

Enhanced Recovery After Surgery Pathways and Their Influence on Postoperative Recovery, Length of Stay, and Complications: A Comparative Cohort Analysis

Dr. K.N. Sai Suraj^{1*} and Dr. Arunraj²

¹Associate Professor, Department of Anaesthesiology,

²Assistant Professor, Department of Community Medicine, Aarupadai Veedu Medical College and Hospital, Puducherry – 607402

***Corresponding Address; Dr. K.N. Sai Suraj**

Associate Professor, Department of Anaesthesiology, Aarupadai Veedu Medical College and Hospital, Kirumampakkam, Bahour Commune Panchayat, Puducherry – 607402

Abstract

Enhanced Recovery After Surgery (ERAS) protocols represent a comprehensive, evidence-based approach to perioperative care that integrates multiple interventions aimed at minimizing surgical stress, promoting early recovery, and improving overall patient outcomes. This comparative cohort study evaluated postoperative recovery profiles among 180 adult patients undergoing major surgical procedures, with 90 patients managed using an ERAS protocol and 90 receiving conventional perioperative care. Recovery outcomes were assessed through key clinical milestones, including time to initiation of oral intake, ambulation, return of bowel function, length of hospital stay, postoperative complications, and hospital readmission rates. Statistical analyses were performed using independent t-tests and chi-square tests, with multivariable adjustment to account for baseline demographic and clinical differences between groups. Patients managed under the ERAS pathway demonstrated significantly improved recovery profiles compared with those receiving conventional care. Early initiation of oral feeding, faster mobilization, and quicker restoration of bowel function were consistently observed in the ERAS group, reflecting enhanced physiological recovery following surgery. Furthermore, the average length of hospital stay was significantly reduced in patients treated with the ERAS protocol (4.2 days versus 6.5 days; $p < 0.001$), indicating more efficient postoperative recovery and resource utilization. The incidence of postoperative complications was also lower among ERAS patients, suggesting that coordinated perioperative interventions contribute to improved surgical outcomes and reduced morbidity. Importantly, these benefits were achieved without an increase in hospital readmissions, demonstrating that earlier discharge did not compromise patient safety or quality of care. The findings support the growing body of evidence that ERAS programs enhance recovery, reduce complications, and optimize healthcare utilization. Routine implementation of ERAS protocols may therefore represent an effective strategy for improving perioperative outcomes and promoting patient-centered surgical care across a wide range of major surgical procedures.

Keywords: Enhanced recovery after surgery; ERAS; Postoperative recovery; Length of stay; Perioperative care; Complications

1. Introduction

Enhanced Recovery After Surgery (ERAS) protocols represent a comprehensive, multidisciplinary approach to perioperative care that integrates a series of evidence-based interventions designed to minimize the physiological stress associated with surgery and promote faster recovery. These protocols encompass multiple components across the surgical pathway, including preoperative patient education and optimization, reduced fasting periods, opioid-sparing multimodal analgesia, goal-directed fluid therapy, early postoperative nutrition, and prompt mobilization [1,2]. By targeting factors that contribute to delayed recovery and postoperative complications, ERAS pathways aim to improve patient outcomes while enhancing the efficiency of healthcare delivery. Over the past two decades, substantial evidence has demonstrated the effectiveness of ERAS programs in a variety of surgical specialties, including colorectal, gastrointestinal, orthopedic, gynecological, and urological procedures. Studies have consistently reported reductions in postoperative morbidity, shortened hospital stays, accelerated return of gastrointestinal function, and improved patient satisfaction without compromising safety [3,4]. A key contributor to the success of ERAS implementation is the active involvement of anesthesiologists, who play a central role in perioperative optimization through the use of multimodal analgesic strategies, prevention of postoperative nausea and vomiting, individualized fluid management, maintenance of physiological homeostasis, and facilitation of early recovery measures [5]. These interventions not only reduce postoperative discomfort

and complications but also support earlier achievement of recovery milestones such as oral intake, ambulation, and restoration of bowel function. Despite the growing body of evidence supporting ERAS pathways, the extent of implementation varies considerably among institutions due to differences in clinical practice patterns, resource availability, organizational support, and adherence to protocol components. Consequently, local assessment of ERAS outcomes remains important to evaluate effectiveness in specific healthcare settings, identify opportunities for improvement, and encourage wider adoption of evidence-based perioperative practices [6]. Furthermore, comparative evaluations between ERAS and conventional perioperative care provide valuable information regarding the real-world impact of these protocols on recovery trajectories and healthcare utilization. Therefore, the present comparative cohort study was undertaken to assess postoperative recovery profiles among patients managed under an enhanced recovery protocol compared with those receiving conventional perioperative care, with particular emphasis on recovery milestones, length of hospital stay, postoperative complications, and hospital readmission rates.

