Patient Safety in Surgery

REVIEW

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Impact of "Enhanced Recovery After Surgery" (ERAS) protocols vs. traditional perioperative care on patient outcomes after colorectal surgery: a systematic review

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Abstract

Background Colorectal surgery is associated with a high risk of postoperative complications, including technical complications, surgical site infections, and other adverse events affecting patient safety and overall patient experience. "Enhanced Recovery After Surgery" (ERAS) is considered a new standard of care for streamlining the perioperative care of surgical patients with the goal of minimizing complications and optimizing timely patient recovery after surgery. This systematic review was designed to investigate the evidence-based literature pertinent to comparing patient outcomes after ERAS versus conventional perioperative care.

Methods This systematic review evaluates the performance of ERAS protocols against conventional care in colorectal surgery, focusing on various postoperative outcome measures. An extensive search was conducted across multiple electronic databases and registers from July 2 to July 5, 2024, complemented by citation searching on November 30, 2024. This approach led to the identification of 11 randomized controlled trials (RCTs) from the past decade, involving 1,476 adult participants. To ensure methodological rigor and transparency, the review followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines and was registered with PROSPERO (CRD42024583074).

Results The implementation of ERAS protocols resulted in a notable decrease in hospital stay duration compared to conventional care, with reductions varying between 3 and 8 days across studies. ERAS patients also had faster gastrointestinal recovery, including quicker times to bowel movement, defecation, and resumption of normal diet. Furthermore, patients in ERAS groups showed notably reduced postoperative complications and opioid consumption, with patients experiencing lower pain scores on the Visual Analogue Scale (VAS) and reduced reliance on opioids. Additionally, nutritional recovery in ERAS patients was enhanced, with elevated albumin and total protein levels, alongside decreased inflammatory markers and improved immune function.

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Conclusion This systematic review provides compelling evidence supporting the integration of ERAS protocols into standard colorectal surgical practices. Future studies should aim to explore the variations in ERAS implementation, pinpoint the most impactful elements of ERAS, and work towards personalizing and standardizing these protocols across clinical settings. Additionally, evaluating long-term outcomes will help refine ERAS strategies, ensuring their enduring impact on patient recovery.

Keywords Enhanced recovery after surgery, ERAS protocol, Colorectal surgery, Postoperative outcomes, Systematic review, Patient satisfaction

Introduction

Colorectal surgery, driven by the rising incidence of colorectal cancer, is one of the most commonly performed procedures worldwide, with over 600,000 conducted annually in the United States alone [1]. These surgeries are accompanied by a considerable morbidity rate, which varies between 24.6% and 48.3% [2].

To address these challenges, the Enhanced Recovery After Surgery (ERAS) protocol was first proposed by Professor Henrik Kehlet in the late 1990s, aiming to optimize recovery outcomes specifically for colorectal surgery patients [3]. Originally designed for colorectal surgery, the ERAS principles have since been successfully and effectively adopted in various other surgical disciplines beyond gastrointestinal surgery [4].

ERAS represents a comprehensive approach to perioperative care aimed at minimizing surgical stress and promoting rapid postoperative recovery [5]. This paradigm shift in perioperative management focuses on a standardized package of care, encompassing the entire patient journey from the preoperative, intraoperative, and postoperative phases [6]. The success of ERAS programs relies on the collaborative efforts of a multidisciplinary team, comprising surgeons, anesthesiologists, nurses, and other allied healthcare professionals [6].

ERAS programs have been associated with notable improvements in patient outcomes and cost-effectiveness, demonstrating their role in value-based care [7]. In comparison to conventional perioperative management, implementation of ERAS has been linked to decreased hospital stays, fewer postoperative complications, and an earlier return to baseline functional status [8].

The global adoption of ERAS protocols has expanded significantly, demonstrating efficacy in diverse healthcare settings, including resource-limited environments and regional centers, with recent studies reporting faster return to baseline functional status, shorter hospital stays, and fewer complications in these settings as well [9–11].

While ERAS has shown benefits across various surgical disciplines, its impact on outcomes following colorectal surgery continues to be explored [12]. This systematic review compares ERAS protocols with conventional care methods, focusing on patient outcomes in colorectal surgery and addressing gaps in the current literature, particularly in the areas of elderly patient outcomes, nutritional and immune recovery, and individual recovery milestones, with the goal of delivering a comprehensive analysis of the impact of ERAS protocols on various aspects of postoperative recovery within this surgical domain.

Methods

Protocol registration

To ensure our review followed a clear and structured plan, we registered the protocol with PROSPERO (registration number: CRD42024583074). This registration confirms adherence to a pre-defined methodology and supports the transparency and reproducibility of our research. For further details on the review's design and methodology, please refer to the published protocol [13].

Search strategy

Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines [14], an extensive search across several reputable electronic databases and registers was conducted from July 2 to July 5, 2024. This search, focused on identifying articles published within the last decade, initially retrieved 651 studies for consideration. The search strategy incorporated a combination of Medical Subject Headings (MeSH) terms and carefully selected keywords related to our research topic. A detailed account of the search strategy employed for each database (PubMed/MEDLINE, ScienceDirect, Cochrane Central Register of Controlled Trials [CENTRAL], Europe PMC (Europe PubMed Central), EBSCO (Elton B. Stephens Company) Open Dissertations, and ClinicalTrials.gov) is presented in Table 1 below. This approach was customized to fit the specific syntax requirements of each database. Additionally, to ensure a comprehensive review, citation searching was performed. This process was conducted on November 30, 2024, and led to the identification of 8 additional studies.

