

Systematic Review

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ABSTRACT

Background: Enhanced Recovery After Surgery (ERAS) is an evidence-based, multidisciplinary perioperative care pathway that aims to minimize the physiological stress of surgery, accelerate recovery, and improve patient outcomes. **Objective:** To review the current evidence on the principles, implementation, clinical outcomes, and future perspectives of ERAS across different surgical specialties.

Materials and Methods: A comprehensive literature search was conducted using PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and the Cochrane Library. Randomized controlled trials, systematic reviews, meta-analyses, and international guidelines published between 2015 and 2025, along with landmark studies, were reviewed. Data on ERAS interventions, postoperative outcomes, complications, hospital length of stay, readmission, mortality, and patient satisfaction were synthesized narratively.

Results: The reviewed evidence consistently demonstrated that ERAS improves perioperative outcomes across multiple surgical specialties. Meta-analyses have shown reductions in postoperative complications, shorter hospital stays, decreased opioid use, earlier mobilization, faster return of bowel function, and lower healthcare costs without increasing readmission or mortality. The greatest benefits were observed in colorectal surgery, with increasing evidence supporting ERAS in gynecological, orthopedic, urological, hepatobiliary, thoracic, and cardiac procedures.

Conclusion: ERAS is a safe, effective, and cost-efficient perioperative care model that enhances recovery and improves surgical outcomes. Successful implementation requires multidisciplinary collaboration, adherence to standardized protocols, and continuous quality improvement. Wider adoption of ERAS is expected to further improve patient care and healthcare efficiency.

Keywords: Enhanced Recovery After Surgery (ERAS); perioperative care; fast-track surgery; multimodal rehabilitation; postoperative recovery; evidence-based practice; patient outcomes; enhanced recovery pathway.

INTRODUCTION

Enhanced Recovery After Surgery (ERAS) is a multimodal, evidence-based perioperative care pathway developed to reduce the physiological stress associated with surgery and promote faster postoperative recovery. First introduced by Henrik Kehlet in the 1990s, ERAS integrates a series of standardized interventions across the preoperative, intraoperative, and postoperative phases of surgical care. These interventions are designed to maintain normal physiological function, reduce surgical complications, improve patient outcomes, and

shorten the length of hospital stay while ensuring patient safety.

Traditional perioperative care has often been characterized by prolonged preoperative fasting, routine use of drains and nasogastric tubes, delayed postoperative feeding, and extended bed rest. Although these practices were intended to minimize surgical complications, accumulating evidence has shown that many of them may delay recovery, increase postoperative morbidity, and prolong hospitalization. In contrast, ERAS protocols emphasize patient education, optimized nutrition, minimal fasting with preoperative carbohydrate

loading, multimodal opioid-sparing analgesia, goal-directed fluid therapy, maintenance of normothermia, early oral nutrition, and early mobilization. Together, these measures attenuate the surgical stress response, preserve organ function, and facilitate rapid recovery. Over the past two decades, ERAS protocols have been successfully implemented across a wide range of surgical specialties, including colorectal, gynecological, orthopedic, urological, hepatobiliary, thoracic, and cardiac surgery. Numerous randomized controlled trials, systematic reviews, and meta-analyses have demonstrated that ERAS programs reduce postoperative complications, decrease hospital length of stay, improve patient satisfaction, and lower healthcare costs without increasing readmission or mortality rates. Consequently, ERAS has become an internationally accepted standard for perioperative care, supported by the ERAS Society, which regularly publishes evidence-based clinical practice guidelines for various surgical procedures.^[1,2]

Despite its proven benefits, successful implementation of ERAS remains challenging in many healthcare settings due to variations in institutional resources, multidisciplinary coordination, adherence to protocol components, and clinician awareness. Continuous education, regular audit, and adaptation of ERAS pathways to local healthcare systems are therefore essential for maximizing patient outcomes.^[3,4]

This review summarizes the principles, key components, current evidence, clinical benefits, implementation strategies, and future perspectives of ERAS, highlighting its role in improving perioperative care and promoting patient-centered surgical recovery.

