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ORIGINAL ARTICLE

Implementation of an Enhanced Recovery After Surgery (ERAS) Protocol in a General Surgical Unit: A Prospective Cohort Study on Outcomes in Colorectal Surgery

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ABSTRACT

Background: Enhanced Recovery After Surgery (ERAS) protocols improve outcomes in elective colorectal surgery, but their efficacy in general surgical units, as opposed to specialized high-volume centres, is less established. This study evaluated the impact of a standardized ERAS protocol in a general surgical unit in Malaysia. **Methods:** A prospective observational study was conducted comparing 60 patients managed under a 24-element ERAS protocol to a historical cohort of 56 patients managed with traditional care. All patients underwent elective colorectal resection for malignancy. The primary outcomes were length of hospital stay (LOS), postoperative complication rates (Clavien-Dindo classification), 30-day readmission, and 30-day mortality. Adherence rate to the ERAS protocol was evaluated as the secondary outcome. **Results:** Baseline demographics were comparable between groups. The ERAS group demonstrated a significant reduction in median LOS (5 days [IQR: 2] vs. 8 days [IQR: 5], $p<0.001$) and a significantly higher rate of patients with no postoperative complications (58.3% vs. 44.6%, $p=0.006$). The rate of major complications (Clavien-Dindo ≥III) was nearly halved (10.0% vs. 17.9%). There were non-significant trends toward reduction in 30-day readmission (11.7% vs. 17.9%) and mortality (1.7% vs. 7.1%). Overall, ERAS protocol compliance was high (>70% for most elements). **Conclusion:** The implementation of a multidisciplinary ERAS protocol in a general surgical unit is feasible

and effective. It significantly reduces length of stay and postoperative morbidity for patients undergoing elective colorectal surgery, demonstrating that the benefits of ERAS can be successfully translated beyond specialized centres into a broader surgical setting.

INTRODUCTION

Colorectal surgery imposes a significant physiological stress on patients, traditionally associated with prolonged hospital stays, substantial morbidity, and high healthcare costs. The Enhanced Recovery After Surgery (ERAS) paradigm, pioneered by Kehlet, represents a fundamental shift towards evidence-based, multimodal perioperative care designed to attenuate the surgical stress response and accelerate recovery (Greer et al.,2018, Mangone et al., 2024). These protocols integrate numerous elements across preoperative, intraoperative, and postoperative phases, focusing on patient education, minimally invasive techniques, optimized analgesia, early enteral nutrition, and enforced mobilization (Schwenk et al.,2021).

Numerous meta-analyses and studies from high-volume tertiary centres have consistently demonstrated that ERAS protocols in elective colorectal surgery reduce length of stay (LOS) and complication rates, while potentially lowering readmissions and healthcare costs (Ljungqvist et al.,2017, Issac et al., 2021). However, a significant proportion of colorectal procedures, particularly in settings like Malaysia, are performed in general surgical units. These units often differ from specialized colorectal centres in case mix, surgeon sub-specialization, and resource allocation. The question of whether the established benefits of ERAS can be replicated in this broader, generalist setting remains pertinent. Validating the efficacy of ERAS in this specific context is crucial to encourage its widespread adoption. This study aimed to evaluate the impact of a standardized ERAS protocol on clinical outcomes for elective colorectal surgery within a general surgical unit, comparing results to a historical cohort managed with traditional care principles.

METHODOLOGY

A prospective observational study was conducted at the General Surgery Unit of Hospital Sultan Ismail, a tertiary centre in Johor Bahru, Malaysia. The study compared all consecutive patients undergoing elective colorectal resection for malignancy over two 12-month periods: a pre-ERAS cohort (June 2023-May 2024) managed with traditional care and an ERAS cohort (June 2024-May 2025) after protocol implementation. Exclusion criteria included emergency surgery, multi-visceral resection, re-do surgery, neurological impairment, and American Society of Anaesthesiologists (ASA) physical status class >3. A total of 116 patients were included (56 in the Pre-ERAS group and 60 in the ERAS group).

Prior to implementation, a multidisciplinary ERAS team was established at the hospital level, comprising leads from general surgery, anaesthesiology, dietetics, physiotherapy, pharmacy, and enterostomal therapy. Healthcare staff received comprehensive education through multiple seminars and courses.