Selection of studies

A total of 651 records were initially identified through the comprehensive database search. After excluding 106 duplicates and 361 studies deemed irrelevant to the topic, 186 records remained for screening by title and abstract. Subsequently, 14 full-text articles were obtained

Table 1 Search Strategy

Search Strategy	Databases/Registers	Number of studies before and after filters
(("Enhanced Recovery After Surgery" OR ERAS OR "Fast-track surgery" OR "Enhanced Recovery After Surgery"[Mesh]) AND ("Colorectal Surgery" OR "Colorectal Resection" OR "Colorectal Cancer Surgery" OR "Colorectal operation" OR "Colonic Surgery" OR "Colon Surgery" OR "Colon Resection" OR Colectomy OR Hemicolectomy OR Sigmoidectomy OR "Rectal Surgery" OR "Rectum Surgery" OR "Rectal Resection" OR "Rectum Resection" OR Proctectomy OR "Anterior Resection" OR "Abdominoperineal resection" OR "Low anterior resection" OR "Total mesorectal excision" OR "Surgery for Colorectal Cancer" OR "Colorectal cancer resection" OR "Rectal Cancer Surgery" OR "Colon Cancer Surgery" OR Colo* OR Rect* OR Proct* OR "Large Bowel Surgery" OR "Large Intestine Surgery" OR "Diverticulitis Surgery" OR "Resection of the Colon" OR "Resection of the Rectum" OR "Large Intestine Resection" OR "Colorectal Surgery"[Majr])) AND ("Postoperative outcome*" OR "Postoperative complication*" OR "Postoperative result*" OR "Postoperative recover*" OR "Surgical recover*" OR "Surgery recover*" OR "Post-surgical outcome*" OR "Recovery of function" OR "Patient outcome*" OR "Patient satisfaction" OR "Length of hospital stay" OR "Length of stay" OR "Hospital stay" OR "Recovery time" OR "Quality of life" OR (("Postoperative Complications"[Mesh] OR "Postoperative Cognitive Complications"[Mesh]) OR "Length of Stay"[Majr]) OR "Patient Outcome Assessment"[Mesh] OR "Patient Reported Outcome Measures"[Mesh] OR "Treatment Outcome"[Mesh] OR "Patient Preference"[Mesh])	PubMed/Medline	BEFORE FILTERS: 1378 AFTER FILTERS: 186 FILTERS USED: Full text Studies: Clinical Study, Clinical Trial, Multicenter Study, Comparative Study, RCT Adults (19 + years) Humans English Last 10 years
IDSearchHits #1"Enhanced Recovery After Surgery" OR ERAS OR "Fast-track surgery"2187 #2MeSH descriptor: [Enhanced Recovery After Surgery] explode all trees180 #3#1 OR #22,187 #4"Colorectal Surgery" OR "Colorectal Resection" OR "Colorectal Cancer Surgery" OR "Colorectal operation" OR "Colonic Surgery" OR "Colon Surgery" OR "Colon Resection" OR Colectomy OR Hemicolectomy OR Sigmoidectomy OR "Rectal Surgery" OR "Rectum Surgery" OR "Rectal Resection" OR "Rectum Resection" OR Proctectomy OR "Anterior Resection" OR "Abdominoperineal resection" OR "Low anterior resection" OR "Total mesorectal excision" OR "Surgery for Colorectal Cancer" OR "Colorectal cancer resection" OR "Rectal Cancer Surgery" OR "Colon Cancer Surgery" OR Colo OR Rect OR Proct OR "Large Bowel Surgery" OR "Large Intestine Surgery" OR "Diverticulitis Surgery" OR "Resection of the Colon" OR "Resection of the Rectum" OR "Large Intestine Resection"9308 #5MeSH descriptor: [Colorectal Surgery] explode all trees357 #6#4 OR #59,308 #7(Postoperative NEXT outcome*) OR (Postoperative NEXT complication*) OR (Postoperative NEXT result*) OR (Postoperative NEXT recover*) OR (Surgical NEXT recover*) OR (Surgery NEXT recover*) OR (Postsurgical NEXT outcome*) OR "Recovery of function" OR (Patient NEXT outcome*) OR "Patient outcome assessment" OR (Treatment NEXT outcome*) OR "Patient satisfaction" OR "Length of hospital stay" OR "Length of stay" OR "Hospital stay" OR "Recovery time" OR "Quality of life"469,700 #8MeSH descriptor: [Postoperative Complications] this term only23593 #9MeSH descriptor: [Length of Stay] explode all trees9572 #10#7 OR #8 OR #9,469,700 #11#10 AND #6 AND #3320	Cochrane Library (CENTRAL)	BEFORE FILTERS: 320 AFTER FILTERS: 289 FILTERS USED: Study: Trials Language: English
("Enhanced Recovery After Surgery" OR "ERAS" OR "Fast-track surgery" AND ""Colorectal Surgery"" OR ""Colorectal Resection"" OR ""Colorectal Cancer Surgery"" OR ""Colorectal operation"" OR ""Colonic Surgery"" OR ""Colon Surgery"" OR ""Colon Resection"" OR "Colectomy" OR "Hemicolectomy" OR "Sigmoidectomy" OR ""Rectal Surgery"" OR ""Rectum Surgery"" OR ""Rectal Resection"" OR ""Rectum Resection"" OR "Proctectomy" OR ""Anterior Resection"" OR ""Abdominoperineal resection"" OR ""Low anterior resection"" OR ""Total mesorectal excision"" OR ""Surgery for Colorectal Cancer"" OR ""Colorectal cancer resection"" OR ""Rectal Cancer Surgery"" OR ""Colon Cancer Surgery"" OR "Colo*" OR "Rect*" OR "Proct*" OR ""Large Bowel Surgery"" OR ""Large Intestine Surgery"" OR ""Diverticulitis Surgery"" OR ""Resection of the Colon"" OR ""Resection of the Rectum"" OR ""Large Intestine Resection"") AND (PUB_TYPE:"Clinical Trial" OR PUB_TYPE:"Comparative Study" OR PUB_TYPE:"Controlled Clinical Trial" OR PUB_TYPE:"Multicenter Study" OR PUB_TYPE:"Randomized Controlled Trial") AND (LANG:"eng" OR LANG:"en" OR LANG:"us") AND (((SRC: MED OR SRC: PMC OR SRC: AGR OR SRC: CBA) NOT (PUB_TYPE:"Review"))) AND (HAS_FT: Y OR (HAS_FREE_FULLTEXT: Y))	Europe PMC (Europe PubMed Central)	BEFORE FILTERS: 1318 AFTER FILTERS: 132 FILTERS USED: Full text English Type: Research article Studies: Clinical Trial, Multicenter Study, Comparative Study, Controlled Clinical Trial, RCT Last 10 years

Table 1 (continued)