Aim: To compare recovery profiles between enhanced recovery and conventional perioperative care.

Primary objective: To compare length of stay between groups.

Secondary objectives: (i) To compare recovery milestones (oral intake, ambulation, bowel function); (ii) to compare complications and readmission.

Hypotheses: Null (H_0) — recovery profiles do not differ between groups. Alternative (H_1) — enhanced recovery is associated with faster recovery and fewer complications.

2. Materials and Methods

This study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for comparative cohort studies to ensure methodological transparency and completeness.

2.1 Study Design and Setting

A comparative cohort study was carried out in the Department of Anaesthesiology. The study was designed to evaluate and compare postoperative recovery outcomes between patients managed using an Enhanced Recovery After Surgery (ERAS) protocol and those receiving conventional perioperative care. Eligible patients undergoing major elective surgical procedures were assigned to either the ERAS cohort or the conventional care cohort according to the perioperative pathway implemented during their treatment.

2.2 Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants before inclusion in the study, where applicable. All study procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments.

2.3 Study Participants

Adult patients scheduled for major elective surgical procedures and considered suitable candidates for an enhanced recovery pathway were eligible for inclusion. Patients undergoing emergency surgery, those with contraindications to one or more ERAS protocol components, and individuals with incomplete clinical or follow-up data were excluded from the study. A total of 180 participants were included, comprising 90 patients managed according to the ERAS protocol and 90 patients receiving conventional perioperative care.

2.4 Perioperative Interventions

Patients in the ERAS group received a structured perioperative care bundle incorporating evidence-based interventions aimed at optimizing recovery. These measures included comprehensive preoperative counselling, preoperative carbohydrate loading, multimodal opioid-sparing analgesia, goal-directed fluid therapy, minimization of routine drains and tubes, early postoperative enteral nutrition, and early mobilization. In contrast, patients in the conventional care group received standard perioperative management based on traditional institutional practices, including routine fasting, conventional analgesic regimens, standard fluid administration, delayed oral intake, and mobilization according to surgeon preference and clinical judgment [1,7].

2.5 Outcome Measures

The primary outcome was postoperative length of hospital stay. Secondary outcomes included time to initiation of oral intake, time to first ambulation, return of bowel function, incidence of postoperative complications, and 30-day hospital readmission rates. Postoperative complications were classified and graded according to the Clavien–Dindo classification system. Recovery milestones were assessed using standardized clinical documentation and patient records.

2.6 Sample Size Determination

Sample size estimation was based on the ability to detect a clinically meaningful difference in postoperative length of stay between the two groups. Assuming a mean difference of 1.5 days, a standard deviation of approximately 3 days, a two-sided significance level (α) of 0.05, and a statistical power of 80%, a minimum of 64 patients per group was required. To account for potential exclusions, incomplete data, and to increase study precision, 90 participants were enrolled in each cohort, resulting in a total sample size of 180 patients.

2.7 Statistical Analysis

Data were analyzed using SPSS version III. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, depending on data distribution. Comparisons between groups were performed using the independent-samples t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Categorical variables were summarized as frequencies and percentages and compared using the chi-square test or Fisher's exact test when appropriate. Multivariable regression analysis was performed to adjust for potential confounding factors, including age, American Society of Anesthesiologists (ASA) physical status classification, and type of surgery. Statistical significance was established at a two-sided p-value of less than 0.05.

