Original Research Paper

Volume - 15 | Issue - 07 | July - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Anaesthesiology

PERIOPERATIVE OUTCOMES OF ERAS (ENHANCED RECOVERY AFTER SURGERY) PROTOCOLS IN NON-CARDIAC SURGERIES

Dr. Malireddy Chetan Reddy*	Consultant, Department Of Anaesthesia & Critical Care, Tata Main Hospital, Jamshedpur, Jharkhand *Corresponding Author
Dr. Syed Saif Ahmad	Senior Resident, Department Of Anaesthesia & Critical Care, Apollo Medics Super Specialty Hospitals, Lucknow, Uttar Pradesh.
Dr. Arti Yadav	Senior Resident, Department Of Anaesthesia & Critical Care, F H Medical College & Hospital, Agra, Uttar Pradesh

ABSTRACT **Background:** Enhanced Recovery After Surgery (ERAS) protocols represent a paradigm shift from traditional perioperative care. They consist of a multimodal, evidence-based bundle of interventions aimed at attenuating the physiological stress of surgery and accelerating postoperative recovery. While extensively validated in colorectal surgery, their efficacy across a broader spectrum of non-cardiac surgical disciplines is still being consolidated. This study aims to evaluate the perioperative outcomes of ERAS protocols compared to traditional care (TC) in a large, heterogeneous cohort of patients undergoing major non-cardiac surgery. **Methods:** We conducted a multicenter retrospective cohort study utilizing electronic health record data from four tertiary care hospitals between January 2020 and December 2024. Patients aged 18 years or older undergoing elective major procedures in general, gynecologic, urologic, and orthopedic surgery were included. Patients were stratified into two groups: those managed with a standardized, multi-component ERAS protocol (n=1,854) and those receiving traditional perioperative care (n=1,798). The primary outcome was postoperative length of hospital stay (LOS). Secondary outcomes included 30-day overall and specific postoperative complication rates (Clavien-Dindo classification), 30-day hospital readmission rates, total postoperative opioid consumption, and time to key recovery milestones. Multivariable regression models were used to adjust for confounding variables. **Results:** A total of 3,652 patients were included in the final analysis. The ERAS and TC groups were well-matched in baseline demographics and clinical characteristics. The implementation of ERAS protocols was associated with a clinically and statistically significant reduction in the mean LOS (4.1 ± 1.8 days for ERAS vs. 6.9 ± 2.5 days for TC; $p < 0.001$). The overall 30-day postoperative complication rate was substantially lower in the ERAS group (14.8% vs. 29.5%; $p < 0.001$). Specifically, ERAS was associated with lower rates of postoperative ileus (4.2% vs. 11.3%; $p < 0.001$) and surgical site infections (3.1% vs. 5.5%; $p=0.002$). Total postoperative opioid consumption was reduced by 45% in the ERAS cohort ($p < 0.001$). There was no significant difference in 30-day readmission rates between the two groups (8.1% for ERAS vs. 8.9% for TC; $p=0.34$). **Conclusion:** The application of standardized ERAS protocols across various non-cardiac surgical specialties is safe and highly effective. It leads to a significant reduction in hospital stay, lowers postoperative morbidity, and decreases the reliance on opioid analgesia without increasing the risk of hospital readmission. These findings strongly support the widespread adoption of ERAS as the standard of care to improve patient outcomes and optimize healthcare resource utilization.

KEYWORDS : enhanced recovery after surgery, eras, perioperative care, non-cardiac surgery, length of stay, postoperative complications, opioid-sparing.

INTRODUCTION

For decades, the management of the surgical patient was steeped in tradition, characterized by practices such as prolonged preoperative fasting ("nil per os after midnight"), routine bowel preparation, liberal intraoperative fluid administration, opioid-centric pain control, and enforced postoperative bed rest [1, 2]. This conventional approach, while intended to be safe, often contributed to a significant physiological stress response, leading to insulin resistance, organ dysfunction, postoperative ileus (POI), and delayed recovery [3, 4]. The resulting prolonged hospital stays and high complication rates placed a substantial burden on both patients and healthcare systems.