Search Strategy	Databases/Registers	Number of studies before and after filters
("Enhanced Recovery After Surgery" OR ERAS OR "fast-track surgery") AND ("colorectal surgery" OR "colorectal resection" OR "colon surgery" OR "rectal surgery") AND ("postoperative outcomes" OR "postoperative complications")	Science Direct	BEFORE FILTERS: 73 AFTER FILTERS: 37 FILTERS USED: English Research articles Last 10 years (Search strategy in title/abstract only - not all fields)
("Enhanced Recovery After Surgery" OR ERAS OR "Fast-track surgery") AND ("Colorectal Surgery" OR "Colorectal Resection" OR "Colorectal Cancer Surgery" OR "Colorectal operation" OR "Colonic Surgery" OR "Colon Surgery" OR "Colon Resection" OR Colectomy OR Hemicolectomy OR Sigmoidectomy OR "Rectal Surgery" OR "Rectum Surgery" OR "Rectal Resection" OR "Rectum Resection" OR Proctectomy OR "Anterior Resection" OR "Abdominoperineal resection" OR "Low anterior resection" OR "Total mesorectal excision" OR "Surgery for Colorectal Cancer" OR "Colorectal cancer resection" OR "Rectal Cancer Surgery" OR "Colon Cancer Surgery" OR Colo* OR Rect* OR Proct* OR "Large Bowel Surgery" OR "Large Intestine Surgery" OR "Diverticulitis Surgery" OR "Resection of the Colon" OR "Resection of the Rectum" OR "Large Intestine Resection") AND ("Postoperative outcome*" OR "Postoperative complication*" OR "Postoperative result*" OR "Postoperative recover*" OR "Surgical recover*" OR "Surgery recover*" OR "Post-surgical outcome*" OR "Recovery of function" OR "Patient outcome*" OR "Patient satisfaction" OR "Length of hospital stay" OR "Length of stay" OR "Hospital stay" OR "Recovery time" OR "Quality of life") | Completed studies | Adult (18–64), Older adult (65+) | Interventional, Observational studies	Clinicaltrials.gov	BEFORE FILTERS: 18 AFTER FILTERS: 2 FILTERS USED: Adult (18+) Completed study Interventional study
("Enhanced Recovery After Surgery" OR "ERAS" OR "Fast-track surgery") AND ("Colorectal Surgery" OR "Colorectal Resection" OR "Colorectal Cancer Surgery" OR "Colorectal operation" OR "Colonic Surgery" OR "Colon Surgery" OR "Colon Resection" OR Colectomy OR Hemicolectomy OR Sigmoidectomy OR "Rectal Surgery" OR "Rectum Surgery" OR "Rectal Resection" OR "Rectum Resection" OR Proctectomy OR "Anterior Resection" OR "Abdominoperineal resection" OR "Low anterior resection" OR "Total mesorectal excision" OR "Surgery for Colorectal Cancer" OR "Colorectal cancer resection" OR "Rectal Cancer Surgery" OR "Colon Cancer Surgery" OR Colo* OR Rect* OR Proct* OR "Large Bowel Surgery" OR "Large Intestine Surgery" OR "Diverticulitis Surgery" OR "Resection of the Colon" OR "Resection of the Rectum" OR "Large Intestine Resection") AND ("Postoperative outcome*" OR "Postoperative complication*" OR "Postoperative result*" OR "Postoperative recover*" OR "Surgical recover*" OR "Surgery recover*" OR "Post-surgical outcome*" OR "Recovery of function" OR "Patient outcome*" OR "Patient satisfaction" OR "Length of hospital stay" OR "Length of stay" OR "Hospital stay" OR "Recovery time" OR "Quality of life")	EBSCO (Elton B. Stephens Company) - Open Dissertations	BEFORE FILTERS: 9 AFTER FILTERS: 7 FILTERS USED: English Last 10 years

for in-depth evaluation, as they satisfied the predefined inclusion and exclusion criteria outlined in Table 2. Of these, 5 studies were found to meet the inclusion criteria. As part of the study selection process, redundant and duplicate publications were carefully assessed and excluded. Two studies were identified as reporting identical datasets and were removed to avoid bias and ensure the integrity of the review. The issue of redundant publications has been widely discussed in the literature, with studies highlighting their potential to skew evidence-based medicine, inflate publication records, and distort scientific data, posing a potential threat to patient safety [15]. Additionally, 8 studies were identified through citation searching. After assessing the eligibility of the 8 studies identified through citation searching, 6 were included in the final review, while 2 were excluded: one due to not being a randomized controlled trial, and the other because of a high risk of bias. This process is visually depicted in the PRISMA flow diagram (Fig. 1) under the results section, which outlines the stages of study selection, from initial identification through to final inclusion, including the reasons for exclusions at each stage. After thorough full-text evaluation, 11 studies fulfilled our inclusion criteria and were incorporated into the final review.

Data extraction

A standardized form for data extraction was designed to systematically collect pertinent information from the selected studies. Relevant study characteristics, patient

Table 2 Eligibility criteria for inclusion of studies

CRITERIA	INCLUSION	EXCLUSION
Population	Adults (18 years and above) undergoing colorectal surgery	Pediatric patients (patients under the age of 18 years), Patients undergoing non-colorectal surgery
Intervention	Implementation of standardized Enhanced Recovery After Surgery (ERAS) protocols, including preoperative optimization (e.g., nutritional assessments, carbohydrate loading), intraoperative care (e.g., minimally invasive techniques, optimal fluid management), and postoperative care (e.g., early mobilization, multimodal pain management, early oral feeding).	Studies not adhering to standardized ERAS protocols or lacking clear implementation details
Comparison	Traditional or standard of care without implementation of the ERAS protocols	Comparisons with enhanced or alternative recovery protocols, mixed care pathways, or unclear definitions of standard care
Outcome	Studies reporting postoperative outcomes, including hospital stay durations, readmission rates, complication and mortality rates, gastrointestinal recovery milestones (e.g., first flatus, defecation, bowel sounds), patient satisfaction and well-being, nutritional recovery (e.g., early enteral feeding), and markers of inflammation and immune function.	Studies that do not report on the postoperative outcomes relevant to the review
Study Design	Randomized Controlled Trials (RCTs) only	Non-RCTs, including observational studies (cohort, case-control, cross-sectional), case reports, case series, reviews, editorials, commentaries, preprints, animal or laboratory studies, and studies with low methodological quality (lacking clear controls or proper statistical analysis)
Year of Publication	Studies published in the last 10 years only (July 2014-July 2024)	Studies published outside this time-frame (before July 2014 and after July 2024)
Language	Studies published in English only	All foreign language publications (studies published in languages other than English)

demographics, intervention details, outcome measures, and important results were extracted for analysis. Two independent reviewers conducted the data extraction process, with any disagreements resolved through discussion or by consulting a third reviewer.