3. Results

3.1 Cohort Characteristics and Recovery Outcomes

A total of 180 patients were included in the study, with 90 patients managed using the Enhanced Recovery After Surgery (ERAS) protocol and 90 patients receiving conventional perioperative care. The overall mean age of the study population was 50 ± 14 years, and 95 participants (53%) were male. Baseline demographic and clinical characteristics were comparable between the two groups, indicating that the cohorts were well matched and suitable for comparative analysis (Table 1). Patients managed under the ERAS protocol demonstrated significantly improved postoperative recovery profiles compared with those receiving conventional care. The mean time to initiation of oral intake was markedly shorter in the ERAS group (10 ± 4 hours) than in the conventional care group (20 ± 6 hours), representing a statistically significant reduction ($p < 0.001$). Similarly, patients in the ERAS cohort achieved postoperative ambulation substantially earlier, with a mean time of 12 ± 5 hours compared with 24 ± 7 hours in the conventional care cohort ($p < 0.001$). These findings indicate that implementation of ERAS measures facilitated earlier restoration of normal physiological function and promoted accelerated recovery [8]. Length of hospital stay, the primary outcome measure, was also significantly reduced among patients managed with the ERAS pathway. The mean duration of hospitalization was 4.2 ± 1.6 days in the ERAS group compared with 6.5 ± 2.2 days in the conventional care group, reflecting a reduction of more than two days ($p < 0.001$). This finding highlights the effectiveness of ERAS protocols in improving recovery efficiency and optimizing utilization of hospital resources. The incidence of postoperative complications was lower in the ERAS group, with 18 patients (20%) experiencing complications compared with 31 patients (34%) in the conventional care group. This difference was statistically significant ($p = 0.03$), suggesting that the enhanced recovery approach may contribute to reduced postoperative morbidity. In contrast, no significant difference was observed in 30-day hospital readmission rates between the two groups. Readmission occurred in 7 patients (8%) managed with ERAS and 11 patients (12%) receiving conventional care ($p = 0.33$). These findings indicate that the shorter hospital stay associated with ERAS did not result in an increased risk of readmission, supporting the safety and effectiveness of the enhanced recovery pathway [9].

3.2 Recovery and complications

The enhanced recovery group reached milestones earlier (Figure 1) and had fewer complications without increased readmission (Figure 2). Differences persisted after adjustment for age, ASA grade, and surgery type.

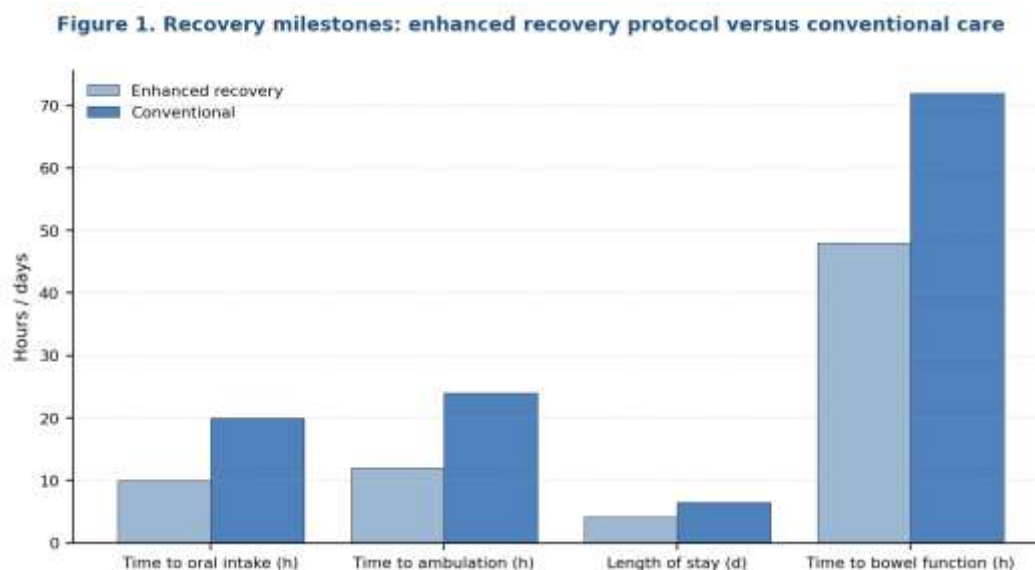


Figure 1. Recovery milestones by protocol.