MATERIALS AND METHODS

This review was conducted using a comprehensive literature search to identify current evidence on Enhanced Recovery After Surgery (ERAS). Electronic databases including PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and the Cochrane Library were searched for articles published in English. The search strategy incorporated combinations of the following keywords: "Enhanced Recovery After Surgery," "ERAS," "fast-track surgery," "perioperative care," "multimodal recovery," "clinical guidelines," "systematic review," and "postoperative recovery."

Original research articles, randomized controlled trials, systematic reviews, meta-analyses, clinical practice guidelines, and consensus statements published between 2015 and 2025 were considered for inclusion. Landmark studies published before this period were also included when they provided important historical or foundational information regarding the development of ERAS protocols.

Articles were screened based on their titles and abstracts, followed by full-text evaluation for eligibility. Studies focusing on the principles, implementation, outcomes, and clinical effectiveness of ERAS across various surgical specialties were included. Editorials, conference abstracts, duplicate publications, case reports, and studies lacking sufficient methodological detail or outcome data were excluded.

Relevant information was extracted from the selected studies, including study design, patient population, surgical specialty, ERAS interventions, clinical outcomes, postoperative complications, length of hospital stay, readmission rates, patient satisfaction, and healthcare costs. The findings were synthesized narratively to summarize current evidence, identify consistent recommendations, and highlight recent advances and future directions in ERAS implementation.

This review was based exclusively on previously published literature and did not involve human participants, animal subjects, or the collection of primary data. Therefore, institutional ethical approval and informed consent were not required.

RESULTS

A comprehensive review of the published literature demonstrated that Enhanced Recovery After Surgery (ERAS) protocols consistently improve perioperative outcomes across multiple surgical specialties. The evidence from randomized controlled trials, systematic reviews, meta-analyses, and international guidelines supports the implementation of ERAS as the standard of perioperative care.

The reviewed studies showed that ERAS protocols reduce postoperative complications, shorten hospital length of stay, facilitate earlier return of bowel function, decrease opioid consumption, improve patient satisfaction, and reduce healthcare costs without increasing mortality or hospital readmission rates. The benefits were observed in colorectal, gynecological, urological, orthopedic, hepatobiliary, thoracic, and cardiac surgery.

Table 1: Major Meta-analyses Evaluating ERAS

Author (Year)	Study Design	Surgical Specialty	No. of Studies	Sample Size	Major Findings
Peden et al.[5]	Meta-analysis of RCTs	Multiple surgical specialties	74 RCTs	9,076	Hospital stay reduced by 1.88 days ; complications reduced (RR 0.71, 95% CI 0.59–0.87); no increase in readmission or mortality.
Greco et al.[6]	Meta-analysis	Colorectal surgery	16 RCTs	2,376	Overall morbidity reduced (RR 0.60, 95% CI 0.46–0.76); hospital stay

					reduced by 2.28 days ; readmission unchanged.
Eskicioglu et al[7]	Meta-analysis	Colorectal surgery	4 RCTs	Approximately 300 patients	Postoperative complications reduced (RR 0.61, 95% CI 0.42–0.88); shorter hospital stay.
Zhang et al[8]	Systematic review and meta-analysis	Minimally invasive colorectal surgery	5 studies	2,324	Overall complications reduced (OR 0.55, 95% CI 0.44–0.68); hospital stay reduced by 2.38 days ; postoperative ileus reduced (OR 0.57).

Table 1 summarizes the highest-quality evidence supporting ERAS from systematic reviews and meta-analyses. Across 99 studies involving more than 13,700 patients, ERAS consistently reduced postoperative complications and shortened hospital

stay without increasing readmission or mortality. The largest and most recent meta-analysis by Peden et al. (2024) provides strong evidence that ERAS improves perioperative outcomes across multiple surgical specialties.

Table 2: Effect of ERAS on Major Clinical Outcomes

Outcome	Pooled Effect Estimate	Interpretation
Length of hospital stay	Mean reduction 1.88 days (95% CI 0.95–2.81)	Significant reduction
Overall postoperative complications	RR 0.71 (95% CI 0.59–0.87)	29% lower risk
Overall morbidity (colorectal surgery)	RR 0.60 (95% CI 0.46–0.76)	40% lower risk
Postoperative ileus	OR 0.57 (95% CI 0.38–0.86)	Significant reduction
Readmission	No significant difference	Comparable to conventional care
Mortality	No significant difference	ERAS is safe

Table 2 presents the pooled effect estimates of ERAS on key postoperative outcomes. ERAS significantly reduced the length of hospital stay by approximately 1.9 days, decreased postoperative complications by

29–40%, and lowered the incidence of postoperative ileus. Importantly, there was no significant increase in hospital readmission or mortality, confirming that ERAS is both effective and safe.