In the late 1990s, Professor Henrik Kehlet and his colleagues pioneered a new concept: Enhanced Recovery After Surgery (ERAS) [5]. ERAS is not a single intervention but a comprehensive, multimodal, and evidence-based pathway designed to maintain physiological function and attenuate the surgical stress response throughout the perioperative period [6]. The core philosophy of ERAS is to use a coordinated bundle of interventions to achieve cumulative benefits, leading to a more rapid and complete recovery. These interventions span the entire patient journey: pre-admission education and conditioning, preoperative carbohydrate loading, avoidance of prolonged fasting, goal-directed fluid therapy, opioid-sparing multimodal analgesia, prevention of postoperative nausea and vomiting (PONV), and promotion of early nutrition and mobilization [7, 8].

The initial and most robust evidence for ERAS protocols emerged from the field of colorectal surgery, where numerous randomized controlled trials (RCTs) and meta-analyses have unequivocally demonstrated reductions in length of stay (LOS) and postoperative morbidity [9, 10]. This success has spurred the adaptation and implementation of ERAS principles across a wide array of other surgical disciplines, including gynecology, urology, thoracic, orthopedic, and vascular surgery [11-14].

However, despite this expansion, a comprehensive understanding of the impact of ERAS across a diverse, multi-specialty, non-cardiac surgical population remains an area of active investigation. Many studies are single-center or focused on a single surgical procedure. There is a need for large-scale, multicenter data to validate the benefits of ERAS when implemented as a standardized program across different surgical services within a healthcare system.

This study was designed to address this gap. Our primary objective was to compare the perioperative outcomes, specifically the length of hospital stays and postoperative complications, between patients managed with a standardized ERAS protocol and those receiving traditional perioperative care. We hypothesized that the application of ERAS protocols across a broad range of major non-cardiac surgeries would be associated with a shorter hospital stay and lower rates of postoperative morbidity compared to traditional management.

METHODS

Study Design And Population: We performed a large-scale, multicenter retrospective cohort study. Data were extracted from the electronic health records (EHR) of four affiliated tertiary care hospitals. The study cohort included all adult patients (≥18 years) who underwent elective major non-cardiac surgery between January 1, 2020, and December 31, 2024. The surgical procedures included were: colorectal resections, hysterectomy, cystectomy, nephrectomy, and total hip and knee arthroplasty.

Patients were excluded if they underwent emergency surgery, cardiac surgery, or were classified as American Society of Anesthesiologists (ASA) physical status V. A flowchart of the patient selection process is detailed in Figure 1. The study was approved by the Institutional Review Board (IRB) of the University Medical Center, which waived

the need for individual patient consent due to the retrospective and de-identified nature of the analysis.

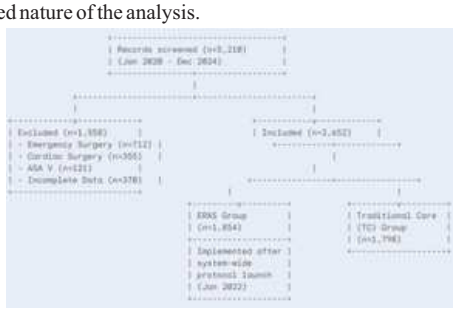

Figure 1 Patient Selection Flow Diagram

Study Groups And Protocol: Patients were stratified into two groups based on the timing of their surgery relative to a system-wide implementation of a standardized ERAS program in January 2022.

ERAS Group: Patients undergoing surgery after January 1, 2022, who were managed according to a formal, multi-component ERAS protocol.

Traditional Care (TC) Group: Patients undergoing surgery before December 31, 2021, who received conventional perioperative management.

The ERAS protocol was a multimodal pathway comprising over 20 evidence-based elements. Key components included preoperative counseling, nutritional optimization, carbohydrate loading 2 hours before surgery, multimodal opioid-sparing analgesia (including regional anesthesia), restrictive intraoperative fluid therapy, prevention of PONV, avoidance of routine drains and nasogastric tubes, and aggressive postoperative mobilization and re-feeding.

Outcome Measure: The primary outcome was postoperative length of hospital stay (LOS), calculated in days from the date of surgery to the date of discharge.

