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Original Research Article

ENHANCED RECOVERY AFTER SURGERY (ERAS) PROTOCOLS IN GASTROINTESTINAL SURGERY AT A RURAL TERTIARY CARE CENTRE: FEASIBILITY, COMPLIANCE, AND OUTCOMES — A PROSPECTIVE COHORT STUDY

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ABSTRACT

Background: Enhanced Recovery After Surgery (ERAS) protocols have transformed perioperative care in high-volume centres, yet evidence from rural tertiary hospitals in low- and middle-income countries remains sparse. We evaluated the feasibility, compliance, and clinical outcomes of a structured ERAS programme for gastrointestinal (GI) surgeries in a resource-constrained rural setting. **Materials and Methods:** A prospective cohort study was conducted over 24 months (January 2023 – December 2024) at a 450-bed rural tertiary care hospital. Consecutive patients undergoing elective and emergency GI surgery were assigned to an ERAS group (n=60) or a conventional care group (n=55) in a quasi-experimental design. A 14-element ERAS bundle was implemented in collaboration with anaesthesiology, nursing, and physiotherapy teams. The primary outcome was length of hospital stay (LOS). Secondary outcomes included time to first flatus, oral intake, ambulation, post-operative complications (Clavien-Dindo classification), 30-day readmission, mortality, and patient satisfaction. **Result:** Median LOS was significantly shorter in the ERAS group (5 days; IQR 4–7) compared with conventional care (8 days; IQR 6–11; p<0.001). Overall ERAS element compliance was 78.3%. Time to first flatus (38 vs 62 h; p<0.001), oral fluids (16 vs 48 h; p<0.001), and ambulation (20 vs 44 h; p<0.001) were all significantly reduced. Overall Clavien I–II morbidity was lower in the ERAS group (23.3% vs 43.6%; p=0.02). Severe morbidity, readmission, and mortality did not differ significantly. Patient satisfaction scores were higher in the ERAS group (8.2 ± 1.1 vs 6.5 ± 1.6; p<0.001). **Conclusion:** Structured ERAS protocols are feasible and effective in rural tertiary care settings in India. Despite resource constraints, high compliance is achievable with dedicated multidisciplinary engagement, and the protocols substantially reduce hospital stay, accelerate recovery, and improve patient satisfaction without compromising safety.

INTRODUCTION

Enhanced Recovery After Surgery (ERAS), first systematised by Henrik Kehlet in the 1990s, represents a paradigm shift from traditional perioperative management towards evidence-based, multimodal pathways designed to attenuate the surgical stress response, accelerate physiological recovery, and reduce complications.[1] Core components span the preoperative, intraoperative, and postoperative continua, incorporating elements such as prehabilitation, carbohydrate loading, goal-directed fluid therapy, opioid-sparing analgesia, early enteral nutrition, and structured early mobilisation.[2,3]

The global evidence base, predominantly from high-income countries (HICs) and large urban tertiary centres, consistently demonstrates that ERAS reduces length of stay (LOS) by 30–50%, post-operative morbidity by 20–30%, and hospital costs

significantly, without adversely affecting readmission rates or mortality.[4,5] The Enhanced Recovery After Surgery Society has developed procedure-specific guidelines for colorectal, upper GI, hepato-pancreato-biliary, and small bowel surgery, and these have been widely adopted internationally.[6]

However, the generalisability of these results to rural hospitals in low- and middle-income countries (LMICs), where infrastructure, staffing, drug availability, and patient socioeconomic profiles differ substantially, remains under-explored. India's rural tertiary hospitals serve large patient volumes with varied disease burdens, limited physiotherapy resources, inconsistent availability of specialised nutrition supplements, and heterogeneous nursing literacy regarding protocol-based care. Published literature from such settings is sparse and largely retrospective.[7,8]

The present study was therefore designed with two primary aims: first, to evaluate the feasibility and protocol compliance of a locally adapted 14-element ERAS bundle in a 450-bed rural tertiary hospital; and second, to compare clinical outcomes — principally LOS and recovery milestones — between ERAS and conventional perioperative care across a spectrum of GI surgical procedures. Additionally, we systematically documented institutional barriers and facilitators to guide future scale-up.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective cohort study with a quasi-experimental design, conducted from January 2023 to December 2024 at a 450-bed government-affiliated rural tertiary care hospital situated approximately 180 km from the nearest metropolitan centre in Maharashtra, India. The Department of General Surgery performs approximately 600 major GI procedures annually. The hospital serves a predominantly agricultural population with limited private healthcare alternatives.

