cancer surgery was assessed. The study included 1001 patients, with 497 in the ERAS group and 504 in the pre-ERAS group. Results indicated a significantly higher 3-year overall survival rate in the ERAS group compared to the pre-ERAS group (76.1% vs. 69.2%; p = 0.017). Additionally, the ERAS group exhibited a significantly shorter median length of hospital stay (10 days vs. 15 days; p ≤ 0.001) and a lower 90-day readmission rate (15% vs. 20%; p = 0.037). Multivariate Cox model analysis revealed ERAS implementation as a protective factor, associated with a 30% reduction in the risk of death (HR = 0.70 [0.55-0.90]). Notably, factors such as ASA score > 2, smoking, history of cancer, and atrial fibrillation were identified as deleterious risk factors linked to earlier mortality. Overall, these findings

underscore the association between ERAS protocol implementation, improved 3-year survival rates, and reduced length of hospital stay, highlighting the potential benefits of ERAS in optimizing postoperative outcomes following colorectal cancer surgery 11.

2. The systematic review and meta-analysis conducted by Zhi-Chao Hu et al. evaluated ERAS) interventions in orthopedic surgery by encompassing data from 15 published studies, revealed compelling findings regarding postoperative outcomes. Specifically, patients in the ERAS group exhibited a significantly lower incidence of postoperative complications (OR, 0.70; 95% CI, 0.64 to 0.78) which reduced the mortality rate, and researchers noted a noteworthy decline in the 30-day mortality rate among patients in the ERAS group compared to those receiving standard care. The meta-analysis revealed an odds ratio of 0.40 (95% CI, 0.23 to 0.67), signifying a substantial reduction in mortality within the first month post-surgery 12.
3. The study compared mortality rates between traditional and modified ERAS protocols for obstructive colorectal cancer surgery. In the traditional group (n=42), one patient died due to postoperative complications. In contrast, no deaths were recorded in the ERAS group (n=80). While the difference in mortality rates was not statistically significant ($p = 0.34$), the absence of mortality in the ERAS group suggests a potential benefit of ERAS protocols in reducing postoperative mortality. Further research with larger sample sizes and randomized controlled trials is warranted to conclusively determine the impact of ERAS protocols on mortality in patients undergoing obstructive colorectal cancer surgery 13.
4. Teeuwen and colleagues found that there were no deaths in the ERAS group, while 1.6% of the conventional group died from medical causes. The p-value of 0.55 indicates that there was not a statistically significant difference in mortality rates between the two groups 14.

Pain management

1. Previous research has extensively investigated the efficacy of ERAS protocols in managing postoperative pain across various surgical procedures. Studies have consistently shown that implementing multimodal analgesia as part of ERAS pathways effectively reduces acute pain intensity and opioid consumption in surgical patients. For instance, a systematic review by Kehlet et al. (2018) highlighted those multimodal analgesic strategies, including non-opioid medications such as acetaminophen, NSAIDs, and gabapentinoids, led to a statistically significant reduction in pain scores compared to opioid monotherapy ($p < 0.05$).
2. A meta-analysis by Nelson et al. (2020) demonstrated that ERAS protocols incorporating regional anesthesia techniques, such as epidural analgesia or peripheral nerve blocks, resulted in a statistically significant decrease in postoperative opioid requirements compared to conventional analgesic approaches ($p < 0.001$). These findings underscore the statistical significance of multimodal analgesia within ERAS protocols for optimizing pain management in surgical patients 15.
3. Opioid-induced constipation is a significant concern impacting quality of life and discharge readiness in ambulatory settings. It is the most experienced gastrointestinal side effect of chronic opioid therapy. Morphine and its closely related analogs, such as fentanyl and hydromorphone, are highly useful for managing acute surgical pain in the perioperative period. These opioids afford significant pain relief with minimized risk of adverse effects when

given in a properly monitored setting Chronic opioid use increases opioid need, intensifies pain sensation, and leads to dose-dependent reliance on opioids. Synthetic opioids like methadone and buprenorphine require specialized perioperative ERAS management due to their unique pharmacological profiles16. NSAIDs decrease postoperative pain, opioid consumption, and postoperative nausea and vomiting (PONV). Acetaminophen works synergistically with NSAIDs to decrease opioid consumption and effectively manage mild to moderate postoperative pain 17. Enhanced Recovery After Surgery (ERAS) protocols leverage various pharmacological agents for pain management and improved outcomes. Gabapentinoids, including gabapentin and pregabalin, have shown efficacy in reducing tramadol and opioid requirements postoperatively. NMDA receptor antagonist ketamine demonstrates pain reduction by decreasing pain intensity and opioid requirements, albeit with abuse potential and neuropsychiatric side effects in chronic users. Cannabis, though not definitively linked to increased perioperative risk, may impact cardiovascular parameters, while benzodiazepines and barbiturates, largely avoided in the elderly due to associations with delirium, exhibit limited pain management benefits. Alpha-2 agonists like dexmedetomidine and clonidine offer multifaceted pain relief, decreasing morphine requirements postoperatively and improving outcomes within an ERAS framework 20. Each medication provides a nuanced approach to pain management within the perioperative period, highlighting the importance of tailored pharmacological strategies in optimizing patient recovery. Inhaled solvents encompass a range of substances, such as difluoroethane, known for their quick, euphoric effects and widespread abuse, especially among adolescents. Acutely, they induce a rush followed by symptoms like lightheadedness and ataxia, with chronic use potentially leading to visual hallucinations and cardiopulmonary complications. Notably, sudden sniffing death syndrome poses a significant risk, regardless of frequency. Neuraxial anesthesia, including intrathecal morphine and thoracic epidural analgesia, offers effective pain control, though outcomes vary based on surgical approach 21. Regional anesthetic techniques like TAP blocks show promise in reducing opioid requirements postoperatively, while alcohol use, prevalent among surgical patients, necessitates tailored perioperative management due to its diverse physiological effects, from metabolic disruptions to cardiovascular complications. Careful consideration of each substance's impact informs optimal pain management and patient safety within the ERAS framework 16.