The unit adopted the ERAS protocol adapted from the ERAS Society guidelines (Gustafsson et al.,2025). Key protocol elements are summarized below:

- Preoperative: Structured patient education and counselling; nutritional screening and supplementation; a multimodal pre-rehabilitation program (nutrition, physical therapy, psychosocial); early referral for medical optimization and anemia management (early referral to anemia clinic for screening and management); mechanical bowel preparation (using Polyethylene Glycol a day prior) with oral antibiotics only for rectal resections;

preoperative fasting (solid food and liquid food until 6 hours and 2 hours prior to induction respectively) with carbohydrate loading (using 2 packets of ResourceR 12 hours and 1 packet 2 hours prior to induction); and avoidance of preoperative intravenous fluids.

- Intraoperative: Standardized anaesthetic protocol using short-acting agents with opioid-sparing techniques regardless of surgical technique; routine PONV prophylaxis; goal-directed fluid therapy; active warming to prevent hypothermia; avoidance of routine nasogastric tubes; and selective use of drains (for rectal resections).
- Postoperative: Multi-modal analgesia centered on a transversus abdominis plane (TAP) block and continuous pre-peritoneal catheter infusion of local anaesthetic; enforced early mobilization (starting Postoperative Day 1); initiation of pharmacological thromboprophylaxis (low molecular weight heparin) on postoperative Day 1 with mechanical thromboprophylaxis ; early initiation of oral nutrition supplements (liquids on Postoperative Day 0, advancing to a low-residue diet); tailored fluid management to achieve near-zero balance; and early removal of urinary catheters and drains.

Protocol Modifications: Two notable deviations from ERAS Society guidelines were implemented:

1. Analgesia: A continuous pre-peritoneal catheter system was used instead of epidural analgesia, as evidence supports its efficacy for pain control and it is less obstructive to mobilization (Hwee et al.,2022, Ozer et al.,2014).Pre-peritoneal catheter analgesia was performed intra-operatively using 2 multi-hole catheter placed in the peri-peritoneal space lateral to the wound site. The catheter is then attached to a balloon pump containing 400mls of bupivacaine that is delivered 2mls per hours via each catheter for approximately 96 hours. The pump is then attached to a sling bag that can be worn by the patient and this does not dampen the early mobilisation when compared to patient-controlled analgesia or epidural.
2. 2Carbohydrate Loading: This was omitted for diabetic patients during the initial implementation phase due to concerns over glycemic control and delayed gastric emptying, despite literature suggesting its safety (Katie et al., 2021).

Data were prospectively collected from a dedicated database and electronic medical records. The primary outcomes were:

- Length of Stay (LOS): Defined as the number of days from surgery to discharge, based on standardized criteria (tolerating oral diet, adequate pain control with oral analgesia, mobile, passed stool).
- Postoperative complication rate: Graded using the Clavien-Dindo classification within 30 days of surgery.
- 30-day readmission rate.
- 30-day mortality rate.

Secondary outcome was overall ERAS protocol compliance, with satisfactory adherence defined as >70% for each element.

Statistical analysis was performed using SPSS version 28. Continuous non-parametric variables were expressed as medians with interquartile ranges (IQR) and compared using the Mann-Whitney U test. Categorical variables were expressed as numbers (percentages) and compared using the Chi-square or Fisher's exact test, as appropriate. A two-sided p-value of <0.05 was considered statistically significant.

RESULTS

Baseline demographic and clinical characteristics were well-balanced between the ERAS (n=60) and Pre-ERAS (n=56) groups, with no statistically significant differences observed in age, gender, race, diagnosis, or type of surgery performed. The majority of procedures in both cohorts were open surgeries. The data are summarized in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics

	ERAS (n=60)	Pre-ERAS (n=56)	*p*-value
Age (years), Median (IQR)	64 (30-89)	66 (38-27)	0.884[a]
Race			
Malay	33 (55%)	32 (57.1%)	0.619[b]
Chinese	24 (40%)	19 (33.9%)	
Indian	3 (5%)	5 (8.9%)	
Gender			
Male	35 (58.3%)	37 (66.1%)	0.391[b]
Female	25 (41.7%)	19 (33.9%)	
Diagnosis			
Rectal	26 (43.3%)	33 (58.9%)	0.275[b]
Sigmoid	21 (35%)	11 (19.6%)	
Left sided	3 (5%)	3 (5.4%)	
Right sided	10 (16.7%)	9 (16.1%)	
Type of Surgery			
Abdomino-perineal resection (APR)	2 (3.3%)	13 (23.2%)	0.335[b]
Open low anterior resection (LAR)	9 (15%)	5 (8.9%)	
Open anterior resection (AR)	25 (41.7%)	18 (32.1%)	
Open left colectomy	9 (15%)	8 (14.3%)	
Open right colectomy	4 (6.7%)	2 (3.6%)	
Open total colectomy	2 (3.3%)	3 (5.4%)	
Laparoscopic anterior resection (AR)	9 (15%)	7 (12.5%)	