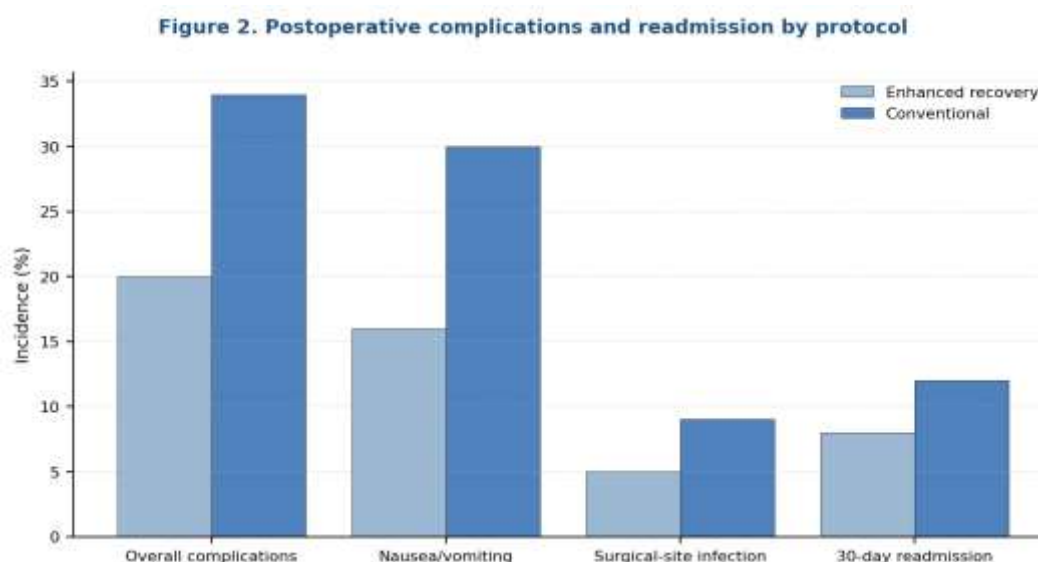


Figure 2. Postoperative complications and readmission by protocol.

4. Discussion

The present comparative cohort study demonstrated that implementation of an Enhanced Recovery After Surgery (ERAS) protocol was associated with significantly improved postoperative recovery outcomes compared with conventional perioperative care. Patients managed under the ERAS pathway achieved key recovery milestones earlier, including initiation of oral intake and postoperative ambulation, experienced a shorter length of hospital stay, and had a lower incidence of postoperative complications. Importantly, these benefits were achieved without a significant increase in 30-day hospital readmission rates, indicating that accelerated recovery and earlier discharge did not compromise patient safety. These findings are consistent with the growing body of literature demonstrating the effectiveness of ERAS protocols across a broad range of surgical specialties and healthcare settings [10]. The observed improvements may be attributed to the multimodal nature of ERAS programs, which are designed to attenuate the physiological stress response associated with surgery. Components such as preoperative counselling, carbohydrate loading, opioid-sparing multimodal analgesia, goal-directed fluid therapy, early enteral nutrition, and prompt mobilization work synergistically to preserve physiological function and facilitate recovery [11,12]. Earlier oral intake and mobilization likely contributed to the faster return of gastrointestinal function and reduced postoperative morbidity observed in the ERAS group. Furthermore, the lower complication rate supports previous evidence that enhanced recovery pathways can minimize adverse postoperative

events while promoting functional recovery [13,14]. The role of the anaesthesiologist is particularly important in successful ERAS implementation. Optimized perioperative analgesia, individualized fluid management, prevention of postoperative nausea and vomiting, and support for early mobilization are central elements of enhanced recovery pathways. Consequently, anaesthesiologists contribute substantially to improving patient outcomes and ensuring adherence to ERAS principles throughout the perioperative period [5]. The findings of the present study therefore support broader implementation of ERAS protocols and highlight the importance of continuous auditing of recovery profiles to monitor effectiveness and identify opportunities for further improvement [15,16]. This study possesses several strengths, including the evaluation of multiple clinically relevant recovery outcomes and the use of multivariable analyses to adjust for potential baseline differences between groups. Nevertheless, certain limitations should be acknowledged. The non-randomized cohort design introduces the possibility of residual confounding and selection bias. Additionally, the single-centre setting may limit the generalizability of the findings to other institutions and patient populations. Protocol adherence was also not systematically quantified, making it difficult to determine the relative contribution of individual ERAS components to the observed outcomes. Future research should focus on multicentre randomized controlled trials or stepped-wedge implementation studies incorporating detailed adherence assessments and patient-reported outcome measures. Such investigations would provide stronger evidence regarding the causal effects of ERAS interventions and facilitate optimization of perioperative recovery pathways across diverse surgical settings [17].