Screening and risk of bias assessment

A thorough screening process was implemented, using the Rayyan app [16] for preliminary record management. The initial screening process involved assessing titles and abstracts of studies retrieved from multiple databases and registers by two independent reviewers. Irrelevant studies and duplicates were removed, followed by a detailed evaluation of the remaining articles to ensure they satisfied our inclusion criteria. The quality of the included studies was evaluated using the updated Cochrane Risk of Bias 2 (ROB 2) tool [17], tailored specifically for randomized controlled trials. Studies were then categorized as having low, high, or some concerns regarding bias. Studies identified with a high risk of bias were excluded from the review.

Data synthesis

The extracted data were analyzed with consideration of each study's design and reported outcome measures. Given the expected heterogeneity in study methodologies and designs, a narrative synthesis method was employed to integrate the findings effectively.

Results

The comprehensive search strategy and study selection process, outlined in the Methods section, initially yielded 651 records from multiple databases and registers, with an additional 8 records identified through citation searching. After applying the inclusion criteria, 11 studies were selected for inclusion in the final analysis. The PRISMA flowchart (Fig. 1) below visually depicts the study selection process in detail.

Assessment of risk of bias

The Cochrane Risk of Bias 2 (RoB 2) tool [17] was utilized to evaluate the risk of bias in the eleven RCTs included in our review. Table 3 below presents the detailed Cochrane RoB 2 assessments for the eleven RCTs included in the study. Each trial was evaluated independently to ensure a thorough evaluation of methodological quality and to provide insights into the reliability of the study findings.

Of the eleven included RCTs, five studies - Forsmo et al. (2016) [18] and Bednarski et al. (2019) [19], Shetiwy et al. (2017) [20], Taupyk et al. (2015) [21] and Ostermann et al. (2019) [22] exhibited some concerns regarding the blinding of outcome assessors and/or lack of detailed randomization information when assessed using the RoB 2 tool [17]. Nevertheless, all studies demonstrated well-designed interventions, consistent implementation, and complete data for the primary outcome. The remaining studies were assessed as having good overall quality. This

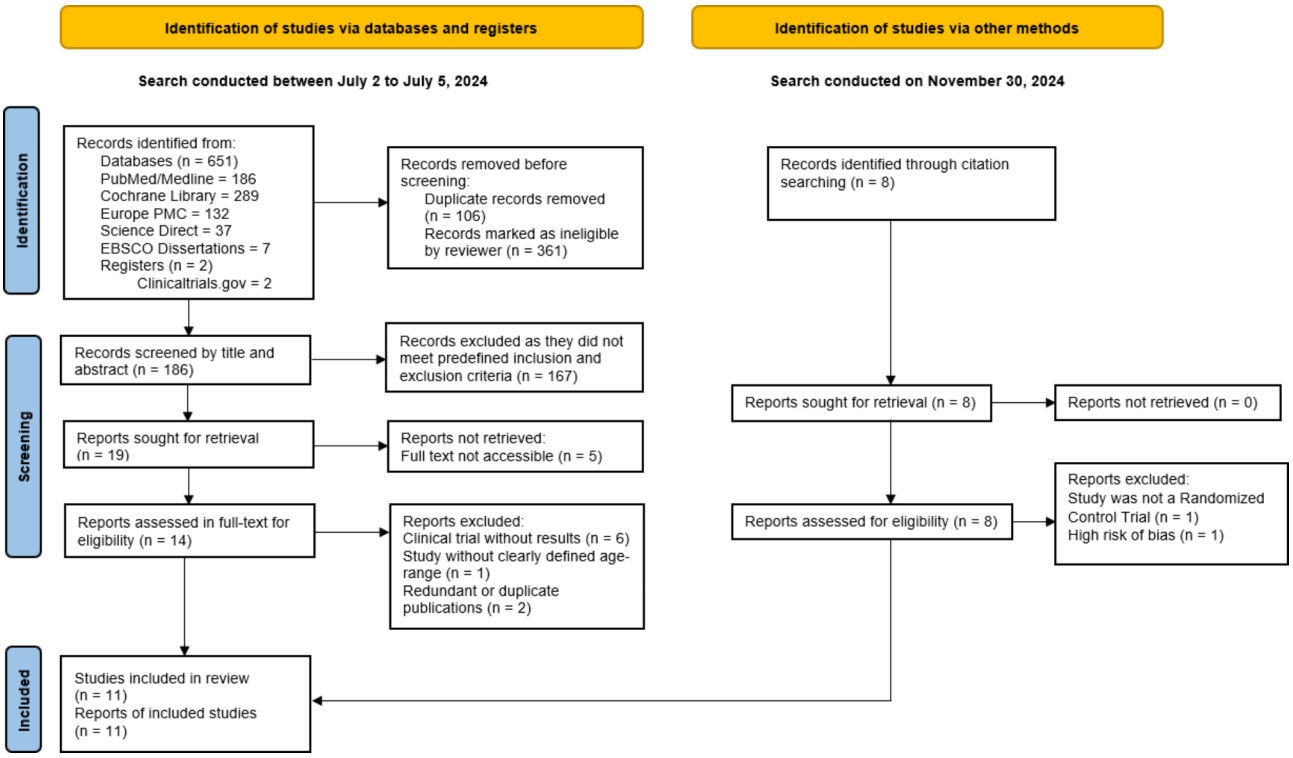

Fig. 1 PRISMA flowchart depicting the study selection process

Table 3 Risk of Bias Assessment of Randomized clinical trials: Cochrane Risk-of-Bias Tool (RoB 2)

Study by/Year of Publication	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall
Forsmo et al. (2016) [18]	+	+	+	!	+	!
Bednarski et al. (2019) [19]	+	+	+	!	+	!
Forsmo et al. (2016) [23]	+	+	+	+	+	+
Li et al. (2019) [24]	+	+	+	+	+	+
ElRahman et al. (2020) [25]	+	+	+	+	+	+
Shetiwy et al. (2017) [20]	+	!	+	!	+	!
Taupyk et al. (2015) [21]	+	+	+	!	+	!
Mari et al. (2016) [26]	+	+	+	+	+	+
Feng et al. (2016) [27]	+	+	+	+	+	+
Ostermann et al. (2019) [22]	+	!	+	+	+	!
Iqbal et al. (2024) [28]	+	+	+	+	+	+

Note: RoB 2 domains: (1) Randomization process, (2) Deviations from intended interventions, (3) Missing outcome data, (4) Measurement of outcome, (5) Selection of reported result

+: low risk of bias; -: high risk of bias; !: some concerns about risk of bias

overall assessment justified the inclusion of all eleven studies in the final analysis.

