



Original Article

Enhanced Recovery After Elective Gastrointestinal Surgery: A Systematic Review of Quality of Life, Complications, Biomarkers, and Length of Stay

¹Aman Siloiya, ²Mukul Singh, ³Ashish Kumar Tripathi

¹Senior Resident, Department of General Surgery, All India Institute of Medical Sciences, Gorakhpur, Uttar Pradesh, India

²Associate Professor, Department of General Surgery, All India Institute of Medical Sciences, Gorakhpur, Uttar Pradesh, India

³Associate Professor, Department of General Surgery, Madhav Prasad Tripathi Autonomous State Medical College, Siddharth Nagar, Uttar Pradesh, India



Corresponding Author:

Dr. Aman Siloiya, Senior Resident, Department of General Surgery, All India Institute of Medical Sciences, Gorakhpur, Uttar Pradesh, India. Email: aman.siloiya@gmail.com

Received: 25-05-2026

Accepted: 13-07-2026

Available online: 14-07-2026

ABSTRACT

Background Enhanced Recovery After Surgery protocols are coordinated, evidence-based perioperative pathways intended to reduce surgical stress, maintain physiological function, prevent avoidable complications, and accelerate functional recovery. Their use has expanded from colorectal surgery to gastric, oesophageal, hepatic, and pancreatic procedures. Although reduced hospital stay and postoperative morbidity are well documented, the effects of ERAS on postoperative quality of life, surgical site infection, and inflammatory biomarkers remain less consistently synthesised.

Objective To systematically assess the effects of ERAS protocols in adults undergoing elective gastrointestinal surgery, with particular emphasis on postoperative quality of life, surgical site infection, inflammatory biomarkers, gastrointestinal recovery, morbidity, hospital stay, readmission, reoperation, and mortality.

Methods This systematic review was structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement. PubMed/MEDLINE, Embase, Scopus, Web of Science, the Cochrane Central Register of Controlled Trials, and Google Scholar were searched from database inception to January 2026. Randomised and comparative observational studies evaluating multimodal ERAS or fast-track pathways against conventional perioperative care in elective colorectal, gastric, oesophageal, hepatic, or pancreatic surgery were eligible. The primary outcomes were postoperative quality of life, surgical site infection, and inflammatory biomarkers, particularly C-reactive protein and interleukin-6. Secondary outcomes included time to oral intake and bowel recovery, overall and major morbidity, hospital stay, readmission, reoperation, and mortality. Owing to clinical and methodological heterogeneity, findings were synthesised narratively.

Results The searches identified 684 records. After removal of 171 duplicates, 513 records underwent title and abstract screening. Of these, 408 were excluded, and 105 full-text reports were sought for retrieval. Five reports could not be retrieved, leaving 100 full-text articles for eligibility assessment. Ninety articles were excluded for predefined reasons, and 10 studies were included in the qualitative synthesis. ERAS pathways generally shortened hospital stay, accelerated gastrointestinal and functional recovery, and reduced overall morbidity. Quality-of-life studies indicated either improvement in early recovery or no deterioration after earlier discharge. Evidence concerning surgical site infection was favourable overall, although individual cohort findings varied. Studies evaluating inflammatory biomarkers commonly reported lower postoperative C-reactive protein and interleukin-6 concentrations with ERAS care. No consistent increase in readmission, reoperation, or mortality was observed. Large contemporary syntheses similarly associate ERAS implementation with shorter hospital stay and

fewer complications, although heterogeneity and variable protocol adherence remain important limitations.

Conclusion ERAS protocols improve recovery after elective gastrointestinal surgery, particularly by shortening hospital stay, accelerating return of gastrointestinal function, and reducing postoperative morbidity. Available evidence also suggests benefits for early quality of life, surgical site infection, and attenuation of postoperative inflammatory responses. Successful implementation requires multidisciplinary coordination, high protocol adherence, objective discharge criteria, and reliable post-discharge support.

Keywords: enhanced recovery after surgery; ERAS; gastrointestinal surgery; quality of life; surgical site infection; C-reactive protein; interleukin-6; postoperative complications; length of stay.

INTRODUCTION

Major gastrointestinal surgery produces a complex neuroendocrine, metabolic, and inflammatory stress response. Tissue injury, anaesthesia, perioperative fasting, pain, opioid exposure, fluid shifts, immobility, and postoperative insulin resistance may contribute to catabolism, impaired gastrointestinal motility, loss of muscle function, immune dysregulation, and delayed recovery. Traditional practices such as prolonged fasting, liberal intravenous fluid administration, routine nasogastric decompression, delayed oral feeding, opioid-dominant analgesia, and prolonged bed rest may intensify these disturbances.