*Values expressed in median
a Mann-Whitney test, b Chi-Square test

Implementation of the ERAS protocol was associated with significantly improved clinical outcomes (Table 2). The ERAS group demonstrated a markedly lower overall complication burden. A significantly higher proportion of ERAS patients had no complications (58.3% vs. 44.6%, p=0.006). The rate of major complications (Clavien-Dindo Grade III-V) was nearly halved in the ERAS group (10.0% vs. 17.9%). These major complications in the ERAS group included anastomotic leaks (n=4), myocardial infarction (n=1), and pneumonia (n=1). The Pre-ERAS group experienced more anastomotic leaks (n=5), pneumonia (n=3), pulmonary embolism (n=1), and burst abdomen (n=1), with more patients requiring intensive care support.

Table 2: Primary Clinical Outcomes

Clinical outcomes	ERAS (n=60)	Pre-ERAS (n=56)	*p*-value
Clavien Dindo			
None	35 (58.3)	25 (44.6%)	0.006[c]
I-II	18 (30%)	21 (37.5%)	
III-V	6 (10%)	10 (17.9%)	
Length of stays in days, Median (IQR)	5 (2)	8 (5)	<0.001[a]
Readmission within 30 days	7 (11.7%)	10 (17.9)	0.184[b]
Mortality	1 (1.7%)	4 (7.1%)	0.195[c]

*Values expressed in median
a Mann-Whitney test, b Chi-Square test, c Fischer's Exact test

The median LOS was reduced by 3 days in the ERAS group (5 days, IQR: 2) compared to the Pre-ERAS group (8 days, IQR: 5) (p<0.001). The narrower IQR in the ERAS group indicates more consistent and predictable recovery. There was a non-significant trend towards reduction in both 30-day readmission (11.7% vs. 17.9%, p=0.184) and 30-day mortality (1.7% vs. 7.1%, p=0.195) rates in the ERAS group.

Overall compliance with the 24-element ERAS protocol was high (Figure 1). Adherence exceeded the 70% target for most components. The main elements with suboptimal compliance were the use of bowel preparation (only used in rectal resections with oral antibiotics), preoperative carbohydrate loading (primarily due to the exclusion of diabetic patients), laparoscopic approach, and routine usage of drains in rectal resections.

DISCUSSION

The introduction of Enhanced Recovery After Surgery (ERAS) protocols has fundamentally transformed perioperative care in colorectal surgery, shifting the paradigm from traditional, often prolonged, recovery toward evidence-based, multimodal rehabilitation. By systematically attenuating the surgical stress response, ERAS pathways aim to accelerate physiological recovery, thereby reducing postoperative complications and enhancing patient outcomes (Brescia et al., 2017). This is

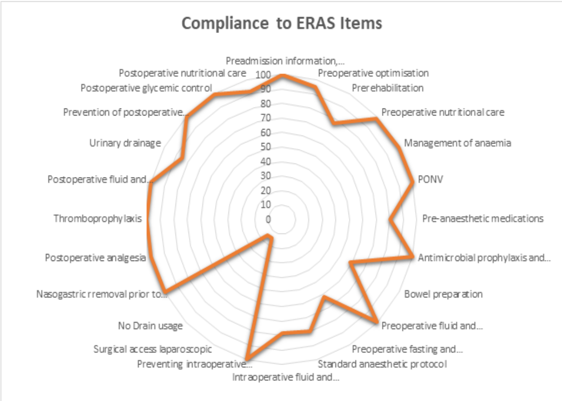

Figure 1: ERAS Protocol Adherence Rate

of paramount importance, as postoperative morbidity not only impacts short-term recovery but has also been shown to adversely affect long-term survival in cancer patient (Gustafsson et al., 2016). Evidence suggests that reducing early complications through ERAS principles may contribute to improved overall survival, underscoring the critical value of these protocols (Khuri et al., 2005).