Characteristics of the included studies

This systematic review integrates findings from eleven RCTs that evaluate ERAS protocols against conventional care in colorectal surgery. The studies involved adult patients (18 years and older) undergoing colorectal surgical procedures. Sample sizes across the studies ranged from a minimum of 30 to a maximum of 324 patients, with 1476 participants across all eleven RCTs.

The review explores how ERAS protocols influence patient recovery and postoperative outcomes following colorectal surgery, contrasting these effects with conventional care approaches. The findings from this review suggest that the adoption of ERAS protocols is associated with reduced hospital stays, expedited recovery timelines, and a reduced rate of adverse events in the post-operative period. In addition, ERAS protocols were associated with lower opioid use, reflecting better pain management strategies. Moreover, patients in the ERAS group showed lower inflammatory markers and

Table 4 Summary of included studies

Author/Year	Aim of study	Sample size/Age	Participants Characteristics	Key findings
Forsmo et al. (2016) [18]	To compare the outcomes of patients undergoing elective colorectal resection with a multimodal ERAS approach emphasizing counseling against those receiving conventional standard care	324 (18 + years)	Adult patients eligible for open or laparoscopic colorectal resection – randomized to an ERAS programme or standard care	Hospital Stay: ERAS patients had a shorter stay (median 5 days vs. median 8 days; $P = 0.001$). Other outcomes: No differences in morbidity, reoperations, readmissions, or 30-day mortality. Nutrition & Inflammation: Similar enteral nutrition tolerance and inflammatory response in both groups, as indicated by postoperative C-reactive protein levels.
Bednarski et al. (2019) [19]	To assess if combining MIS, ERP, and a structured telemedicine program (TeleRecovery) could reduce the total 30-day LOS by 50%	30 (18–80 years)	English-speaking adult patients undergoing curative surgery for colon or rectal cancer - randomized into experimental and control groups.	The RecoverMI approach, integrating MIS, ERAS, and TeleRecovery, significantly reduced 30-day and index length of stay (LOS) after colorectal cancer resection ($p < 0.05$) compared to controls. While the control group's 30-day LOS was just over 2 days, the RecoverMI group achieved a further reduction ($p < 0.05$). Postoperative pain scores were slightly higher in the RecoverMI arm, likely due to earlier discharge. There were no significant differences in readmissions or adverse events ($p > 0.05$)
Forsmo et al. (2016) [23]	To evaluate the effectiveness of an ERAS program with specialized ERAS and stoma nurse specialists in reducing hospital stays, readmissions, stoma-related complications, and improving HRQoL compared to standard stoma education and care.	122 (18 + years)	Adult patients set to undergo laparoscopic or open colorectal resection with a planned stoma - equally divided into 2 groups: ERAS program with extended stoma education and Standard care with current stoma education	Hospital stay: The ERAS group had a shorter stay (median 6 days) than standard care (median 9 days; $p < 0.001$). Other outcomes: No significant differences between the two groups in terms of overall morbidity, readmission rates, HRQoL, stoma-related complications, or 30-day mortality.
Li et al. (2019) [24]	To assess the clinical benefits of combining ERAS with laparoscopic techniques in radical colorectal cancer resection	200 (55–65 years)	Patients undergoing laparoscopic colorectal cancer surgery - divided equally into an ERAS group and a conventional care group	The ERAS group experienced notably shorter durations for first exhaust, first defecation, and extubation (all $P < 0.05$); Had a lower overall complication rate compared to the conventional group ($P < 0.05$); Showed significantly higher levels of albumin and total protein (both $P < 0.05$)
ElRahman et al. (2020) [25]	To evaluate and compare the effectiveness of ERP versus conventional perioperative care in elective open surgery for left-sided colonic carcinoma, focusing on hospital stay and postoperative complications	80 (27–66 years)	Adults with stage I or II left-sided colon cancer and eligible for elective resection were equally divided into two groups: Conventional Care and ERP	Compared to conventional care, the enhanced recovery group had: Significantly reduced pain (VAS: 3 vs. 4.6, $P = 0.024$) Less postoperative nausea and vomiting (17.5% vs. 37.5%, $P = 0.045$) Shorter hospital stay (5.4 vs. 7.6 days, $P < 0.001$)
Shetiwy et al. (2017) [20]	To evaluate the effectiveness of ERAS protocols in comparison to conventional recovery care in colorectal cancer patients undergoing elective laparoscopic resection, with a focus on hospital stay, recovery of gastrointestinal function, postoperative complications, and readmission rates.	70 (36–65 years)	Adult patients with colorectal cancer scheduled for elective laparoscopic colorectal surgery were randomly assigned to 2 groups: A conventional recovery group ($n = 35$) and an enhanced recovery group ($n = 35$).	Hospital Stay: ERAS group had a significantly shorter stay (4.49 days) compared to the conventional group (13.31 days) ($P < 0.001$) NGT Removal: ERAS group had faster removal of NGTs (0.77 days) compared to conventional care (3.26 days) ($P < 0.001$) Enteral Feeding: ERAS patients achieved enteral feeding sooner (1.89 days) than the conventional group (5.46 days) ($P < 0.001$) Drain Removal: Time to removal of intra-abdominal drains was significantly shorter in the ERAS group (2.94 days) versus conventional care (9.06 days) ($P < 0.001$) Complications: Fewer complications were observed in the ERAS group (25.7%) compared to the conventional group (65.7%) ($P = 0.001$) Readmission Rates: similar between both groups

Table 4 (continued)