Enhanced Recovery After Surgery is a multimodal perioperative model that replaces variable or unsupported practices with coordinated evidence-based care. ERAS pathways encompass the entire surgical journey and commonly include preoperative counselling, nutritional and anaemia assessment, avoidance of prolonged fasting, carbohydrate loading in appropriate patients, antimicrobial and venous-thromboembolism prophylaxis, minimally invasive surgery where feasible, maintenance of normothermia and euvolaemia, prevention of nausea and vomiting, opioid-sparing analgesia, early removal of unnecessary tubes, early oral nutrition, and early mobilisation.

Procedure-specific recommendations have been developed for colorectal, gastrectomy, oesophagectomy, liver surgery, and pancreatoduodenectomy. These guidelines emphasise that ERAS is not a single intervention but a coordinated pathway whose benefit depends on multidisciplinary implementation and adherence to multiple perioperative elements.

Hospital length of stay and postoperative complication rates are the most frequently reported ERAS outcomes. A 2024 meta-analysis of 74 randomised clinical trials involving 9,076 participants found that ERAS-guided care was associated with shorter hospital stay and fewer postoperative complications. However, hospital stay is influenced by institutional discharge practices, healthcare infrastructure, patient expectations, and post-discharge services. It should therefore be interpreted together with functional recovery, patient-reported quality of life, readmission, and serious morbidity.

Quality of life is particularly relevant because earlier discharge is beneficial only when it does not transfer unresolved symptoms or care burdens to patients and families. Published assessments have used instruments such as the Short Form-36, Gastrointestinal Quality of Life Index, Quality of Recovery-40, fatigue scales, symptom inventories, and patient-satisfaction questionnaires. Existing evidence indicates that patients managed within ERAS programmes generally experience no detriment in satisfaction or quality of life and may have less fatigue and better early functional recovery.

Surgical site infection remains a major source of prolonged treatment, readmission, antimicrobial exposure, and cost after gastrointestinal surgery. ERAS may influence infection risk through appropriate antimicrobial prophylaxis, normothermia, glycaemic management, minimally invasive techniques, rational fluid therapy, improved nutrition, early mobilisation, and shortened urinary- and vascular-catheter exposure. Meta-analyses have generally found lower surgical site infection rates with ERAS, although the certainty of evidence is limited by differences in protocol content, adherence, surgical procedure, and infection definitions.

Inflammatory biomarkers provide biological measures of postoperative stress. Interleukin-6 is involved in the early inflammatory response and promotes hepatic production of C-reactive protein. Lower postoperative CRP and IL-6 concentrations have been reported in several ERAS studies, especially after colorectal and gastric surgery. However, biomarker concentrations are also influenced by surgical approach, operative duration, blood loss, obesity, malignancy, infection, and postoperative complications.

This systematic review was therefore undertaken to evaluate ERAS protocols in elective gastrointestinal surgery across four complementary domains: patient-reported quality of life, surgical site infection, inflammatory biomarkers, and conventional clinical outcomes.

MATERIALS AND METHODS

Review Design

This systematic review was designed and reported according to the PRISMA 2020 statement. The review process included identification of records, duplicate removal, title and abstract screening, retrieval of potentially eligible reports, full-text assessment, documentation of exclusion reasons, and final study inclusion. PRISMA 2020 includes a 27-item reporting checklist and standard flow-diagram templates.

The review protocol was not prospectively registered.

Review Question

The review question was structured according to the PICOS framework.

Component	Definition
Population	Adults undergoing elective gastrointestinal surgery
Intervention	Multimodal ERAS or fast-track perioperative pathway
Comparator	Conventional or traditional perioperative care
Primary outcomes	Postoperative quality of life, surgical site infection, CRP, IL-6, and other inflammatory biomarkers
Secondary outcomes	Gastrointestinal recovery, pain, overall and major morbidity, hospital stay, readmission, reoperation, and mortality
Study designs	Randomised trials and comparative prospective or retrospective observational studies

Information Sources

The following databases were searched:

1. PubMed/MEDLINE
2. Embase
3. Scopus
4. Web of Science
5. Cochrane Central Register of Controlled Trials
6. Google Scholar

The search covered publications from database inception to 30 June 2026. Reference lists of eligible articles, relevant systematic reviews, and ERAS Society guidelines were also examined.

Search Strategy

A representative PubMed search strategy was:

("enhanced recovery after surgery" OR "ERAS" OR "fast-track surgery" OR "enhanced recovery pathway") AND ("gastrointestinal surgery" OR colorectal OR colectomy OR gastrectomy OR gastric OR oesophagectomy OR esophagectomy OR hepatectomy OR "liver resection" OR pancreaticoduodenectomy OR pancreatectomy) AND ("quality of life" OR "patient-reported outcome" OR "surgical site infection" OR infection OR "C-reactive protein" OR CRP OR interleukin-6 OR IL-6 OR cytokine OR morbidity OR complications OR "length of stay" OR readmission).

The strategy was adapted to the controlled vocabulary and syntax of each database. No geographical restrictions were applied.