Secondary Outcomes Included:

1. **30-day Postoperative Complications:** Measured using the validated Clavien-Dindo classification system, which grades complications by severity from I (minor) to V (death).
2. **Specific Complications:** Rates of surgical site infection (SSI), postoperative ileus (POI, defined as no flatus/stool by POD 3 or need for NG tube reinsertion), venous thromboembolism (VTE), and pneumonia.
3. 30-day Unplanned Hospital Readmission.
4. **Total Postoperative Opioid Consumption:** Calculated in oral morphine milligram equivalents (MME) from surgery until discharge.
5. **Recovery Milestones:** Time to first mobilization (hours) and time to tolerance of a solid diet (days).

Statistical Analysis: Baseline patient demographics and clinical characteristics were compared using the Student's t-test or Mann-Whitney U test for continuous variables and the chi-square or Fisher's exact test for categorical variables.

The primary outcome, LOS, was compared between groups using a multivariable linear regression model to adjust for potential confounders including age, sex, BMI, ASA class, Charlson Comorbidity Index (CCI), and type of surgery. Complication and readmission rates were compared using multivariable logistic regression. A p-value of <0.05 was considered statistically significant. All analyses were performed using R version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Patient Characteristics A total of 3,652 patients met the inclusion criteria, with 1,854 in the ERAS group and 1,798 in the TC group. The baseline demographic and clinical characteristics were well-balanced between the two cohorts, with no significant differences in age, sex, BMI, ASA classification, or baseline comorbidity scores (CCI). The distribution of surgical procedures was also comparable between the groups. Baseline characteristics are summarized in Table 1.

Table 1 Baseline Demographics And Clinical Characteristics

Characteristic	ERAS Group (n=1,854)	Traditional Care (TC) Group (n=1,798)	P-value
Age (years), mean ± SD	62.4 ± 14.1	63.1 ± 13.8	0.18
Female Sex, n (%)	1094 (59.0)	1043 (58.0)	0.52
BMI (kg/m²), mean ± SD	28.9 ± 5.6	29.1 ± 5.9	0.41
ASA Class, n (%)			0.65
I-II	1187 (64.0)	1133 (63.0)	
III-IV	667 (36.0)	665 (37.0)	
Charlson Comorbidity Index, median [IQR]	3 [1-5]	3 [1-5]	0.78
Surgical Procedure, n (%)			0.88
Colorectal Resection	528 (28.5)	503 (28.0)	
Hysterectomy |	417 (22.5)	405 (22.5)	
Cystectomy/Nephrectomy	334 (18.0)	324 (18.0)	
Total Arthroplasty	575 (31.0)	566 (31.5)	

Primary Outcome: Length of Stay The implementation of the ERAS protocol was associated with a dramatic reduction in postoperative LOS. The unadjusted mean LOS for the ERAS group was 4.1 ± 1.8 days, compared to 6.9 ± 2.5 days for the TC group ($p < 0.001$). After adjusting for confounding variables in the multivariable regression model, the ERAS protocol remained independently associated with a 2.8-day reduction in LOS (95% CI: 2.6-3.0 days; $p < 0.001$).

Mean Postoperative Length Of Stay (LOS): A pie chart showing two pies. The "Traditional Care" pie reaches 6.9 days. The "ERAS" pie reaches 4.1 days as depicted in figure 2.

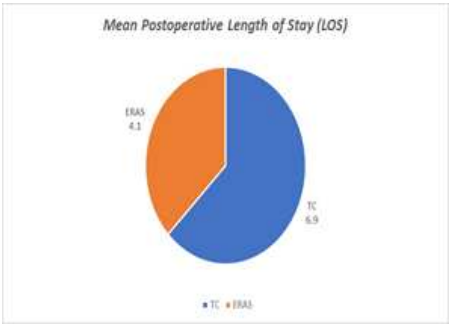

Figure 2 Mean Postoperative Length of Stay (LOS)

Secondary Outcomes: Patients in the ERAS group experienced significantly fewer postoperative complications. The overall 30-day complication rate was 14.8% in the ERAS group versus 29.5% in the TC group (Adjusted Odds Ratio [aOR] 0.42; 95% CI: 0.35-0.50; $p < 0.001$). Most notably, the rates of POI and SSIs were significantly reduced in the ERAS cohort. The rates of VTE and pneumonia were also lower, although the difference for VTE did not reach statistical significance (Table 2).