Author/Year	Aim of study	Sample size/Age	Participants Characteristics	Key findings
Taupyk et al. (2015) [21]	To assess the effectiveness of FTS, a in improving recovery outcomes for colorectal cancer patients undergoing surgery.	70 (50–67 years)	Adult patients with colorectal cancer undergoing elective laparoscopic surgery were divided into 2 groups: 31 patients in the FTS group and 39 patients in the control group	Hospital Stay: FTS group (5.9 ± 0.8 days) vs. control group (10.9 ± 1.3 days), $P < 0.05$ Postoperative Stay: FTS group (4.3 ± 0.8 days) vs. control group (8.0 ± 1.1 days), $P < 0.05$ First Flatus Time: FTS group (1.6 ± 0.8 days) vs. control group (2.5 ± 0.9 days), $P < 0.05$ Defecation Time: FTS group (2.2 ± 0.7 days) vs. control group (4.5 ± 0.7 days), $P < 0.05$ CRP Levels: FTS group had lower postoperative CRP levels than control group, $P < 0.05$ Time to restoration of solid diet: FTS group (1.1 ± 0.3 days) vs. control group (3.6 ± 0.9 days), $P < 0.05$ Postoperative complications: No significant differences in between the groups
Mari et al. (2016) [26]	To compare immune and nutritional serum markers in patients undergoing elective colorectal laparoscopic surgery with an ERAS protocol versus standard care	140 (39–87 years)	Adult patients undergoing major colorectal laparoscopic surgery were randomized into two groups – an ERAS group and a standard care group with 70 patients in each	IL-6 levels: Lower in the ERAS group on postoperative days 1, 3, and 5 ($P < 0.05$); returned to preoperative levels by day 3 only in the ERAS group CRP levels: Lower in the ERAS group on postoperative days 1, 3, and 5 ($P < 0.05$) Cortisol and prolactin: No significant differences between groups Prealbumin: Higher in the ERAS group on day 5 ($P < 0.05$) First Flatus: Day 1.6 (ERAS) vs. 2.1 (Standard) ($P < 0.05$) Solid Meal: Day 1.5 (ERAS) vs. 3 (Standard) ($P < 0.05$) Discharge: Day 5 (ERAS) vs. 7.2 (Standard) ($P < 0.05$)
Feng et al. (2016) [27]	To study the effects of FTS on immunity and inflammation in colorectal surgery patients	230 (47–69 years)	Adult patients with histologically confirmed colorectal cancer scheduled for colorectal surgery were randomly divided into 2 groups – FTS group (116 patients) and traditional group (114 patients)	Inflammatory Markers: CRP, IL-6, and TNF-α were lower in the FTS group on POD 1, POD 4, and POD 6 ($p < 0.05$). Immune Function: IgG, IgA, C3, and C4 levels were higher in the FTS group on POD 4 and POD 6 ($p < 0.05$). Recovery Milestones: Time to first flatus, defecation, oral intake, and ambulation was shorter in the FTS group ($p < 0.05$). Complications: FTS group had fewer total complications ($p < 0.05$). Hospital Stay: No significant difference in postoperative hospital duration between groups ($p > 0.05$).
Ostermann et al. (2019) [22]	To determine the effectiveness and feasibility of ERP for elderly patients (≥ 70 years) undergoing elective colorectal surgery when compared to standard care	150 (70–91 years)	Elderly patients (70 years and older) planned for elective colorectal surgery were randomly assigned to either one of the 2 groups: ERP (75 patients) or standard care (75 patients)	Reduced postoperative morbidity: 47% reduction in morbidity (35% in ERP vs. 65% in standard care, $p = 0.0003$) Total complications significantly lower in ERP group (54 vs. 118, $p = 0.0003$) Fewer infectious complications in ERP group – reduced by 52% (13 vs. 29, $p = 0.001$) No anastomotic leaks in ERP group vs. 5 in standard care group ($p = 0.01$) Flatus returned earlier (POD 2 vs. POD 3, $p = 0.0004$); defecation occurred sooner (POD 3 vs. POD 4, $p = 0.03$) in ERP compared to standard care More nasogastric tubes removed intraoperatively in ERP (87% vs. 61%, $p = 0.0005$) with no increase in replacements for postoperative ileus. ERP patients had lower opioid consumption (19 mg vs. 32 mg, $p = 0.028$) to maintain a VAS pain score < 3
Iqbal et al. (2024) [28]	To evaluate the effectiveness of ERAS protocols compared to conventional care methods in patients undergoing elective colorectal surgery	60 (20–50 years)	Adult patients scheduled for elective colorectal surgery were divided into 2 equal groups (30 patients each) – ERAS (Group A) and conventional care (Group B)	Time to return of bowel sounds: Group A: 20.63 ± 2.66 h vs. Group B: 27.0 ± 2.07 h ($P = 0.0001$) Time to first flatus: Group A: 18.67 ± 2.38 h vs. Group B: 25.93 ± 2.88 h ($P = 0.0001$) Surgical Site Infections (SSI): Group A: 4 patients (13.33%) vs. Group B: 9 patients (30.0%) ($P = 0.1172$)

ERAS (Enhanced Recovery After Surgery), ERP (Enhanced Recovery Program), HRQoL (Health-related quality of life), Minimally Invasive Surgery (MIS), Length Of Stay (LOS), VAS (Visual analogue scale), NGT (Nasogastric Tube), FTS (Fast-Track Surgery), CRP (C-Reactive Protein), IL-6 (Interleukin-6), TNF-α (Tumor Necrosis Factor alpha), IgG (Immunoglobulin G), IgA (Immunoglobulin A), C3 (Complement Component 3), C4 (Complement Component 4)

improved immune function, further supporting the protocol's role in enhancing recovery and reducing postoperative complications.

These findings advocate for the adoption of ERAS protocols in standard colorectal surgical practice. A comprehensive overview of the results is presented in Table 4.

Discussion

This systematic review assessed the efficacy of ERAS protocols versus traditional care in colorectal surgery, concentrating on a range of patient outcomes, including hospital stay duration, postoperative complications, gastrointestinal recovery milestones, immune function, pain management and overall patient comfort. The review included eleven RCTs involving a total of 1476 participants, all of whom were adults undergoing elective colorectal procedures. The findings consistently demonstrated that ERAS protocols significantly improved patient recovery metrics, thereby supporting their integration into standard surgical practices. The studies included in this review highlighted several key similarities and differences in patient outcomes between ERAS protocols and traditional care methods.