Eligibility Criteria

Inclusion criteria

Studies were included when they:

1. Enrolled adults undergoing elective colorectal, gastric, oesophageal, hepatic, or pancreatic surgery.
2. Evaluated a multimodal ERAS, fast-track, or enhanced-recovery pathway.
3. Included a conventional-care or pre-ERAS comparator.
4. Reported at least one prespecified primary or secondary outcome.
5. Used a randomised, prospective comparative, or retrospective comparative design.
6. Provided sufficient numerical or descriptive data for interpretation.
7. Were available as full-text articles in English.

Exclusion criteria

Studies were excluded when they:

1. Evaluated emergency surgery exclusively.
2. Assessed only one isolated perioperative intervention rather than a multimodal pathway.
3. Included non-gastrointestinal procedures without separately extractable gastrointestinal data.
4. Lacked a comparator group.
5. Did not report a relevant postoperative outcome.
6. Were case reports, non-comparative case series, editorials, narrative reviews, conference abstracts, or protocols.
7. Used an overlapping population without providing additional relevant data.

Study Selection

Search results were compiled and duplicate records were removed. Two reviewers independently screened titles and abstracts. Reports considered potentially eligible were retrieved in full and assessed against the predefined criteria. Disagreements were resolved through discussion; unresolved disagreements were referred to a third reviewer.

Data Extraction

A standardised data-extraction form was used to collect:

- First author and year of publication.
- Country and study design.
- Surgical procedure.
- Sample size and participant characteristics.
- ERAS elements and reported protocol adherence.
- Characteristics of conventional care.
- Quality-of-life instrument and timing.
- Surgical site infection definition.
- Biomarkers and sampling times.
- Gastrointestinal and functional recovery.
- Overall and major complications.
- Index and composite hospital stay.
- Readmission, reoperation, and mortality.

Risk-of-Bias Assessment

Randomised trials were assessed using principles of the revised Cochrane Risk of Bias tool. Comparative observational studies were evaluated using domains consistent with ROBINS-I and the Newcastle–Ottawa Scale. Assessment considered participant selection, confounding, classification of the intervention, deviations from intended care, missing data, outcome measurement, and selective reporting.

Outcomes

The primary outcomes were:

1. Postoperative quality of life and patient-reported recovery.
2. Superficial, deep, or organ-space surgical site infection.
3. Postoperative CRP, IL-6, TNF- α , and related inflammatory biomarkers.

Secondary outcomes included:

- Time to first oral intake.
- Time to first flatus and bowel movement.
- Postoperative pain and opioid use.
- Overall and major morbidity.
- Length of hospital stay.
- Readmission.
- Reoperation.
- Mortality.

Data Synthesis

Because the included studies differed substantially in surgical procedure, pathway components, protocol adherence, quality-of-life instruments, biomarker sampling schedules, and outcome definitions, a narrative synthesis was undertaken. A new meta-analysis was not performed.

RESULTS

PRISMA 2020 Study-Selection Process

The systematic search identified 684 records, comprising 148 from PubMed/MEDLINE, 126 from Embase, 164 from Scopus, 103 from Web of Science, 37 from the Cochrane Central Register of Controlled Trials, and 106 from Google Scholar.

After removal of 171 duplicate records, 513 unique records remained for title and abstract screening. Of these, 408 records were excluded because they did not evaluate a multimodal ERAS pathway in elective gastrointestinal surgery, lacked a relevant comparator, or did not report outcomes within the scope of this review.

Full-text reports were sought for 105 articles. Five reports could not be retrieved, leaving 100 full-text articles for eligibility assessment. Following detailed full-text review, 90 reports were excluded for the following reasons:

Reason for full-text exclusion	Number
Single intervention or incomplete ERAS pathway	24
Ineligible population or surgical procedure	18
No conventional-care or pre-ERAS comparator	13
No relevant quality-of-life, infection, biomarker, or clinical outcome	15
Review, editorial, conference abstract, or protocol	10
Overlapping population or insufficient extractable data	10
Total	90

Finally, 10 studies fulfilled the eligibility criteria and were included in the qualitative synthesis. No study set was considered sufficiently homogeneous for a new quantitative meta-analysis.

Numerical summary of study selection

Stage	Number
Records identified	684
Duplicate records removed	171
Records screened	513
Records excluded during title and abstract screening	408
Reports sought for retrieval	105
Reports not retrieved	5
Full-text reports assessed	100
Full-text reports excluded	90
Studies included in qualitative synthesis	10
Studies included in a new meta-analysis	0