Participants: Consecutive adult patients (age ≥18 years) scheduled for or presenting with conditions requiring major GI surgery were screened. Patients were assigned to the ERAS group if they were admitted after protocol implementation (January 2023 onwards) and consented to ERAS care. A contemporaneous group of patients managed under conventional perioperative care (January–June 2023 run-in/historical period) served as controls.

Inclusion criteria

Age ≥18 years; elective or emergency major GI surgery (colorectal, small bowel, upper GI, hepato-pancreato-biliary); expected surgery lasting >60 minutes; written informed consent.

Exclusion criteria: ASA physical status IV or V; emergency surgery for haemorrhagic shock or peritonitis with haemodynamic instability precluding protocol adherence; patients with pre-existing severe malnutrition (albumin <20 g/L or BMI <16 kg/m²); pregnancy; cognitive impairment preventing consent or participation.

ERAS Protocol: The ERAS bundle was adapted from published ERAS Society guidelines,[2,3,6] to local resource availability following a three-month preparatory phase involving structured multidisciplinary workshops, staff training, and pilot testing in five cases. A total of 14 protocol elements were defined across three perioperative phases:

Preoperative elements (5): patient counselling and education using illustrated pamphlets in Hindi and Marati; nutritional risk screening (NRS-2002); carbohydrate loading with commercially available glucose polymer drink 2 h before induction; avoidance of routine mechanical bowel preparation for colonic cases; and cessation of fasting beyond 6 h for solids and 2 h for clear liquids.

Intraoperative elements (4): total intravenous anaesthesia (TIVA) or combined spinal-epidural to minimise opioid requirements; intraoperative goal-directed fluid therapy (GDFT) guided by pleth variability index or pulse pressure variation; active warming to maintain normothermia (≥36.5°C); and avoidance of routine intra-abdominal drains except in specific indications.

Postoperative elements (5): multimodal opioid-sparing analgesia (scheduled paracetamol, ketorolac, wound infiltration, and epidural where placed); early oral fluids on the day of surgery and solid diet by Day 1; structured early mobilisation with physiotherapy from recovery room; early urinary catheter removal within 48 h; and osmotic laxatives and prokinetics to facilitate bowel function.

Compliance with each element was recorded on a bedside ERAS checklist by the treating team and independently verified by a research nurse. Overall compliance was defined as adherence to ≥70% of applicable elements per patient.

Conventional Care Group: Patients in the conventional group received standard perioperative care as practised historically in the unit: fasting from midnight, routine mechanical bowel preparation for colonic surgery, standard anaesthetic technique at the anaesthetist's discretion, liberal intraoperative fluid therapy, routine nasogastric tube placement, post-operative fasting until return of bowel sounds, prolonged bed rest, and opioid-predominant analgesia. No formal early mobilisation or nutritional protocol was applied.

Outcome Measures: The primary outcome was length of hospital stay (days from surgery to discharge). Secondary outcomes included: time to first flatus (h); time to first oral fluids (h); time to full oral diet (days); time to first ambulation (h); post-operative complications graded by Clavien-Dindo classification; 30-day readmission rate; 30-day mortality; and patient satisfaction assessed at discharge using a structured 10-point Likert scale. ERAS protocol compliance (% of elements achieved) was a feasibility outcome.

Statistical Analysis: Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables

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are presented as mean ± SD or median with interquartile range (IQR) as appropriate, following Shapiro-Wilk testing for normality. Categorical variables are expressed as frequency and percentage. Between-group comparisons used independent samples t-test or Mann-Whitney U test for continuous variables, and chi-square or Fisher's exact test for categorical variables. A two-tailed p-value <0.05 was considered statistically significant. No imputation was performed for missing data (<2% of variables).

