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EFFECT OF AN ERAS (ENHANCED RECOVERY AFTER SURGERY) BUNDLE ON 30-DAY POSTOPERATIVE COMPLICATIONS AND LENGTH OF HOSPITAL STAY AFTER ELECTIVE COLORECTAL RESECTION: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Objective: To compare the frequency of 30-day postoperative complications and postoperative length of hospital stay between patients managed with a standardized Enhanced Recovery After Surgery (ERAS) bundle and those receiving conventional perioperative care after elective colorectal resection.

Study Design: Prospective, quasi-experimental, non-randomized before-and-after comparative study.

Setting: Department of Surgery, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

Period: Five months from 5 December 2025 to 18 April 2026, following approval from Institutional Review Board clearance.

Material & Methods: Ninety-six adults undergoing elective open or laparoscopic colorectal resection were enrolled by non-probability purposive sampling. The first 48 consecutive patients (Group A) received the department's existing conventional perioperative care; the next 48 (Group B) received an eight-element ERAS bundle covering counselling, avoidance of prolonged fasting, opioid-sparing analgesia, restrictive fluid therapy, normothermia, selective nasogastric use, early oral feeding and early mobilization. The primary outcomes were any 30-day postoperative complication (Clavien-Dindo grade I-V) and postoperative length of stay. Groups were compared using the chi-square test, independent-samples t-test and Mann-Whitney U test, with multivariable logistic and linear regression to adjust for age, ASA grade, operative approach, site, diagnosis and diabetes; $p \leq 0.05$ was significant.

Results: Groups were comparable for age, sex, ASA grade, operative approach, site and diagnosis. Mean ERAS compliance was 7.1±1.0 of 8 elements (89%), with 44/48 (91.7%) achieving ≥6/8. Thirty-day complications occurred in 27/48 (56.3%) conventional-care patients versus 16/48 (33.3%) ERAS patients (relative risk 0.59, 95% CI 0.37-0.95; p=0.040). Major complications (Clavien-Dindo ≥IIIa) were similar (12.5% versus 12.5%; p=1.000). Mean postoperative stay fell from 7.25±1.68 days to 4.19±1.48 days with the ERAS bundle (mean difference 3.06 days, 95% CI 2.45-3.66; p<0.001). On adjusted analysis, ERAS remained independently associated with lower complication odds (adjusted odds ratio 0.27, 95% CI 0.09-0.78; p=0.016) and shorter stay (adjusted difference −3.05 days; p<0.001).

Conclusion: A pragmatic, locally deliverable ERAS bundle significantly reduced 30-day postoperative complications and postoperative length of stay after elective colorectal resection at a high-volume public-sector centre, supporting its adoption as standard perioperative practice.

KEYWORDS: Colorectal Surgery, Enhanced Recovery After Surgery, Length of Stay, Perioperative Care, Postoperative Complications.

INTRODUCTION

Enhanced Recovery After Surgery (ERAS) is a multimodal, evidence-based perioperative pathway that reduces surgical stress and accelerates recovery through coordinated preoperative, intraoperative and postoperative measures. Colorectal resection has historically been associated with a prolonged hospital stay and a complication rate of 10-20% under conventional perioperative care, driven largely by paralytic ileus, surgical-site infection and delayed mobilization.1 The ERAS Society and the American Society of Colon and Rectal Surgeons/Society of American Gastrointestinal and Endoscopic Surgeons guidelines recommend structured patient counselling, avoidance of prolonged fasting, multimodal opioid-sparing analgesia, restrictive or goal-directed

fluid therapy, active maintenance of normothermia, selective rather than routine nasogastric decompression, early oral intake and early mobilization out of bed as core elements of colorectal perioperative care.2,3