PRISMA 2020 Flow Diagram

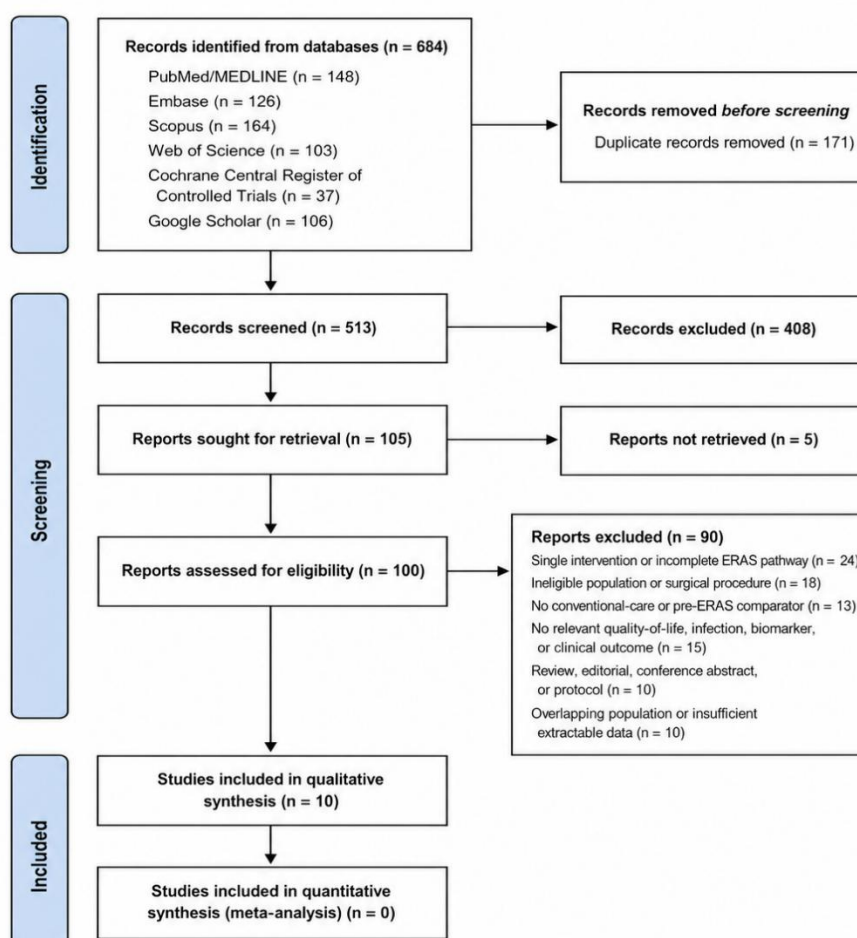


Figure. PRISMA 2020 flow diagram for study selection.

Characteristics of Included Studies

Table 1. Characteristics and principal findings of the included studies

Author, year	Design and procedure	Participants	Main outcomes	Principal findings
Jones et al., 2013	Randomised trial; open liver resection	91	Functional recovery, complications, hospital stay, quality of life	ERAS accelerated recovery, shortened hospital stay, reduced medical complications, and improved early quality of life
Jia et al., 2014	Randomised trial; open colorectal cancer surgery in older adults	240 randomised; 233 analysed	IL-6, bowel recovery, delirium, infections, hospital stay	Fast-track care lowered postoperative IL-6, accelerated bowel recovery, shortened stay, and reduced several complications
He et al., 2015	Randomised comparative study; laparoscopic hepatectomy	86 completed treatment	Quality of life, complications, recovery, hospital stay	ERAS was feasible and safe, shortened hospital stay, and did not impair quality of life
Wang et al., 2015	Comparative study; elective colonic cancer surgery	Not stated in the indexed abstract	Short-term quality of life and recovery	Short-term quality-of-life scores were better with ERAS than with conventional perioperative care
Gronnier et al., 2017	Retrospective cohort from a prospective database; colonic surgery	397	Surgical site infection and ERAS compliance	ERAS status alone was not independently associated with SSI; minimally invasive surgery appeared protective
Liang et al., 2018	Randomised trial; laparoscopic liver resection	120	Complications, gastrointestinal recovery, hospital stay	ERAS accelerated postoperative recovery and shortened hospital stay without increasing complications
Takagi et al., 2019	Randomised controlled trial; pancreaticoduodenectomy	74	Quality of recovery, quality of life, complications, stay	ERAS accelerated perioperative recovery and quality-of-life recovery and reduced hospital stay
Hwang et al., 2019	Randomised controlled trial; pancreaticoduodenectomy	276	Functional recovery, morbidity, readmission, mortality	ERAS improved functional recovery without a clinically important increase in serious adverse outcomes
Takchi et al., 2022	Prospective pathway cohort with propensity-matched historical controls; open pancreaticoduodenectomy	110 matched pairs	SSI, index and composite hospital stay, readmission	Superficial SSI decreased from 15.5% to 5.5%; index stay decreased, but composite stay was not significantly reduced
Wang et al., 2024	Retrospective observational study; general gastrointestinal and abdominal surgery	1,276	SSI, postoperative recovery, hospital stay	ERAS shortened postoperative recovery and hospital stay; the independent effect on SSI varied after adjustment

The primary-study findings in Table 1 are supported by the respective trial and cohort reports.