Table 3: Clinical Benefits of ERAS Across Surgical Specialties

Surgical Specialty	Evidence	Major Outcomes
Colorectal surgery	Strong	Reduced complications, earlier bowel recovery, shorter hospital stay
Gynecological surgery	Moderate	Less postoperative pain, earlier discharge
Orthopedic surgery	Moderate	Earlier mobilization and reduced opioid consumption
Urological surgery	Moderate	Reduced postoperative morbidity and shorter hospitalization
Hepatobiliary surgery	Moderate	Improved recovery and lower complication rates
Thoracic surgery	Emerging	Reduced pulmonary complications and faster recovery
Cardiac surgery	Emerging	Shorter ICU stay and earlier rehabilitation

Table 3 demonstrates that the benefits of ERAS are consistent across a wide range of surgical specialties. The strongest evidence exists for colorectal surgery, while moderate and emerging evidence supports its use in gynecological, orthopedic, urological,

hepatobiliary, thoracic, and cardiac surgery. Regardless of specialty, ERAS is associated with faster recovery, fewer complications, and shorter hospitalization.

Table 4: Summary of Quantitative Evidence Supporting ERAS

Outcome	Number of Studies	Total Patients	Overall Conclusion
Hospital length of stay	74 RCTs	9,076	Significantly reduced
Postoperative complications	74 RCTs	9,076	Reduced by approximately 29%
Overall morbidity	16 RCTs	2,376	Reduced by approximately 40%
Readmission	Multiple meta-analyses	>10,000	No significant increase
Mortality	Multiple meta-analyses	>10,000	No significant increase

Table 4 provides an overall quantitative overview of the available evidence. Data from more than 10,000 patients show that ERAS significantly reduces hospital stay and postoperative morbidity while maintaining similar readmission and mortality rates compared with conventional perioperative care. These findings support the routine implementation of ERAS protocols in elective surgical practice and reinforce current international guideline recommendations.

Across all reviewed studies, ERAS protocols consistently demonstrated improved perioperative outcomes compared with conventional care. The most reproducible benefits were shorter hospital stay, fewer postoperative complications, earlier functional recovery, lower opioid requirements, and improved patient satisfaction. Importantly, these benefits were achieved without increasing 30-day readmission or mortality rates, supporting the routine implementation of ERAS pathways in elective surgical practice.

DISCUSSION

The present review demonstrates that Enhanced Recovery After Surgery (ERAS) has transformed perioperative care by integrating evidence-based interventions throughout the surgical pathway. The reviewed literature consistently showed that ERAS protocols reduce postoperative complications, shorten hospital length of stay, improve patient satisfaction, and decrease healthcare costs without increasing readmission or mortality. These findings are consistent across multiple surgical specialties and support the widespread adoption of ERAS as the standard of perioperative care.

Henrik Kehlet,^[8] widely recognized as the pioneer of ERAS, first proposed the concept of multimodal rehabilitation to attenuate the physiological stress response associated with surgery. His early work demonstrated that combining several evidence-based perioperative interventions resulted in faster recovery than any single intervention alone. Subsequent developments by the ERAS Society expanded these principles into standardized protocols applicable to various surgical specialties.^[10]

The findings of the present review are in agreement with the meta-analysis by Peden et al,^[5] which analyzed 74 randomized controlled trials involving 9,076 patients. Their study reported a significant reduction in hospital length of stay (mean difference -1.88 days) and postoperative complications (RR 0.71; 95% CI 0.59–0.87), while demonstrating no increase in mortality or hospital readmission. These results strongly support the safety and effectiveness of ERAS across multiple surgical specialties and reinforce the conclusions of the present review.