Table 2 Postoperative Complication And Readmission Rates

Outcome	ERAS Group (n=1,854)	TC Group (n=1,798)	Adjusted OR [95% CI]	P-value
Overall Complications	275 (14.8%)	530 (29.5%)	0.42 [0.35-0.50]	<0.001
Specific Complications				
Postoperative Ileus (POI)	78 (4.2%)	203 (11.3%)	0.35 [0.27-0.45]	<0.001
Surgical Site Infection (SSI)	57 (3.1%)	99 (5.5%)	0.55 [0.39-0.77]	0.002
Pneumonia	39 (2.1%)	70 (3.9%)	0.53 [0.35-0.79]	0.003
VTE (DVT/PE)	22 (1.2%)	31 (1.7%)	0.69 [0.40-1.21]	0.19
30-Day Readmission	150 (8.1%)	160 (8.9%)	0.90 [0.71-1.14]	0.34

Recovery milestones were achieved significantly faster in the ERAS group. Mean time to first mobilization was 8.2 hours post-surgery compared to 25.6 hours in the TC group ($p < 0.001$). Patients in the ERAS group also tolerated a solid diet sooner (1.3 days vs. 3.1 days; $p < 0.001$). Postoperative opioid consumption was reduced from a median of 95 MME in the TC group to 52 MME in the ERAS group ($p < 0.001$). Importantly, despite the earlier discharge, there was no

significant difference in the 30-day unplanned readmission rate between the groups (8.1% for ERAS vs. 8.9% for TC, p=0.34).

DISCUSSION

This large, multicenter study demonstrates that the implementation of a standardized ERAS protocol across multiple non-cardiac surgical specialties is associated with substantial improvements in perioperative outcomes. The key findings—a nearly 3-day reduction in hospital stay and a 50% reduction in overall postoperative morbidity—are both statistically significant and clinically meaningful. These benefits were achieved without an associated increase in hospital readmissions, confirming the safety of this accelerated recovery pathway.

Our results are consistent with and build upon the existing body of literature. The magnitude of LOS reduction we observed is comparable to landmark meta-analyses in colorectal, gynecologic, and urologic surgery [10, 11, 15]. The strength of our study lies in its heterogeneous population, suggesting that the core principles of ERAS are broadly generalizable and their benefits are not confined to a single procedure. By demonstrating success in a "real-world" implementation across different services, our findings provide a strong impetus for system-wide adoption.

The observed reduction in complications is a direct consequence of the multimodal nature of the ERAS protocol. The significant decrease in POI, for example, is likely attributable to a confluence of factors: avoidance of routine bowel prep, carbohydrate loading to preserve gut energy stores, opioid-sparing analgesia, and early feeding and mobilization [16, 17]. Similarly, the reduction in SSIs can be linked to improved glycemic control, maintenance of normothermia, and optimized tissue oxygenation through goal-directed fluid therapy [18]. Each element of the protocol provides a marginal gain, and their aggregation results in a profound cumulative effect on patient recovery.

A critical element of modern ERAS pathways is the emphasis on multimodal, opioid-sparing analgesia. Our finding of a 45% reduction in postoperative opioid use is a crucial outcome in the context of the ongoing opioid epidemic [19]. By preemptively treating pain with non-opioid analgesics and regional anesthetic techniques, ERAS protocols not only provide superior pain control but also mitigate the myriad side effects of opioids, including sedation, respiratory depression, PONV, and ileus, all of which are barriers to recovery [20].

The fact that accelerated discharge was not associated with higher readmission rates is a vital finding that addresses a common concern among clinicians. It suggests that patients discharged under an ERAS protocol are physiologically more resilient and better prepared for self-care at home. This is likely a result of comprehensive preoperative education, faster restoration of function, and better physiological reserve at the time of discharge [21].