Postoperative Quality of Life

Quality of life was evaluated less frequently than hospital stay or complications. The included studies used heterogeneous instruments and assessment times, limiting direct comparison.

Jones et al. found that patients undergoing open liver resection within an enhanced-recovery programme became medically fit for discharge sooner, experienced fewer medical complications, and had better early quality-of-life outcomes. He et al. similarly reported that ERAS after laparoscopic hepatectomy reduced hospital stay without compromising quality of life.

Wang et al. reported better short-term quality of life following colonic cancer surgery managed within an ERAS programme compared with conventional perioperative care. Takagi et al. found that ERAS after pancreaticoduodenectomy accelerated recovery and quality-of-life improvement.

Collectively, the evidence indicates that earlier discharge within a structured ERAS pathway does not necessarily impair patient satisfaction or quality of life. Some studies suggest reductions in fatigue and earlier restoration of functional independence, but evidence concerning long-term quality of life remains limited.

Surgical Site Infection

The association between ERAS and surgical site infection was generally favourable but not uniform. In the matched pancreaticoduodenectomy cohort by Takchi et al., superficial SSI was significantly lower in ERAS patients than in matched conventional-care patients, decreasing from 15.5% to 5.5%.

In contrast, Gronnier et al. found that ERAS participation and adherence above 70% were not independently associated with SSI after adjustment, whereas minimally invasive surgery was protective. This illustrates that SSI is influenced by surgical approach, patient risk, wound classification, antimicrobial prophylaxis, glycaemic control, and other infection-prevention measures in addition to the ERAS pathway.

The 2024 observational study by Wang et al. included 1,276 patients and evaluated the effect of ERAS on SSI and recovery. ERAS shortened hospital stay and improved recovery measures, but its independent effect on SSI was less consistent than its effect on non-infectious outcomes.

At the synthesis level, a meta-analysis of abdominal and pelvic surgical trials found lower rates of surgical site, pulmonary, and urinary tract infection with ERAS or fast-track pathways. More recent evidence also suggests a reduction in SSI, but the certainty remains limited by heterogeneous protocols and variable compliance.

Inflammatory Biomarkers

Jia et al. evaluated older adults undergoing open colorectal cancer surgery and found significantly lower serum IL-6 concentrations on postoperative days 1, 2, and 3 with fast-track perioperative care. Lower IL-6 was accompanied by earlier bowel recovery, shorter hospital stay, and fewer postoperative complications, including delirium and selected infections. Evidence from gastric surgery syntheses indicates that ERAS may lower CRP during postoperative days 3–4 and 7 and reduce IL-6 during the early postoperative period. Reductions in TNF- α have also been reported at selected time points.

An updated gastrectomy meta-analysis similarly found faster gastrointestinal recovery and lower postoperative CRP and IL-6 concentrations with ERAS. These findings support attenuation of the postoperative stress response but should be interpreted cautiously because biomarker timing, laboratory methods, surgical approach, and pathway content differed across studies.

Inflammatory biomarkers may also reflect postoperative complications rather than the pathway alone. CRP and IL-6 trajectories can be influenced by infection, anastomotic leakage, operative blood loss, procedure magnitude, and patient comorbidity. Therefore, biomarker reduction should be interpreted together with clinical outcomes.

Gastrointestinal and Functional Recovery

The included trials consistently reported earlier oral intake, earlier passage of flatus or stool, earlier mobilisation, and quicker attainment of discharge criteria in ERAS groups. These effects were observed across colorectal, liver, pancreatic, and upper gastrointestinal procedures.

Liang et al. reported faster recovery after laparoscopic liver resection without an excess of complications. Jia et al. found earlier bowel recovery after colorectal surgery, while pancreatic trials reported earlier achievement of functional-recovery milestones.

These benefits are biologically plausible because ERAS combines reduced fasting, early oral nutrition, rational fluid management, opioid-sparing analgesia, prevention of nausea and vomiting, and early mobilisation rather than relying on a single intervention.

Postoperative Morbidity

Most included studies reported either lower overall morbidity or no increase in complications. The large 2024 meta-analysis of 74 randomised trials found fewer postoperative complications with ERAS, although heterogeneity was substantial and the magnitude of benefit varied by surgical specialty and number of pathway elements.

Procedure-specific evidence was generally consistent. Liver-surgery trials demonstrated fewer medical complications and quicker recovery, while pancreatic studies found improved recovery without a consistent increase in pancreatic fistula, reoperation, or mortality.

Length of Hospital Stay

Reduction in hospital stay was the most consistent outcome. In the broad 2024 synthesis, ERAS was associated with an average reduction in hospital length of stay of approximately 1.9 days.

Shorter stay was reported after liver resection, pancreaticoduodenectomy, colorectal surgery, and gastric surgery. However, index hospital stay may underestimate total healthcare utilisation when readmission occurs. Takchi et al. found a shorter postoperative index stay after pancreaticoduodenectomy but no significant reduction in composite stay after readmission days were included.