This study demonstrates that the implementation of a structured ERAS protocol in a general surgical unit is both feasible and effective, yielding significant improvements in clinical outcomes that align with those reported by specialized, high-volume centres. Our key findings—a statistically significant reduction in postoperative complication severity and a three-day reduction in median length of stay (LOS)—epitomize the core objectives of the ERAS philosophy. The notable decrease in major complications (Clavien-Dindo Grade III-V) is particularly consequential, as these events are primary drivers of patient morbidity, mortality, and healthcare resource utilization. The concomitant reduction in LOS, accompanied by a narrower interquartile range, further indicates a more standardized, predictable, and efficient recovery process. These results are consistent with findings from numerous other institutions that have adopted ERAS practices (Cavallaro et al., 2019, Varadhan et al., 2010).
Although not statistically significant in this cohort, the observed trends toward reduced readmission and mortality rates are clinically encouraging. The study was likely underpowered to detect differences in these relatively rare outcomes. Future larger, potentially multi-centre, studies are warranted to further elucidate the impact of ERAS on these endpoints.

A critical determinant of success in ERAS implementation is protocol compliance. The high overall adherence rate achieved in this study reflects successful multidisciplinary engagement and a positive cultural shift within our general surgery setting. This is significant because high compliance has been consistently correlated with improved postoperative outcomes, including shorter LOS and reduced complications (Gustafsson et al., 2011). Our ability to achieve this was underpinned by comprehensive staff education, continuous multidisciplinary collaboration, and the unwavering support of hospital administration. However, compliance was suboptimal for specific elements: mechanical bowel preparation was selectively applied only to rectal resections; carbohydrate loading was withheld from diabetic patients due to initial caution; and the adoption of minimally invasive surgery (MIS), though slightly improved from the pre-ERAS period, remained below 70%. Additionally, drain usage persisted based on surgeon preference, though an emphasis on early removal mitigated any potential negative impact on mobilization. Importantly, the protocol demonstrated flexibility, as clinically justified adaptations—such as the use of pre-peritoneal catheters for analgesia—proved effective, indicating that ERAS principles can be successfully tailored to local resources and expertise without compromising outcomes.

The challenges of implementing ERAS in a general surgical unit cannot be understated. It requires a profound cultural shift and unwavering commitment from a multidisciplinary team that led by surgeons which proved to be a key strength of this study.

Success hinges on high protocol compliance, which demands continuous education, audit, and feedback. The "general" nature of the unit, with staff rotating through different services and initial resistance from staff accustomed to traditional practises can be a barrier to maintaining consistency, highlighting the need for dedicated ERAS coordinators or champions which we were fortunate to have at our centre. Moving forward, the focus must shift to sustaining and improving these gains. Continuous auditing, feedback, and ongoing education will be essential to refine our protocol and further enhance patient outcomes in the future.

Enhanced Recovery After Surgery (ERAS) protocols in colorectal surgery come with their own set of contraindications and limitations. Applying the protocol often requires tailored adjustments, particularly for patient groups with relative contraindications, including intraoperative complications, high-risk anastomoses, advanced age or frailty, and excessive stoma output following surgery. Among the potential downsides, excessively stringent perioperative fluid restriction can lead to acute kidney injury. Moreover, premature discharge may sometimes result in readmissions due to complications, overly vigorous mobilization could precipitate cardiac events in vulnerable patients, and the heightened need for nursing and physiotherapy support in the early postoperative period can overburden understaffed facilities. In low-volume centres with inconsistent compliance, an inflexible approach to ERAS frequently undermines the intended benefits and may even result in adverse outcomes (Ayinde et al., 2024). As such, we envision safe adoption through personalized adaptations rather than strict, unwavering adherence to the protocol.

This study has several limitations. Its single-centre design and use of a historical control group introduce the potential for unmeasured confounding and temporal biases. The predominance of open procedures may affect the generalizability of the findings to units with a high laparoscopic volume, though it accurately reflects the current reality in many general surgical centres in Malaysia. Furthermore, the deliberate omission of carbohydrate loading for diabetic patients, though a cautious approach during initial implementation, represents a deviation from current ERAS Society recommendations, indicating an area for future practice improvement (Katie et al., 2021).

CONCLUSION

In conclusion, despite the challenges inherent in changing long-standing traditional practices, the successful implementation of a multidisciplinary ERAS protocol in a general surgical unit significantly improved patient care. This was evidenced by a substantial reduction in postoperative complication rates and a markedly shorter hospital stay. This study provides robust, real-world evidence that the benefits of ERAS are achievable beyond specialized colorectal centres and can be effectively translated into a general surgical setting with commitment and a collaborative team approach. These findings should encourage broader adoption and adaptation of ERAS protocols across diverse surgical environments to improve patient outcomes globally.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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