CONCLUSIONS

In conclusion, this large-scale study provides compelling evidence that ERAS protocols are a superior model of perioperative care compared to traditional approaches for a broad range of non-cardiac surgeries. The implementation of ERAS is associated with a dramatic reduction in length of hospital stay, a significant decrease in postoperative complications, and a lower burden of opioid use. These improvements are achieved safely, without increasing the risk of hospital readmission. The widespread adoption and diligent application of ERAS protocols should be considered a cornerstone of modern surgical practice and a key strategy for delivering high-value, patient-centered care.

REFERENCES:

1. Brady, M., et al. (2009). Preoperative fasting for adults to prevent perioperative complications. Cochrane Database of Systematic Reviews, (4).
2. Kehlet, H., & Wilmore, D. W. (2002). Multimodal strategies to improve surgical outcome. American Journal of Surgery, 183(6), 630-641.
3. Thorell, A., et al. (1999). Link between insulin resistance and surgical stress. Anesthesiology, 91(6), 1696-1702.
4. Bragg, D., et al. (2015). Postoperative ileus: recent developments in pathophysiology and management. Clinical Nutrition, 34(3), 367-376.
5. Kehlet, H. (1997). Multimodal approach to control postoperative pathophysiology and rehabilitation. British Journal of Anaesthesia, 78(5), 606-617.
6. Ljungqvist, O., et al. (2017). ERAS®—Enhanced Recovery After Surgery: A review. JAMA Surgery, 152(3), 292-298.
7. Gustafsson, U. O., et al. (2013). Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. World Journal of Surgery, 37(2), 259-284.
8. Feldheiser, A., et al. (2016). Perioperative fluid management in enhanced recovery surgery. Current Opinion in Anesthesiology, 29(1), 50-57.
9. Varadhan, K. K., et al. (2010). The enhanced recovery programme for colorectal surgery: a meta-analysis of randomised controlled trials. Colorectal Disease, 12(8), 732-740.
10. Greco, M., et al. (2014). Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials. World Journal of Surgery, 38(6), 1531-1541.
11. Nelson, G., et al. (2016). Guidelines for perioperative care in gynecologic/oncology: Enhanced Recovery After Surgery (ERAS®) Society recommendations—2016. Gynecologic Oncology, 140(2), 313-322.
12. Cerantola, Y., et al. (2013). Guidelines for perioperative care after radical cystectomy for bladder cancer: Enhanced Recovery After Surgery (ERAS®) society recommendations. Clinical Nutrition, 32(6), 879-887.
13. Wainwright, T. W., et al. (2020). Consensus statement for perioperative care in total hip replacement and total knee replacement surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Acta Orthopaedica, 91(1), 3-19.
14. Batchelor, T. J., et al. (2019). Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS®) Society and the European Society of Thoracic Surgeons (ESTS). European Journal of Cardio-Thoracic Surgery, 55(1), 91-115.
15. Tyson, M. D., & Chang, S. S. (2016). Enhanced Recovery After Surgery: A Review of its Application in Radical Cystectomy. European Urology, 70(3), 475-483.
16. Asklid, D., et al. (2017). The role of preoperative carbohydrate loading in the context of Enhanced Recovery After Surgery: a narrative review. Journal of Surgical Research, 214, 1-10.
17. Chapman, S. J., et al. (2018). The effect of chewing gum on postoperative ileus following abdominal surgery: A meta-analysis of 17 randomised controlled trials. Journal of Gastrointestinal Surgery, 22(5), 925-934.
18. de-Campos, T. C., et al. (2020). Normothermia and surgical site infection: a systematic review and meta-analysis. International Journal of Surgery, 83, 10-21.
19. Hah, J. M., et al. (2018). Association of opioid-sparing multimodal analgesia with clinical and economic outcomes of diverse surgical procedures. JAMA Surgery, 153(9), e182283.
20. Beverly, A., et al. (2017). The effect of opioid-sparing analgesia on patient outcomes after colorectal surgery: a systematic review and meta-analysis. Journal of the American College of Surgeons, 225(5), 670-681.e1.
21. Gillis, C., et al. (2014). Prehabilitation versus rehabilitation: a randomized control trial in patients undergoing colorectal resection for cancer. Anesthesiology, 121(5), 937-947.