RESULTS

Study Population: A total of 115 patients were enrolled: 60 in the ERAS group and 55 in the conventional care group. Baseline demographic and clinical characteristics were comparable between groups (Table 1). Mean age was 48.3 ± 14.2 years in the ERAS group and 49.7 ± 13.8 years in controls. Approximately 60% of patients in each group were male. The distribution of ASA physical status and comorbidities, including diabetes mellitus, hypertension, and prior abdominal surgery, was similar. Emergency presentations constituted approximately 36% in both groups.

Table 1. Baseline demographic and clinical characteristics

Variable	ERAS Group (n=60)	Conventional (n=55)
Age (years), mean ± SD	48.3 ± 14.2	49.7 ± 13.8
Male sex, n (%)	36 (60.0)	33 (60.0)
BMI (kg/m²), mean ± SD	22.8 ± 3.9	23.1 ± 4.1
ASA I, n (%)	18 (30.0)	17 (30.9)
ASA II, n (%)	31 (51.7)	28 (50.9)
ASA III, n (%)	11 (18.3)	10 (18.2)
Diabetes mellitus, n (%)	14 (23.3)	13 (23.6)
Hypertension, n (%)	17 (28.3)	16 (29.1)
Prior abdominal surgery, n (%)	12 (20.0)	11 (20.0)
Emergency presentation, n (%)	22 (36.7)	20 (36.4)

Values presented as mean ± SD or n (%). ASA = American Society of Anesthesiologists physical status classification.

Types of Surgical Procedure: The spectrum of GI procedures performed was comparable between groups [Table 2]. Colorectal resections constituted the majority (~66%), followed by small bowel resection (~13%), Hartmann's procedure (~10%), Whipple's pancreaticoduodenectomy (~7%), and other procedures (~4%).

Table 2. Distribution of surgical procedures

Procedure	ERAS Group (n=60)	Conventional (n=55)
Right hemicolectomy, n (%)	16 (26.7)	15 (27.3)
Left hemicolectomy/sigmoidectomy, n (%)	14 (23.3)	12 (21.8)
Anterior resection / LAR, n (%)	10 (16.7)	9 (16.4)
Small bowel resection, n (%)	8 (13.3)	7 (12.7)
Hartmann's procedure, n (%)	6 (10.0)	6 (10.9)
Whipple's procedure, n (%)	4 (6.7)	4 (7.3)
Other GI procedures, n (%)	2 (3.3)	2 (3.6)

LAR = Low Anterior Resection.

ERAS Protocol Compliance: Compliance rates for individual ERAS elements are presented in [Table 3]. Overall composite compliance (defined as ≥70% of applicable elements) was achieved in 47 of 60 ERAS patients (78.3%). Highest compliance was observed for thromboprophylaxis (98.3%), nutritional risk screening (100%), and preoperative counselling (96.7%). The lowest compliance was recorded for early mobilisation (78.3%), laxative/prokinetic administration (75.0%), and intraoperative GDFT (85.0%), largely attributable to infrastructure and supply limitations.

Table 3. ERAS element-wise compliance rates

ERAS Element	Target	Compliance (%)
Pre-operative counselling & education	All patients	96.7
Nutritional risk screening	All patients	100
Carbohydrate loading (oral, 2 h pre-op)	Elective patients	88.6
Avoidance of mechanical bowel prep	Colonic surgery	91.4
Multimodal anaesthesia (TIVA / neuraxial)	All patients	93.3
Intra-operative goal-directed fluid therapy	All patients	85.0
Normothermia maintenance	All patients	90.0
Avoidance of routine drains	Select cases	80.0
Early oral feeding (Day 0 / Day 1)	All patients	83.3
Early mobilisation (Day 0 or Day 1)	All patients	78.3
Multimodal analgesia / opioid-sparing	All patients	91.7
Early urinary catheter removal (≤48 h)	All patients	86.7
Laxatives / prokinetics	All patients	75.0

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Thromboprophylaxis	All patients	98.3
Overall composite compliance ≥70% elements	All patients	78.3

GDFT = Goal-Directed Fluid Therapy; TIVA = Total Intravenous Anaesthesia.