Length of hospital stay

Multiple studies have demonstrated a substantial decrease in hospital stay durations for colorectal surgery patients managed under an ERAS pathway. For instance, Forsmo et al. (2016) found that patients in the ERAS group had a median hospital stay of 5 days compared to 8 days for those receiving standard care [18]. Similarly, Bednarski et al. (2019) reported a notable reduction in hospital stays for patients utilizing the RecoverMI approach, which integrated minimally invasive surgery with ERAS principles [19]. Shetiwy et al. (2017) further demonstrated a significantly shorter hospital stay of 4.49 days in the ERAS group compared to 13.31 days in the conventional care group [20]. Taupyk et al. (2015) and Mari et al. (2016) similarly reported reduced stays of 5.9 and 5 days, respectively, under ERAS protocols, compared to 10.9 and 7.2 days in standard care, highlighting the protocol's role in expediting recovery [21, 26]. This reduction in hospital stays not only reflects improved recovery but also has broader implications for healthcare resource utilization, potentially resulting in reduced healthcare costs and increased bed availability for other patients.

Postoperative complications and mortality

Most studies reported a reduced rate of overall postoperative complications among ERAS patients. RCTs conducted by Li et al. (2019) and Feng et al. (2016) reported fewer total complications in the ERAS groups, with both studies showing significant reductions ($p<0.05$) [24, 27]. Similarly, Shetiwy et al. (2017) reported a 40% reduction in complications in the ERAS group compared to standard care [20]. In elderly patients undergoing colorectal surgery, Ostermann et al. (2019) found that ERAS protocols reduced morbidity by 47% (35% vs. 65%, $p=0.0003$), lowered infectious complications by 52% (13 vs. 29, $p=0.001$), halved total postoperative complications (54 vs. 118, $p=0.0003$), and prevented anastomotic leaks (0 vs. 5, $p=0.01$) compared to standard care [22]. ElRahman et al. (2020) further demonstrated a significant reduction in postoperative nausea and vomiting in the ERAS group (17.5% vs. 37.5%, $p=0.045$) [25]. Additionally, Iqbal et al. (2024) reported a reduction in surgical site infections (SSIs) in ERAS patients (13.33% vs. 30.0%, $p=0.1172$), further emphasizing the role of ERAS in lowering infection rates [28]. The reduction in complications such as infections, bleeding, and thromboembolic events can be attributed to the multimodal approach of ERAS protocols, which emphasizes preoperative optimization, minimally invasive techniques, and postoperative care strategies aimed at improving immune function and enhancing recovery. The consistent improvement in postoperative outcomes associated with ERAS protocols reflect their potential to advance care for surgical patients.

Early return of gastrointestinal function

A notable advantage of ERAS protocols is the prompt restoration of gastrointestinal function after colorectal surgery, as demonstrated by several studies included in this review. Studies by Taupyk et al. (2015), Ostermann et al. (2019), Li et al. (2019), Mari et al. (2016), Feng et al. (2016), and Iqbal et al. (2024) showed significant improvements in gastrointestinal recovery milestones for individuals treated under the ERAS pathway, with faster return of bowel sounds and quicker times to first flatus, defecation, extubation, and ambulation [21, 22, 24, 26–28]. Both Shetiwy et al. (2017) and Ostermann et al. (2019) reported earlier nasogastric tube (NGT) removal in ERAS patients, with Shetiwy observing significantly faster removal (0.77 days vs. 3.26 days, $p<0.001$) and Ostermann noting a higher rate of intraoperative NGT removal (87% vs. 61%, $p=0.0005$) without an increase in replacements for postoperative ileus [20, 22]. Additionally, Shetiwy et al. found that intra-abdominal drains were removed significantly earlier in the ERAS group [20]. These observations affirm the effectiveness of ERAS protocols in expediting the recovery of gastrointestinal function.

Nutritional support

An important aspect of ERAS protocols is the emphasis on early nutritional support. Studies have shown that early enteral feeding can reduce the risk of complications

and expedite recovery. RCTs conducted by Shetiwy et al. (2017), Mari et al. (2016), Taupyk et al. (2015), and Feng et al. (2016) demonstrated expedited nutritional recovery in ERAS patients, with earlier enteral feeding (1.89 vs. 5.46 days, $p<0.001$), faster solid meal intake (1.5 vs. 3 days, $p<0.05$), quicker restoration of solid diet (1.1 ± 0.3 vs. 3.6 ± 0.9 days, $p<0.05$), and earlier oral intake ($p<0.05$), respectively, when compared to conventional care [20, 21, 26, 27]. Forsmo et al. (2016) observed comparable enteral nutrition tolerance in both ERAS and standard care groups, indicating that ERAS protocols do not compromise nutritional status despite an accelerated recovery timeline [18]. The study by Li et al. (2019) demonstrated improved nutritional status in ERAS patients, with elevated albumin and total protein levels on postoperative day seven, while Mari et al. (2016) reported significantly higher prealbumin levels on postoperative day five ($p<0.05$), further highlighting the enhanced nutritional recovery associated with ERAS protocols [24, 26].

Postoperative inflammatory markers and immune recovery

ERAS protocols have been shown to positively impact both inflammatory markers and immune function following colorectal surgery. Taupyk et al. (2015) found that CRP (C-Reactive Protein) levels were notably lower in the FTS (Fast-Track Surgery) group ($p<0.05$), reflecting reduced postoperative inflammation [21]. Similarly, Mari et al. (2016) reported significantly lower IL-6 (Interleukin-6) and CRP levels in the ERAS group on postoperative days 1, 3, and 5 ($p<0.05$), with IL-6 returning to preoperative levels by day 3 in the ERAS group [26]. Feng et al. (2016) observed similar reductions in CRP, IL-6, and TNF-α (Tumor Necrosis Factor alpha) in the FTS group on days 1, 4, and 6 ($p<0.05$), further supporting these findings [27]. Furthermore, Feng et al. noted higher levels of immune markers such as IgG (Immunoglobulin G), IgA (Immunoglobulin A), C3 (Complement Component 3) and C4 (Complement Component 4) in the ERAS group on postoperative days 4 and 6 ($p<0.05$), reflecting improved immune recovery [27].