Evidence supporting ERAS in colorectal surgery has strengthened substantially in recent years. A 2024 meta-analysis of randomized clinical trials across surgical specialties found that ERAS pathways shortened hospital stay and reduced postoperative complications without increasing readmission or mortality.4 A colorectal-specific meta-analysis of twelve randomized trials involving 1,920 participants reported an overall length-of-stay reduction of 4.12 days with ERAS.5 A 2025 systematic review of ERAS versus conventional colorectal perioperative care similarly found consistent reductions in length of stay across included trials, without excess morbidity, readmission or mortality in the ERAS arm.6 Diabetes mellitus and malignant diagnosis have separately been identified as independent risk factors for postoperative morbidity after colorectal resection, with diabetic patients carrying a higher risk of surgical-site infection, anastomotic leak and prolonged hospitalization.7,8 Within Pakistan, a randomized trial of elective colorectal patients reported a mean hospital stay of 3.37±1.75 days with ERAS against 8.30±1.68 days with conventional care, and a lower surgical-site infection rate with ERAS (13.3% versus 30.0%).9 A subsequent Karachi implementation study found that the majority of laparoscopic ERAS patients were discharged within 24 hours, while open colorectal patients achieved discharge far less consistently, and a compliance audit from a public-sector Pakistani centre found ERAS adherence to be variable across emergency and elective colorectal cases.10,11 A JPMC-based comparison of laparoscopic and open approaches for rectal resection has separately shown that operative approach itself materially affects early complication rates, underlining the need to account for approach when evaluating a perioperative bundle.12

Although ERAS is internationally recommended, its effectiveness depends on protocol adherence, surgical approach, staffing, available resources and local discharge practices, and Pakistani evidence remains limited to a small number of trials and implementation audits, with high-volume public-sector surgical units under-represented.9-11 We therefore designed this prospective comparative study to evaluate a pragmatic, locally deliverable eight-element ERAS bundle against existing conventional perioperative care in the elective colorectal population at a high-volume public-sector teaching hospital. The primary objective was to compare the frequency of 30-day postoperative complications and postoperative length of hospital stay between the two groups, in order to generate locally relevant evidence to support a standardized perioperative pathway.

MATERIAL AND METHODS

Study Design: This was a prospective, quasi-experimental, non-randomized before-and-after comparative study.

Settings: Department of Surgery, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

Duration: Five months from 5 December 2025 to 18 April 2026, following approval from Institutional Review Board clearance.

Sample Size: Sample size was calculated using the WHO formula for comparison of two independent proportions, using 30-day postoperative morbidity rates of 35% with enhanced recovery and 65% with standard care reported by Ostermann et al.13 With P1=0.35, P2=0.65, 95% confidence ($Z\alpha/2=1.96$) and 80% power ($Z\beta=0.84$), the calculated requirement was 43 patients per group; after allowing 10% for loss to 30-day follow-up, 48 patients were enrolled per group, giving a total sample of 96 patients (Group A=48 conventional care; Group B=48 ERAS bundle).

Sampling Technique: Non-probability, purposive sampling. The first 48 eligible, consecutively presenting patients constituted Group A and received the department's existing conventional perioperative care. Following a standardized team briefing on the eight-element ERAS bundle, the next 48 eligible patients constituted Group B and received the ERAS bundle.

Inclusion Criteria: Patients aged 18-80 years, of either gender, scheduled for elective inpatient resection of the colon and/or rectum for benign or malignant disease, undergoing open or laparoscopic resection under general anaesthesia, with American Society of Anesthesiologists (ASA) physical status I-III, who gave written informed consent and agreed to 30-day follow-up.

Exclusion Criteria: Emergency or urgent surgery for perforation, generalized peritonitis, acute obstruction, uncontrolled bleeding or bowel ischaemia; procedures not involving colorectal resection; planned cytoreductive surgery with HIPEC or simultaneous major non-colorectal surgery; ASA IV-V or requirement for preoperative intensive care; and patients unavailable for 30-day outcome assessment.

Data Collection Procedure: After ethical clearance, eligible patients were approached and written informed consent obtained. Baseline demographic and clinical data-age, gender, body mass index, comorbidities, ASA grade, diagnosis, colorectal site, operative approach and procedure-were recorded on a structured proforma. Group A received conventional perioperative care; antibiotic prophylaxis, venous-thromboembolism prophylaxis and glycaemic control were provided in both groups according to hospital policy. For Group B, each of the eight ERAS elements (structured counselling, avoidance of prolonged fasting, multimodal opioid-sparing analgesia, restrictive/goal-directed fluid therapy, active normothermia, avoidance of routine nasogastric decompression, oral feeding within 24 hours, and mobilization out of bed within 24 hours) was recorded as achieved

or not achieved; compliance ≥6/8 elements (75%) was considered successful ERAS delivery. Identical discharge criteria-haemodynamic stability, adequate oral intake, pain controlled with oral medication, near-baseline mobility, no ongoing intravenous therapy requirement, and no untreated complication-were applied to both groups. Postoperative complications were recorded daily during admission and graded by the Clavien-Dindo classification; patients were reviewed in clinic or by telephone at 30 days to capture complications, reoperation, readmission or death occurring after discharge.[14]