5. Conclusion

Enhanced Recovery After Surgery (ERAS) protocols were associated with substantially improved postoperative recovery outcomes when compared with conventional perioperative care. Patients managed within the ERAS pathway achieved important recovery milestones significantly earlier, including initiation of oral intake, postoperative ambulation, and restoration of physiological function. In addition, ERAS implementation resulted in a meaningful reduction in the length of hospital stay, reflecting enhanced recovery efficiency and improved utilization of healthcare resources. A lower incidence of postoperative complications was also observed among patients receiving enhanced recovery care, suggesting that the coordinated and multidisciplinary nature of ERAS pathways contributes to improved surgical outcomes and reduced postoperative morbidity. These findings are consistent with a growing body of evidence demonstrating that ERAS protocols optimize perioperative management through a combination of evidence-based interventions designed to minimize the physiological stress response to surgery. The benefits observed in the present study may be attributed to the synergistic effects of multiple ERAS components, including preoperative counselling and optimization, multimodal opioid-sparing analgesia, goal-directed fluid therapy, early nutritional support, and prompt postoperative mobilization. Collectively, these interventions promote preservation of physiological function, reduce the adverse consequences of prolonged immobilization and fasting, and facilitate a faster return to normal activity. Importantly, although patients in the ERAS group were discharged earlier than those receiving conventional care, no significant increase in 30-day hospital readmission rates was identified. This finding provides strong support for the safety of enhanced recovery pathways and indicates that accelerated discharge can be achieved without compromising the quality of patient care or increasing the risk of adverse outcomes after hospitalization.

The results reinforce the growing recognition of ERAS as an effective strategy for improving perioperative outcomes while simultaneously enhancing healthcare efficiency. Adoption of these protocols may benefit both patients and healthcare systems by reducing complications, shortening hospital stays, and promoting patient-centered recovery. Consequently, wider implementation of ERAS pathways in routine surgical practice is strongly supported. Nevertheless, further multicentre randomized controlled trials and large-scale implementation studies are warranted to strengthen causal inference, evaluate long-term clinical and economic outcomes, assess adherence to individual protocol components, and identify the most effective elements of enhanced recovery programs across diverse surgical populations and healthcare settings.

References

1. Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. *JAMA Surg.* 2017;152(3):292–298.
2. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth.* 1997;78(5):606–617.
3. Greco M, Capretti G, Beretta L, et al. Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials. *World J Surg.* 2014;38(6):1531–1541.
4. Visionsi A, Shah R, Gabriel E, et al. Enhanced recovery after surgery for noncolorectal surgery? A systematic review and meta-analysis. *Ann Surg.* 2018;267(1):57–65.
5. Scott MJ, Baldini G, Fearon KC, et al. Enhanced Recovery After Surgery (ERAS) for gastrointestinal surgery, part 1: pathophysiological considerations. *Acta Anaesthesiol Scand.* 2015;59(10):1212–1231.

6. Gustafsson UO, Scott MJ, Hubner M, et al. Guidelines for perioperative care in elective colorectal surgery: ERAS Society recommendations: 2018. *World J Surg.* 2019;43(3):659–695.
7. Varadhan KK, Neal KR, Dejong CH, et al. The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis. *Clin Nutr.* 2010;29(4):434–440.
8. Spanjersberg WR, Reurings J, Keus F, van Laarhoven CJ. Fast track surgery versus conventional recovery strategies for colorectal surgery. *Cochrane Database Syst Rev.* 2011;(2):CD007635.
9. Miller TE, Roche AM, Mythen M. Fluid management and goal-directed therapy as an adjunct to enhanced recovery after surgery (ERAS). *Can J Anaesth.* 2015;62(2):158–168.
10. Gustafsson UO, Hausel J, Thorell A, et al. Adherence to the enhanced recovery after surgery protocol and outcomes after colorectal cancer surgery. *Arch Surg.* 2011;146(5):571–577.
11. Bardram L, Funch-Jensen P, Jensen P, et al. Recovery after laparoscopic colonic surgery with epidural analgesia, and early oral nutrition and mobilisation. *Lancet.* 1995;345(8952):763–764.
12. Wind J, Polle SW, Fung Kon Jin PH, et al. Systematic review of enhanced recovery programmes in colonic surgery. *Br J Surg.* 2006;93(7):800–809.
13. Lassen K, Soop M, Nygren J, et al. Consensus review of optimal perioperative care in colorectal surgery: ERAS group recommendations. *Arch Surg.* 2009;144(10):961–969.
14. Nicholson A, Lowe MC, Parker J, et al. Systematic review and meta-analysis of enhanced recovery programmes in surgical patients. *Br J Surg.* 2014;101(3):172–188.
15. Pedziwiatr M, Mavrantonis C, Wierdak M, et al. Current status of enhanced recovery after surgery (ERAS) protocol in gastrointestinal surgery. *Med Oncol.* 2018;35(6):95.
16. Stone AB, Grant MC, Pio Roda C, et al. Implementation costs of an enhanced recovery after surgery program in the United States. *Ann Surg.* 2016;264(2):247–252.
17. Memtsoudis SG, Poeran J, Kehlet H. Enhanced recovery after surgery in the United States: from evidence-based practice to uncertain science? *JAMA.* 2018;321(11):1049–1050.