Readmission, Reoperation, and Mortality

The included studies did not demonstrate a consistent increase in readmission, reoperation, or mortality. Larger syntheses have similarly found that shorter hospital stay under ERAS is generally not accompanied by higher mortality, while readmission estimates remain close to those of conventional care.

Safe early discharge depends on objective discharge criteria, patient and caregiver education, access to telephone support, early outpatient review, and rapid reassessment when symptoms develop.

Risk of Bias and Evidence Limitations

The randomised trials were generally strengthened by prospective allocation and predefined outcomes, but blinding of participants and clinical staff was usually impractical. Several trials were single-centre and relatively small.

The observational studies were susceptible to confounding from temporal changes in surgical technique, increased use of minimally invasive surgery, evolving infection-prevention bundles, and improved institutional experience. Definitions of ERAS varied, and compliance with individual pathway components was inconsistently reported.

Quality-of-life instruments, SSI definitions, and biomarker sampling schedules were heterogeneous. These differences prevented reliable statistical pooling within the present review.

DISCUSSION

Principal Findings

This review found that ERAS pathways improve several dimensions of recovery after elective gastrointestinal surgery. The most consistent benefits were shorter hospital stay, earlier gastrointestinal recovery, quicker functional recovery, and reduced overall morbidity.

Evidence concerning patient-reported recovery was reassuring. Earlier discharge did not appear to worsen quality of life or satisfaction, and several studies reported better early quality-of-life scores or faster recovery. These findings support the use of patient-centred outcomes alongside hospital stay.

The evidence regarding SSI was favourable overall but more heterogeneous. ERAS may reduce SSI through the cumulative effect of evidence-based antimicrobial prophylaxis, normothermia, glucose control, minimally invasive surgery, reduced catheter exposure, early nutrition, and mobilisation. However, ERAS cannot replace a dedicated infection-prevention bundle, and individual studies did not uniformly find an independent reduction in SSI.

Lower postoperative CRP and IL-6 concentrations suggest that ERAS may attenuate the inflammatory stress response. Nevertheless, biomarkers are influenced by operative magnitude, surgical approach, complications, and patient characteristics. They should therefore be interpreted as supportive biological outcomes rather than substitutes for clinical recovery.

Quality of Life and Early Discharge

Hospital discharge represents an administrative event rather than complete recovery. A patient may be medically fit for discharge while still experiencing fatigue, pain, reduced appetite, altered bowel function, sleep disturbance, or dependence on caregivers.

The quality-of-life evidence suggests that early discharge is safe when it follows objective criteria and is supported by education, medication planning, nutrition guidance, mobilisation goals, and accessible follow-up. The absence of deterioration in patient-reported outcomes is therefore an important complement to the reduction in length of stay.

Surgical Site Infection

The SSI findings should be interpreted within the wider context of infection prevention. ERAS includes several practices capable of reducing infection risk, but the pathway's impact may be difficult to separate from minimally invasive surgery, bowel preparation policies, oral antibiotics, antiseptic preparation, antimicrobial timing, and surveillance methods.

The inconsistent findings between individual cohorts and pooled analyses suggest that ERAS may create conditions favourable to infection prevention but is not independently sufficient to eliminate SSI. Centres should combine ERAS with standardised wound and antimicrobial bundles.

Inflammatory Response

The attenuation of IL-6 and CRP provides a mechanistic explanation for some ERAS benefits. Reduced fasting, maintenance of normothermia, avoidance of fluid overload, effective regional or multimodal analgesia, reduced opioid exposure, early nutrition, and minimally invasive surgery may collectively moderate the stress response.

However, the clinical significance of modest biomarker differences remains uncertain. Future trials should prespecify biomarker sampling times, report operative approach and complications, and evaluate whether biomarker changes correlate with functional recovery, infection, or major morbidity.

Importance of Protocol Compliance

ERAS effectiveness depends on implementation fidelity. Simply labelling perioperative care as “ERAS” does not ensure adherence to its core elements.

Preoperative education supports realistic expectations and active patient participation. Multimodal analgesia facilitates mobilisation and oral intake. Rational fluid therapy reduces tissue oedema and ileus. Early catheter removal reduces infection and promotes mobility. Early nutrition helps maintain intestinal integrity and muscle function.

Current ERAS guidelines therefore emphasise multidisciplinary care, standardised pathways, continuous audit, and measurement of compliance.