Data / Statistical Analysis: Data were entered and analyzed using IBM SPSS Statistics version 26. Quantitative variables (age, BMI, operative duration, length of stay) were summarized as mean±standard deviation and compared using the independent-samples t-test or Mann-Whitney U test as appropriate. Categorical variables were presented as frequencies and percentages and compared using the chi-square or Fisher's exact test, with relative risk and 95% confidence interval reported for the primary complication outcome. Potential confounders-age, ASA grade, operative approach, colorectal site, diagnosis and diabetes-were assessed by stratification and multivariable binary logistic regression (for complications) and multiple linear regression (for length of stay). A two-sided p-value ≤0.05 was considered statistically significant.

Ethical Approval: The study was conducted after approval from the Institutional Review Board, in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants, and confidentiality was maintained using study identification numbers.

RESULTS

Ninety-six patients were enrolled, 48 in each group. Baseline demographic and operative characteristics were comparable between groups (Table-I). Mean age was 55.67±12.42 years in the conventional-care group and 52.96±12.73 years in the ERAS group (p=0.294), and mean BMI was 26.05±3.15 kg/m² and 25.12±3.17 kg/m² respectively (p=0.153). ASA grade, operative approach, colorectal site, diagnosis (malignant versus benign), anastomosis and stoma formation did not differ significantly between groups (all p>0.05). Diabetes mellitus was more frequent in the conventional-care group (14/48, 29.2%) than in the ERAS group (4/48, 8.3%; p=0.019); other individual comorbidities and overall comorbidity burden were similar between groups.

Mean ERAS compliance in Group B was 7.1±1.0 of 8 elements (89.1%; median 7, interquartile range 6.75-8.0), and 44/48 patients (91.7%) achieved successful ERAS delivery (≥6/8 elements). Thirty-day postoperative complications occurred in 27/48 patients (56.3%) receiving conventional care compared with 16/48 patients (33.3%) receiving the ERAS bundle, a statistically significant difference (χ^2=4.212, p=0.040), corresponding to a relative risk of 0.59 (95% CI 0.37-0.95) with the ERAS bundle (Table-II). Major complications (Clavien-Dindo grade IIIa or higher) occurred with equal frequency in both groups (6/48, 12.5% each; p=1.000). Among the complication types recorded, postoperative ileus was markedly less frequent with the ERAS bundle (1/48, 2.1%) than with conventional care (12/48, 25.0%); surgical-site infection occurred in 4/48 (8.3%) ERAS patients versus 7/48 (14.6%) conventional-care patients. Anastomotic leak, intra-abdominal collection, pneumonia, urinary tract infection and venous thromboembolism occurred at broadly similar low frequencies in both groups (Figure-1, Table-III). Reoperation within 30 days occurred in 3/48 (6.3%) conventional-care and 1/48 (2.1%) ERAS patients, and unplanned readmission in 5/48 (10.4%) and 3/48 (6.3%) respectively; there was no 30-day mortality in either group.

Mean postoperative length of stay fell from 7.25±1.68 days (median 7, interquartile range 6-8) with conventional care to 4.19±1.48 days (median 4, interquartile range 3-5) with the ERAS bundle, a mean difference of 3.06 days (95% CI 2.45-3.66 days; independent-samples t=9.46, p<0.001; Mann-Whitney U test p<0.001) (Figure-2). The reduction in length of stay with ERAS was consistent on stratification by operative approach: among laparoscopic cases, mean stay fell from 6.79±1.79 to 3.77±1.31 days (p<0.001), and among open cases from 7.78±1.44 to 4.33±1.31 days (p<0.001). The complication reduction with ERAS showed a similar direction within both approach subgroups, although the smaller stratum size limited statistical power (laparoscopic subgroup p=0.108; open subgroup p=0.252).