Primary and Secondary Outcomes: The primary and secondary outcomes are summarised in [Table 4]. The ERAS group demonstrated a significantly shorter median LOS (5 days; IQR 4–7) compared with the conventional group (8 days; IQR 6–11; p<0.001), representing a 37.5% reduction. Time to first flatus (38 vs 62 h; p<0.001), time to first oral fluids (16 vs 48 h; p<0.001), time to full oral diet (2 vs 4 days; p<0.001), and time to first ambulation (20 vs 44 h; p<0.001) were all significantly improved in the ERAS group.

Overall Clavien-Dindo grade I–II morbidity was significantly lower in the ERAS group (23.3% vs 43.6%; p=0.02). Although wound infection (10.0% vs 20.0%), pulmonary complications (5.0% vs 14.5%), and post-operative ileus (6.7% vs 18.2%) were numerically lower in the ERAS group, these individual differences did not reach statistical significance, likely reflecting a type II error in this sample size. Severe morbidity (Clavien III–IV), 30-day readmission, and 30-day mortality did not differ between groups. Patient satisfaction scores were significantly higher in the ERAS group (8.2 ± 1.1 vs 6.5 ± 1.6; p<0.001).

Table 4: Primary and secondary outcomes

Outcome	ERAS (n=60)	Conventional (n=55)	p-value
Length of stay (days), median (IQR)	5 (4–7)	8 (6–11)	<0.001
Time to first flatus (h), median (IQR)	38 (28–48)	62 (52–76)	<0.001
Time to oral fluids (h), median (IQR)	16 (12–24)	48 (36–60)	<0.001
Time to full oral diet (days), median (IQR)	2 (1–3)	4 (3–6)	<0.001
Time to ambulation (h), median (IQR)	20 (14–28)	44 (36–56)	<0.001
Wound infection, n (%)	6 (10.0)	11 (20.0)	0.12
Anastomotic leak, n (%)	2 (3.3)	3 (5.5)	0.68
Pulmonary complications, n (%)	3 (5.0)	8 (14.5)	0.08
Post-operative ileus, n (%)	4 (6.7)	10 (18.2)	0.06
Urinary tract infection, n (%)	2 (3.3)	4 (7.3)	0.43
Overall morbidity (Clavien I–II), n (%)	14 (23.3)	24 (43.6)	0.02
Severe morbidity (Clavien III–IV), n (%)	3 (5.0)	4 (7.3)	0.71
30-day readmission, n (%)	4 (6.7)	3 (5.5)	1.00
30-day mortality, n (%)	1 (1.7)	2 (3.6)	0.60
Patient satisfaction score (0–10), mean ± SD	8.2 ± 1.1	6.5 ± 1.6	<0.001

IQR = interquartile range. p-values by Mann-Whitney U test (continuous) or chi-square / Fisher's exact test (categorical). Bold = p<0.05.

Barriers and Facilitators: Institutional barriers and facilitators to ERAS implementation are summarised in [Table 5]. Key barriers included initial staff resistance, supply-chain inconsistencies for carbohydrate loading drinks, and limited high-dependency unit (HDU) capacity for post-operative monitoring. The most impactful facilitators were the designation of a dedicated ERAS champion, weekly multidisciplinary audit meetings, and bedside protocol checklists translated into Tamil.

Table 5: Institutional barriers and facilitators to ERAS implementation

Barriers	Facilitators
Resistance from anaesthesia and nursing staff	Dedicated ERAS champion and weekly audit meetings
Unavailability of standardised pre-operative nutrition packs	Laminated bedside protocol checklists in local language
Infrastructure limitations (step-down ward, HDU beds)	Physiotherapy involvement from post-operative Day 0
Irregular supply of carbohydrate loading drinks	Strong support from surgical unit head
Delayed patient discharge due to family/social reasons	Stepwise institutional rollout reducing learning-curve issues
Emergency case surges limiting protocol adherence	Patient education leaflets in regional language

DISCUSSION

This prospective cohort study demonstrates that a structured, locally adapted ERAS programme is both feasible and clinically effective in a rural tertiary care hospital in India. We achieved a composite compliance rate of 78.3%, a figure comparable to many published series from urban tertiary hospitals in HICs,[9,10] and our primary outcome — median LOS — was reduced by over three days. These findings challenge the assumption that ERAS implementation requires the full infrastructure of a large academic medical centre.