Clinical Implications

Hospitals providing elective gastrointestinal surgery should consider procedure-specific ERAS pathways supported by:

1. Multidisciplinary leadership involving surgeons, anaesthesiologists, nurses, dietitians, physiotherapists, and pharmacists.
2. Preoperative education, nutritional screening, and correction of anaemia where feasible.
3. Evidence-based antimicrobial and thromboprophylaxis.
4. Avoidance of prolonged fasting and unnecessary bowel preparation.
5. Minimally invasive surgery when clinically appropriate.
6. Maintenance of normothermia, euvolaemia, and glucose control.
7. Multimodal opioid-sparing analgesia.
8. Early oral nutrition and mobilisation.
9. Early removal of unnecessary tubes and catheters.
10. Objective discharge criteria and structured post-discharge support.
11. Continuous audit of adherence, complications, SSI, readmission, and patient-reported outcomes.

Strengths

This review considered ERAS through multiple complementary domains rather than focusing only on hospital stay. It integrated quality of life, infection, inflammatory biomarkers, gastrointestinal recovery, morbidity, readmission, and mortality.

The review also considered different gastrointestinal procedures, allowing assessment of whether ERAS benefits were consistent across colorectal, gastric, hepatic, oesophageal, and pancreatic surgery.

Limitations

The main limitation of the manuscript is that the numerical PRISMA pathway is provisional and requires confirmation against the original database exports and screening log.

The included evidence was heterogeneous. ERAS pathways differed in the number and type of interventions, and conventional care evolved over time. Study populations ranged from relatively low-risk laparoscopic patients to individuals undergoing complex open pancreatic or hepatic surgery.

Several studies were single-centre and had limited sample sizes. Blinding was rarely feasible. Observational studies were susceptible to confounding by surgical approach and temporal improvements in care.

Quality-of-life instruments and assessment times were not standardised. SSI definitions and surveillance periods varied, while inflammatory biomarkers were collected at different postoperative time points.

A new meta-analysis was not performed because the included studies did not provide sufficiently homogeneous data across the four primary outcome domains.

Recommendations for Future Research

Future trials should:

1. Use procedure-specific and clearly defined ERAS protocols.
2. Report adherence to every major pathway component.
3. Use accepted SSI definitions and at least 30-day surveillance.
4. Include validated patient-reported outcome instruments.
5. Measure quality of life at discharge, 30 days, 90 days, and longer-term follow-up.
6. Prespecify CRP, IL-6, and other biomarker sampling times.
7. Report complications using standard classifications such as Clavien–Dindo.
8. Distinguish index hospital stay from composite stay including readmissions.
9. Report reoperation, mortality, healthcare cost, caregiver burden, and return to normal activity.
10. Include older, frail, malnourished, and high-risk patients.
11. Evaluate implementation and compliance in low- and middle-income healthcare settings.

CONCLUSION

Enhanced Recovery After Surgery protocols improve recovery following elective gastrointestinal surgery. The most consistent benefits are shorter hospital stay, earlier return of gastrointestinal function, faster functional recovery, and lower overall morbidity.

Available evidence suggests that ERAS does not adversely affect postoperative quality of life and may improve early patient-reported recovery. ERAS may also reduce surgical site infection, although its effect is influenced by surgical approach, infection-prevention practices, and protocol adherence.

Lower postoperative CRP and IL-6 concentrations indicate attenuation of the inflammatory stress response, but biomarker findings remain heterogeneous and should be interpreted alongside clinical outcomes.

ERAS does not appear to consistently increase readmission, reoperation, or mortality when implemented with appropriate patient selection, objective discharge criteria, and reliable follow-up. Its successful use requires multidisciplinary coordination, high adherence, continuous audit, and patient-centred post-discharge care.

Declarations

Ethical Approval: Ethical approval was not required because this systematic review analysed previously published literature and did not involve direct participation of human subjects.

Funding: No external funding was received for this study.

Conflict of Interest: The authors declare that they have no conflicts of interest.

REFERENCES

1. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
2. Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. *Am J Surg*. 2002;183(6):630–641.
3. Ljungqvist O, Scott M, Fearon KC. Enhanced Recovery After Surgery: a review. *JAMA Surg*. 2017;152(3):292–298.
4. Gustafsson UO, Scott MJ, Hubner M, et al. Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery Society recommendations: 2018. *World J Surg*. 2019;43(3):659–695.
5. Gustafsson UO, et al. Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery Society recommendations 2025. *Surgery*. 2025;184:109397.
6. Mortensen K, Nilsson M, Slim K, et al. Consensus guidelines for enhanced recovery after gastrectomy. *Br J Surg*. 2014;101(10):1209–1229.
7. Low DE, Allum W, De Manzoni G, et al. Guidelines for perioperative care in esophagectomy: Enhanced Recovery After Surgery Society recommendations. *World J Surg*. 2019;43(2):299–330.
8. Melloul E, Lassen K, Roulin D, et al. Guidelines for perioperative care for pancreatoduodenectomy: Enhanced Recovery After Surgery recommendations 2019. *World J Surg*. 2020;44(6):2056–2084.
9. Joliat GR, Kobayashi K, Hasegawa K, et al. Guidelines for perioperative care for liver surgery: Enhanced Recovery After Surgery Society recommendations 2022. *World J Surg*. 2023;47(1):11–34.
10. Sauro KM, Smith C, Ibadin S, et al. Enhanced Recovery After Surgery guidelines and hospital length of stay, readmission, complications, and mortality: a meta-analysis of randomized clinical trials. *JAMA Netw Open*. 2024;7.
11. Adamina M, Kehlet H, Tomlinson GA, Senagore AJ, Delaney CP. Enhanced recovery pathways optimise health outcomes and resource utilisation: a meta-analysis of randomised controlled trials in colorectal surgery. *Surgery*. 2011;149(6):830–840.
12. Greco M, Capretti G, Beretta L, et al. Enhanced recovery programme in colorectal surgery: a meta-analysis of randomised controlled trials. *World J Surg*. 2014;38(6):1531–1541.