On multivariable binary logistic regression adjusting for age, ASA grade, operative approach, colorectal site, malignant diagnosis and diabetes, allocation to the ERAS bundle remained independently associated with lower odds of a 30-day complication (adjusted odds ratio 0.27, 95% CI 0.09-0.78; p=0.016). Malignant diagnosis was independently associated with higher complication odds (adjusted odds ratio 5.73, 95% CI 1.12-29.36; p=0.036), and older age showed a non-significant trend toward higher complication risk (p=0.054). On multiple linear regression, the ERAS bundle remained independently associated with a shorter postoperative stay after adjustment for the same covariates (adjusted mean difference −3.05 days, 95% CI −3.66 to −2.45; p<0.001), and laparoscopic approach was independently associated with a further reduction in stay of approximately one day (p=0.001); the adjusted model explained 61% of the variance in length of stay (R^2=0.61).

Table-I. Baseline demographic and operative characteristics of study groups (n=96)

Characteristic	Conventional care (n=48)	ERAS bundle (n=48)	p-value
Age, years (mean±SD)	55.67±12.42	52.96±12.73	0.294
Male sex, n (%)	30 (62.5)	24 (50.0)	0.304
BMI, kg/m² (mean±SD)	26.05±3.15	25.12±3.17	0.153

Characteristic	Conventional care (n=48)	ERAS bundle (n=48)	p-value
ASA I / II / III, n	8 / 29 / 11	9 / 30 / 9	0.871
Diabetes mellitus, n (%)	14 (29.2)	4 (8.3)	0.019
Any comorbidity, n (%)	29 (60.4)	22 (45.8)	0.220
Malignant diagnosis, n (%)	38 (79.2)	39 (81.3)	1.000
Laparoscopic approach, n (%)	24 (50.0)	22 (45.8)	0.802
Rectal site, n (%)	13 (27.1)	13 (27.1)	1.000
Primary anastomosis, n (%)	41 (85.4)	40 (83.3)	1.000
Operative duration, min (mean±SD)	175.75±32.30	176.62±32.63	0.895

Table-II. Primary outcomes: 30-day postoperative complications and length of stay

Outcome	Conventional care (n=48)	ERAS bundle (n=48)	p-value
Any 30-day complication, n (%)	27 (56.3)	16 (33.3)	0.040
Major complication ≥IIIa, n (%)	6 (12.5)	6 (12.5)	1.000
Reoperation within 30 days, n (%)	3 (6.3)	1 (2.1)	0.618
Unplanned readmission, n (%)	5 (10.4)	3 (6.3)	0.715
30-day mortality, n (%)	0 (0)	0 (0)	-
Postoperative LOS, days (mean±SD)	7.25±1.68	4.19±1.48	<0.001
Postoperative LOS, days (median, IQR)	7.0 (6.0-8.0)	4.0 (3.0-5.0)	<0.001

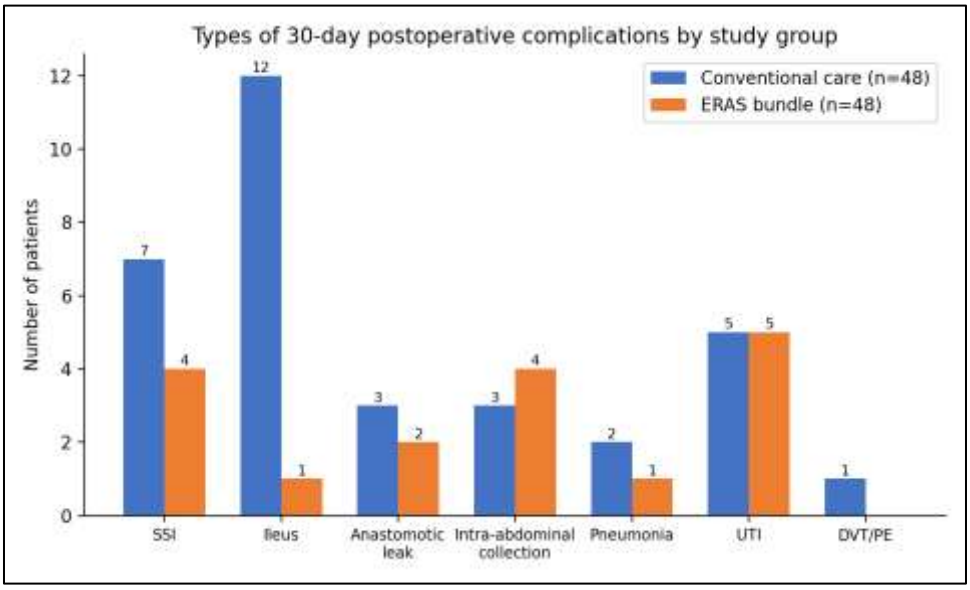

Figure-1. Types of 30-day postoperative complications by study group.