Similarly, Greco et al,^[6] evaluated 16 randomized controlled trials involving 2,376 patients undergoing colorectal surgery and found that ERAS reduced overall postoperative morbidity by approximately 40% (RR 0.60; 95% CI 0.46–0.76) while shortening hospital stay by more than two days. Their findings established colorectal surgery as one of the strongest evidence bases for ERAS implementation and have subsequently influenced international guideline recommendations.

The earlier meta-analysis by Eskicioglu et al,^[7] also demonstrated significant reductions in postoperative complications and hospital stay following ERAS implementation in colorectal surgery. Although the number of included studies was relatively small compared with more recent analyses, their findings provided early high-quality evidence supporting multimodal perioperative care and laid the foundation for subsequent ERAS research.

The present review also agrees with the recommendations published by the ERAS Society.^[9] Current guidelines emphasize standardized perioperative care, including patient education, reduced preoperative fasting with carbohydrate loading, multimodal opioid-sparing analgesia, goal-directed fluid therapy, maintenance of normothermia,

early oral nutrition, and early mobilization. These interventions have been consistently associated with improved recovery and reduced postoperative morbidity. A recent comparison of ERAS Society guidelines also demonstrated broad international consensus regarding the core components of ERAS while identifying areas requiring further research, particularly regarding pharmacotherapy protocols and procedure-specific adaptations.^[10]

Another important observation from the reviewed literature is that adherence to ERAS protocols significantly influences clinical outcomes. Studies have demonstrated that higher compliance with ERAS recommendations is associated with fewer postoperative complications, shorter hospitalization, and even improved long-term survival following colorectal cancer surgery. This emphasizes that successful implementation depends not only on protocol development but also on multidisciplinary collaboration, continuous staff education, and regular auditing of compliance.^[11]

Despite these encouraging findings, several challenges remain. Considerable variability exists in the implementation of ERAS pathways among institutions because of differences in healthcare infrastructure, availability of multidisciplinary teams, institutional resources, and patient characteristics. Furthermore, although evidence supporting ERAS is robust in colorectal surgery, additional high-quality randomized trials are needed in thoracic, cardiac, hepatopancreatobiliary, emergency, and resource-limited surgical settings to strengthen specialty-specific recommendations.

The present review has several strengths. It incorporates evidence from recent randomized controlled trials, systematic reviews, meta-analyses, and international ERAS Society guidelines, providing a comprehensive overview of current knowledge. However, limitations include the narrative nature of the review, heterogeneity among included studies, variation in ERAS protocol components, and differences in outcome reporting, which may limit direct comparison across studies.

Overall, the available evidence strongly supports ERAS as a safe, effective, and cost-efficient perioperative care model. Continued refinement of ERAS pathways through personalized medicine, digital health technologies, artificial intelligence-assisted perioperative monitoring, and ongoing multidisciplinary collaboration is expected to further improve surgical outcomes and optimize patient-centered care.^[12]

CONCLUSION

Enhanced Recovery After Surgery (ERAS) has emerged as an evidence-based, multidisciplinary approach that has significantly improved perioperative patient care across a wide range of surgical specialties. The available evidence from randomized controlled trials, systematic reviews, and

meta-analyses consistently demonstrates that ERAS protocols reduce postoperative complications, shorten hospital length of stay, decrease opioid consumption, enhance functional recovery, and improve patient satisfaction without increasing readmission or mortality.

The success of ERAS lies in its comprehensive perioperative strategy, encompassing preoperative patient education and optimization, standardized intraoperative management, and early postoperative rehabilitation. High compliance with ERAS protocols has been shown to produce superior clinical outcomes, emphasizing the importance of multidisciplinary collaboration among surgeons, anesthesiologists, nurses, physiotherapists, dietitians, pharmacists, and laboratory professionals.

Despite substantial progress, challenges remain in achieving universal implementation because of variations in institutional resources, adherence to protocols, and healthcare infrastructure. Future research should focus on optimizing specialty-specific ERAS pathways, evaluating long-term patient outcomes, integrating digital health technologies and artificial intelligence into perioperative care, and improving implementation strategies in low- and middle-income countries.

In conclusion, ERAS represents the current standard of perioperative care and should be routinely incorporated into surgical practice whenever feasible. Continuous quality improvement, regular audit, and adherence to evidence-based guidelines will further enhance patient safety, accelerate recovery, and improve overall healthcare outcomes.

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