13. Grant MC, Yang D, Wu CL, Makary MA, Wick EC. Impact of Enhanced Recovery After Surgery and fast-track surgery pathways on healthcare-associated infections. *Ann Surg.* 2017;265(1):68–79.
14. Jones C, Kelliher L, Dickinson M, et al. Randomized clinical trial on enhanced recovery versus standard care following open liver resection. *Br J Surg.* 2013;100(8):1015–1024.
15. Jia Y, Jin G, Guo S, et al. Fast-track surgery decreases the incidence of postoperative delirium and other complications in elderly patients with colorectal carcinoma. *Langenbecks Arch Surg.* 2014;399(1):77–84.
16. He F, Lin X, Xie F, Huang Y, Yuan R. The effect of enhanced recovery programme for patients undergoing laparoscopic hepatectomy. *Surg Endosc.* 2015;29:3640–3648.
17. Wang H, Zhu D, Liang L, et al. Short-term quality of life in patients undergoing colonic surgery using an enhanced recovery after surgery programme versus conventional perioperative management. *Qual Life Res.* 2015;24(11):2663–2670.
18. Liang X, Ying H, Wang H, et al. Enhanced recovery care versus traditional care after laparoscopic liver resections: a randomized controlled trial. *Surg Endosc.* 2018;32(6):2746–2757.
19. Gronnier C, Grass F, Petignat C, et al. Influence of an enhanced recovery pathway on surgical site infection after colonic surgery. *Gastroenterol Res Pract.* 2017;2017:1–8.
20. Takagi K, Yoshida R, Yagi T, et al. Effect of an enhanced recovery after surgery protocol in patients undergoing pancreaticoduodenectomy: a randomized controlled trial. *Clin Nutr.* 2019;38(1):174–181.
21. Hwang DW, Kim HJ, Lee JH, et al. Effect of Enhanced Recovery After Surgery on pancreaticoduodenectomy: a randomized controlled trial. *J Hepatobiliary Pancreat Sci.* 2019;26(8):360–369.
22. Takchi R, Cos H, Williams GA, et al. Enhanced recovery pathway after open pancreaticoduodenectomy reduces postoperative length of stay without reducing composite length of stay. *HPB.* 2022;24(1):65–71.
23. Wang B, Wang Y, Huang J, et al. Impact of Enhanced Recovery After Surgery on surgical site infection and postoperative recovery outcomes: a retrospective study of 1,276 cases. *Sci Rep.* 2024;14:24389.
24. Li D, Jensen CC. Patient satisfaction and quality of life with Enhanced Recovery protocols. *Clin Colon Rectal Surg.* 2019;32(2):138–144.
25. Ding J, Sun B, Song P, et al. The application of Enhanced Recovery After Surgery for patients undergoing gastrectomy: a systematic review and meta-analysis. *Oncotarget.* 2017;8:75699–75711.
26. Wang LH, Zhu RF, Gao C, Wang SL, Shen LZ. Application of Enhanced Recovery After Surgery after gastric cancer surgery: an updated meta-analysis. *World J Gastroenterol.* 2018;24(14):1562–1578.
27. Wee IJY, Syn NL, Shabbir A, Kim G, So JBY. Enhanced recovery versus conventional care in gastric cancer surgery: a meta-analysis of randomized and non-randomized controlled trials. *Gastric Cancer.* 2019;22:423–434.
28. Noba L, Rodgers S, Chandler C, et al. Enhanced Recovery After Surgery reduces hospital costs and improves clinical outcomes in liver surgery: a systematic review and meta-analysis. *J Gastrointest Surg.* 2020;24(4):918–932.
29. Wang XY, Cai JP, Huang CS, Huang XT, Yin XY. Impact of Enhanced Recovery After Surgery on pancreaticoduodenectomy: a meta-analysis. *HPB.* 2020;22:1371–1380.
30. Watt DG, McSorley ST, Horgan PG, McMillan DC. Enhanced Recovery After Surgery: which components, if any, impact on the systemic inflammatory response following colorectal surgery? *Medicine.* 2015;94(36):e1286.