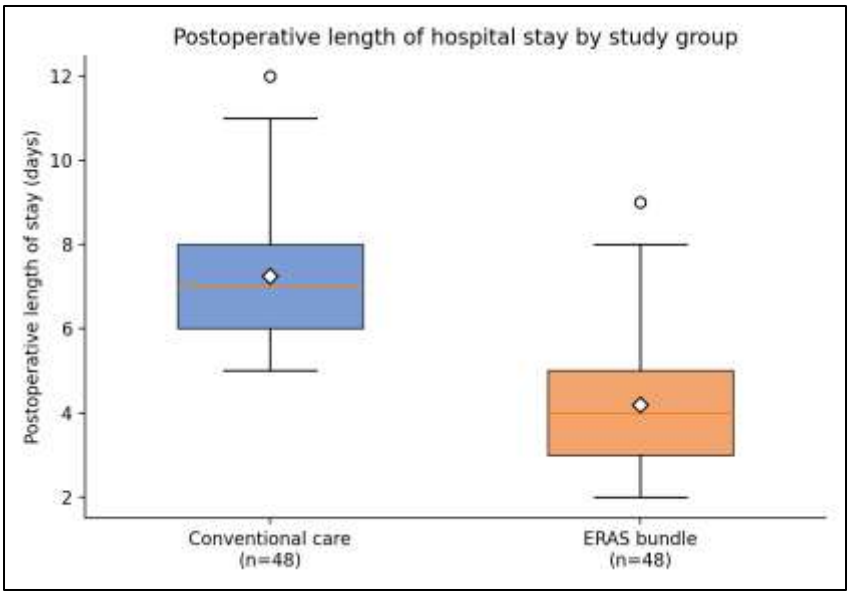

Figure-2. Box plot showing postoperative length of hospital stay by study group.

Table-III. Cross-tabulation of complication type with study group (n=96)

Complication type	Conventional care n (%)	ERAS bundle n (%)	Total
Surgical-site infection	7 (14.6)	4 (8.3)	11
Postoperative ileus	12 (25.0)	1 (2.1)	13
Anastomotic leak	3 (6.3)	2 (4.2)	5
Intra-abdominal collection	3 (6.3)	4 (8.3)	7
Pneumonia	2 (4.2)	1 (2.1)	3
Urinary tract infection	5 (10.4)	5 (10.4)	10
DVT / pulmonary embolism	1 (2.1)	0 (0)	1

Note: Percentages are of group size (n=48); patients could have more than one complication type, so totals exceed the number of patients with any complication.

DISCUSSION

This prospective before-and-after study found that a pragmatic, eight-element ERAS bundle, delivered with 89% mean compliance in a high-volume public-sector colorectal unit, significantly reduced both 30-day postoperative complications and postoperative length of hospital stay, and that the effect on length of stay persisted after adjustment for age, ASA grade, operative approach, site, diagnosis and diabetes. The magnitude of the length-of-stay reduction observed here-from 7.25 to 4.19 days, a difference of just over three days-is consistent with, though somewhat larger than, the 4.12-day reduction reported in a colorectal-specific meta-analysis of twelve randomized trials, and with the range of 3 to 8 days reported across included studies in a recent systematic review of ERAS versus conventional colorectal perioperative care.5,6 It is also closely comparable to a local Pakistani randomized trial that reported a fall in mean hospital stay from 8.30 to 3.37 days with an ERAS pathway, and broadly consistent with a 2025 meta-analysis restricted to trials using a ≥12-element ERAS Society bundle.9,15 Taken together with these data, our results support the conclusion that the length-of-stay benefit of ERAS is reproducible in a resource-constrained, high-volume public-sector setting and is not dependent on a fully resourced, high-income-country perioperative infrastructure.