Cost Reduction

1 In a review of 10 studies involving 3378 patients undergoing pancreaticoduodenectomy, researchers found that Enhanced Recovery After Surgery (ERAS) protocols led to significant cost savings in hospital expenses compared to traditional care. These studies looked at costs in different currencies, such as US dollars, Chinese yuan, euros, Canadian dollars, and South Korean won. The pooled analysis indicated a significant reduction in hospital costs associated with Enhanced Recovery After Surgery (ERAS) protocols compared to traditional care and the standardized mean difference (SMD) was -1.41 with a 95% confidence interval (CI) ranging from -2.05 to -0.77. This means that on average, hospital costs were 1.41 standard deviations lower in the ERAS group than in the traditional care group. This reduction was statistically

significant with a p-value of less than 0.00001 which means there is a substantial decrease in hospital expenses attributable to the implementation of ERAS protocols in pancreaticoduodenectomy. Although there was some variation among the studies (heterogeneity), subgroup analysis by continent revealed consistent cost savings in North America and East Asia. Funnel plots were used to check for publication bias, and sensitivity analysis confirmed the reliability of the results. Overall, these findings indicate that implementing ERAS protocols in pancreaticoduodenectomy is a cost-effective approach, offering substantial savings across various healthcare systems and regions 27.

Patient Satisfaction

1. In a meta-analysis conducted by Anjani et al., 2023 patient satisfaction with ERAS protocols was consistently higher compared to traditional care pathways. Statistical analysis revealed a significant improvement in patient satisfaction with the implementation of ERAS protocols, with a mean difference of 1.02 (95% CI: 0.19 to 1.86, p=0.02). patients valued strategies such as early mobilization, optimized pain management, and individualized nutritional support, which contributed to their comfort and reduced distress post-surgery. ERAS protocols also emphasized patient education and empowerment, fostering a sense of control and confidence. Quicker recovery milestones, like shorter time to return bowel function and oral intake, enabled patients to resume normal activities sooner. Furthermore, the reduced hospital stay, and lower complication rates associated with ERAS protocols were significant contributors to overall satisfaction. This patient-centered approach and focus on individualized care collectively enhanced the surgical experience for patients undergoing major colorectal surgery 9.

2. A study published in the Brazilian Journal of Anesthesiology (English Edition) explored the association between compliance with Enhanced Recovery After Surgery (ERAS) protocols and clinical complications in colorectal surgery. The study included 224 consecutive patients undergoing elective colorectal surgery and assessed ERAS protocol compliance based on a perioperative score above 75%. The primary endpoint, a composite of postoperative events including in-hospital complications, reoperation within 30 days, and readmission after discharge, occurred in 59.2% of non-compliant patients compared to 34.1% of compliant patients. Compliance with the ERAS protocol was associated with a significantly reduced risk for the primary endpoint in logistic regression analysis (odds ratio: 0.42, 95% CI 0.23–0.75, p=0.004). Additionally, compliant patients experienced shorter surgery-to-discharge times and had a reduced need for postoperative opioid adjuvants. These findings highlight the importance of ERAS protocol compliance in reducing clinical complications and improving postoperative outcomes in colorectal surgery 18.
3. Patients undergoing emergency gastrointestinal tract surgery experienced significantly shorter hospitalization periods and improved postoperative recovery with the implementation of Enhanced Recovery After Surgery (ERAS) protocols, leading to higher satisfaction rates compared to conventional approaches 19.

CONCLUSION

From the above research, we can conclude that ERAS has significantly improved patient outcomes in different surgical procedures, including colorectal surgeries, bariatric surgeries, radical cystectomy, orthopedic surgery, emergency gastrointestinal tract surgery, and many more. Specifically, ERAS protocols have led to notable reductions in the length of hospital stay, postoperative complications, mortality rates, and opioid consumption while enhancing pain management and patient satisfaction. Studies have consistently shown that adherence to ERAS guidelines results in expedited recovery minimized hospital resource utilization, and optimized healthcare expenditure. Implementation of ERAS protocols foster a patient-centered approach, empowering individuals through education, support, and active participation in their recovery process. The evidence underscores the cost-effectiveness and clinical efficacy of ERAS protocols, positioning them as integral components of modern surgical practice. By leveraging evidence-based practices and multidisciplinary collaboration, ERAS protocols continue to redefine perioperative care standards, ultimately improving patient outcomes and enhancing the overall surgical experience. Thus, the widespread adoption of ERAS protocols represents a pivotal advancement in surgical care, ensuring optimal outcomes and patient satisfaction across diverse surgical specialties.

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