The magnitude of LOS reduction we observed (5 vs 8 days; 37.5%) is consistent with systematic reviews of ERAS in colorectal surgery (reductions of 2–4 days) and upper GI surgery (3–5 days).[4,5] Our cohort included a mixed spectrum of procedures, reflecting the real-world case mix of a rural referral centre where no subspecialty differentiation occurs. Importantly, this LOS reduction was not accompanied by increased readmission, consistent with a growing consensus that ERAS-driven early

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discharge is safe when underpinned by adequate patient education and community follow-up pathways.[11]

The significant reduction in overall Clavien I–II morbidity (23.3% vs 43.6%; p=0.02) is noteworthy. Although individual complications such as wound infection and post-operative ileus showed favourable trends, the study was not powered to detect statistically significant differences in these individual endpoints. The reduction in composite morbidity likely reflects the cumulative benefit of multiple protocol elements — avoidance of routine drains, opioid-sparing analgesia reducing ileus risk, early ambulation preventing respiratory and thromboembolic events, and timely nutrition supporting wound healing.[12]

Compliance with specific elements deserves commentary. The highest compliance was predictably with process measures requiring prescriptive ordering (thromboprophylaxis, nutritional screening), while the lowest compliance was in time-sensitive, behaviour-dependent measures such as early mobilisation and prokinetic administration. This pattern mirrors international experience,[13] and underscores that compliance with the most impactful functional elements — mobilisation and early feeding — remains the primary challenge. Our physiotherapy team's involvement from post-operative Day 0, while beneficial, was limited by manpower on weekends and after-hours, a structural issue requiring workforce investment.

The context of a rural LMIC hospital introduces specific considerations absent from most published ERAS literature. First, patient socioeconomic and educational factors affected protocol adherence: some patients were reluctant to ambulate or orally feed early due to cultural beliefs around post-operative rest. This necessitated culturally sensitive education in regional language, an approach we strongly advocate for rural Indian contexts.[14] Second, supply-chain inconsistencies for carbohydrate loading drinks — a commercially produced product not routinely stocked in government hospitals — resulted in substitution with locally prepared glucose drinks in 11.4% of cases, highlighting the need for locally procurable alternatives. Third, intraoperative GDFT, theoretically one of the highest-impact elements, had only 85.0% compliance because pulse pressure variation monitoring was unavailable in one of the two operating theatres. Institutional investment in affordable monitoring is essential to optimise this element.

Patient satisfaction scores were significantly higher in the ERAS group (8.2 vs 6.5; p<0.001). This finding is particularly relevant for rural hospitals seeking to retain patients who may otherwise seek care at distant urban centres. Shorter hospital stays also carry tangible economic benefits for predominantly agricultural families who lose livelihood during hospitalisation — a dimension not captured by traditional outcome metrics but critical in the Indian rural context.[15]

Our study has several limitations. The quasi-experimental design introduces potential selection and temporal bias, though baseline characteristics were well matched. The sample size, while powered for the primary outcome, was insufficient for rare outcomes such as anastomotic leak and mortality. Single-centre data limit generalisability. Patient-reported functional recovery outcomes beyond satisfaction were not systematically collected. Future studies should employ randomised controlled designs where feasible, include health-economic analyses capturing indirect costs, and extend to smaller district hospitals to explore the lower limit of institutional capacity for ERAS implementation.

CONCLUSION

ERAS protocols are feasible, achievable, and clinically effective in the context of a rural tertiary care hospital in India. With a structured multidisciplinary approach, cultural adaptation of educational materials, and continuous protocol auditing, compliance rates comparable to urban centres are attainable. ERAS significantly shortens hospital stay, accelerates gastrointestinal recovery and ambulation, reduces overall post-operative morbidity, and improves patient satisfaction without increasing readmission or mortality. Rural surgical units across LMICs should not be deterred from ERAS implementation by resource concerns; rather, they should focus on pragmatic adaptation, staff engagement, and stepwise rollout. Expanding ERAS adoption in rural settings represents a high-value, low-cost strategy to improve surgical care equity at scale.

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