The reduction in 30-day complications with the ERAS bundle (56.3% with conventional care versus 33.3% with ERAS; relative risk 0.59) was driven predominantly by a large reduction in postoperative ileus, from 25.0% to 2.1%, with smaller reductions in surgical-site infection. This pattern is biologically plausible: several of the ERAS elements used in this study-restrictive fluid therapy, avoidance of routine nasogastric decompression, early oral feeding and early mobilization-act directly on the mechanisms of postoperative ileus, whereas major infective and anastomotic complications are influenced by additional factors, including tissue perfusion, surgical technique and oncological stage, that a perioperative bundle alone cannot fully modify.2,16 This may explain why major complications (Clavien-Dindo grade IIIa or higher) did not differ between groups in our study, even though the overall complication rate fell substantially; a similar dissociation between overall morbidity and major morbidity has been reported in other ERAS cohorts, where ERAS chiefly reduces the burden of minor, resource-light complications rather than eliminating major surgical morbidity.6,17 On multivariable analysis, malignant diagnosis remained

an independent predictor of complications regardless of perioperative pathway, consistent with the more extensive dissection and higher physiological burden typically associated with oncological resection compared with benign disease.8

Diabetes mellitus was more prevalent in the conventional-care group than in the ERAS group in this non-randomized, sequentially allocated design, and diabetes is independently associated with a higher risk of surgical-site infection, anastomotic leak and prolonged hospitalization after colorectal resection in the wider literature.18,19 Although diabetes was not an independent predictor of complications or length of stay in our adjusted models, the baseline imbalance is a limitation of the sequential, non-randomized allocation used here, and it is possible that some of the observed benefit of the ERAS bundle reflects, in part, a lower-risk comorbidity profile in Group B rather than the bundle alone; the persistence of the ERAS effect after adjustment for diabetes in regression analysis provides some reassurance on this point, but a randomized design would remove this uncertainty. The length-of-stay benefit of ERAS was consistent across both laparoscopic and open subgroups in our data, and laparoscopic approach itself was independently associated with a further reduction in stay on adjusted analysis, in keeping with a JPMC-based comparison of laparoscopic and open rectal resection that found the laparoscopic approach associated with fewer early complications and a shorter hospital stay, and with the wider literature comparing laparoscopic and open colorectal surgery.12,20 This suggests that ERAS and a minimally invasive approach act at least partly through complementary mechanisms and that the combination, where laparoscopic expertise is available, may offer an additive benefit worth evaluating prospectively in a larger sample.

Mean ERAS compliance of 89% in this study, with 91.7% of patients achieving the pre-specified ≥6/8 element threshold, is higher than the 78.6% compliance reported in a recent prospective Indian implementation study of a 16-item ERAS protocol, and likely reflects both the smaller, more deliverable eight-element bundle used here and the structured team briefing that preceded its introduction.21 Elsewhere, high ERAS compliance has itself been shown to correlate with shorter length of stay independent of the specific elements achieved, and our findings are consistent with this dose-response relationship between adherence and outcome.21,22 This has practical implications for scale-up: a smaller number of well-embedded, high-yield elements, reliably delivered by ward and theatre staff without additional capital investment, may be more sustainable in a public-sector setting than a longer protocol with lower overall adherence.

This study has several limitations. First, allocation was sequential rather than randomized, introducing a risk of secular trends and confounding by indication, as illustrated by the baseline imbalance in diabetes prevalence between groups; a randomized controlled design would strengthen causal inference. Second, the study was conducted at a single tertiary-care centre, which may limit generalizability to other institutions with different staffing, resources or case-mix. Third, the sample size, while adequate for the primary outcomes on the basis of the a priori power calculation, limited the power of subgroup analyses by operative approach and diagnosis, and may not have been sufficient to detect a difference in major (Clavien-Dindo ≥IIIa) complications if a smaller true effect exists. Fourth, outcome assessment, though standardized, was not blinded, which could introduce ascertainment bias, particularly for minor complications relying on clinical judgement. Multicentre, randomized trials with larger sample sizes are recommended to confirm these findings and to assess the durability of the ERAS effect on long-term outcomes.

CONCLUSION

A pragmatic, eight-element ERAS bundle, delivered with high compliance in a high-volume public-sector surgical unit, significantly reduced 30-day postoperative complications and shortened postoperative hospital stay by three days after elective colorectal resection, without increasing major morbidity, reoperation, readmission or mortality. These findings support incorporation of a structured ERAS pathway into routine perioperative practice for elective colorectal resection in similar resource-limited settings.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

1	Author Name: Study conception, data collection, manuscript drafting.
2	Co-Author Name: Data collection, statistical analysis.
3	Senior Author Name: Study design, critical revision, supervision.

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