Patient comfort and postoperative pain management

Patient comfort and effective pain control are crucial components of successful recovery after surgery. Evidence suggests that ERAS protocols improve postoperative pain management and reduce reliance on opioids. Ostermann et al. (2019) found that patients in the ERP (Enhanced Recovery Program) group had significantly lower opioid consumption (19 mg vs. 32 mg, $p=0.028$) while maintaining a Visual Analogue Scale (VAS) pain score of <3 [22]. Similarly, ElRahman et al. (2020) reported significantly reduced pain scores in ERAS patients compared to those receiving conventional care (VAS: 3 vs. 4.6, $p=0.024$) [25]. These findings highlight how implementation of ERAS protocols not only accelerates recovery but also enhances patient comfort by managing pain effectively and minimizing the need for opioids in the postoperative period.

Comparison with other evidence

To gain a deeper insight into the implications of our findings, we compared our results with existing systematic reviews and meta-analysis studies that compared ERAS with conventional care in colorectal surgery. Our cumulative analysis indicates that our findings are consistent with those reported in existing literature.

Consistent with the findings of Turaga (2023), our review shows that ERAS protocols contribute to reduced length of hospital stay, fewer complications in the postoperative period, and rapid recovery milestones [8]. Li et al. (2023) reported that the implementation of ERAS effectively reduced the rate of hospital stay durations, postoperative complications and surgical site infections, supporting its broader application in clinical settings [29]. Similarly, Zhang et al. (2023) demonstrated that the ERAS cohort showed a statistically significant reduction in the time to first flatus, shorter hospital stays, and fewer postoperative complications, including surgical site infections, compared to conventional care [30]. Azhar et al. (2021) corroborated these observations, reporting earlier resumption of gastrointestinal functions such as flatus and oral intake, shorter postoperative stays, and fewer complications in ERAS patients [31]. Although this study demonstrated that the traditional care group had fewer readmissions, the ERAS group experienced fewer total complications [31]. These findings align with results from Wang et al. (2017) and Zhao et al. (2014), who similarly reported reduced complications and shorter recovery times [32, 33]. Furthermore, the meta-analysis by Althobaiti et al. (2020) reinforced these trends, highlighting substantial reductions in hospital stays, complications, and mortality rates among ERAS patients undergoing colorectal surgery [34].

ERAS protocols have also been shown to significantly improve recovery times and reduce complication rates in emergency colorectal surgeries, although variability across studies suggests that further research is needed to refine and tailor these protocols for optimal outcomes in such high-pressure settings [35]. Sauro et al. (2024), in a meta-analysis of randomized clinical trials across various surgical specialties, found that ERAS protocols reduce hospital length of stay and complications without increasing readmissions, emphasizing their broad applicability and the need for their expansion into additional surgical fields and clinical settings worldwide [36].

While these studies highlight several positive patient outcome metrics, they typically reveal no significant differences in readmission and mortality rates between

the ERAS and conventional care groups. This may likely be attributed to the fact that most studies do not assess long-term outcomes associated with ERAS, potentially overlooking its impact on these more extended aspects of recovery.

Strengths of the review

This systematic review synthesizes data from eleven RCTs, providing a robust sample size of 1476 participants. The inclusion of multiple studies enhances the reliability and generalizability of the findings, offering a well-rounded perspective on the effectiveness of ERAS protocols compared to traditional care. In line with the PRISMA 2020 guidelines [14], this review adhered to a structured and transparent approach, enhancing its credibility and facilitating replication in future research. Additionally, the search encompassed multiple databases, ensuring a comprehensive exploration of the literature and the inclusion of studies with moderate to high quality.

The review assessed a wide range of patient outcomes, including hospital stay durations, postoperative complications, gastrointestinal recovery milestones, immune recovery, pain management and patient comfort. This multifaceted approach allows for an in-depth understanding of the impact of ERAS protocols on patient recovery following colorectal surgery, addressing various aspects of the surgical experience. By highlighting the collaborative nature of ERAS protocols, which involve a multidisciplinary team, the review underscores the importance of coordinated care in enhancing patient outcomes. This focus on teamwork reflects the current best practices in perioperative management.

Moreover, the review consistently demonstrated that ERAS protocols lead to improved recovery metrics, such as shorter hospital stays and reduced overall complications. These findings provide compelling evidence supporting the integration of ERAS protocols into standard surgical practices, potentially influencing clinical guidelines and policies.

Limitations and challenges of the review process

Despite the strengths of this review, it is not without limitations. Variability in ERAS protocol implementation and outcome measures among the included studies may hinder the ability to draw definitive conclusions and make direct comparisons. Furthermore, the limited sample sizes in some of the studies may affect the statistical strength and broader applicability of the results.

While most studies were assessed as having a low risk of bias, 5 RCTs exhibited 'some concerns' regarding the blinding of outcome assessors and/or lack of detailed randomization information when assessed using the ROB2 tool [17]. This potential for bias could influence the validity of the findings. Furthermore, many of the included studies focused primarily on short-term outcomes, such as length of hospital stay and immediate postoperative complications. There is a need for further research assessing long-term outcomes, including quality of life and functional recovery beyond the initial postoperative period.

The lack of standardized implementation of ERAS protocols across studies poses a challenge in evaluating their effectiveness uniformly. Differences in the specific components of the ERAS protocols used may contribute to variations in outcomes, complicating the interpretation of results. The review could also be influenced by publication bias, as studies with favorable results are more likely to be published compared to those with negative or inconclusive outcomes. This bias could skew the overall assessment of the effectiveness of ERAS protocols. Finally, the scope of this review is confined to studies published in English, potentially omitting relevant research published in other languages.

By addressing these strengths and limitations, the review provides a balanced perspective on the current evidence regarding ERAS protocols in colorectal surgery, highlighting both the promise and challenges of implementing these protocols in clinical practice.

Directions for future research

Future investigations into ERAS protocols for colorectal surgery should concentrate on several critical areas to deepen understanding and improve implementation. First, there is a need for large-scale multicenter trials that can provide more comprehensive data across diverse patient populations and healthcare settings. Such studies would validate existing research findings and confirm that the advantages of ERAS protocols extend to a wider range of patient demographics. Additionally, pragmatic trials, which evaluate ERAS implementation in real-world clinical settings, are essential for assessing the applicability and effectiveness of these protocols across diverse healthcare environments.

Second, long-term outcomes should be a primary focus of future investigations. While current studies often emphasize short-term recovery metrics, understanding the long-term implications of ERAS protocols such as sustained functional recovery, chronic pain, recurrence rates, and quality of life is crucial. This could involve follow-up assessments extending beyond the immediate postoperative period to capture the full impact of these protocols and provide a comprehensive understanding of patient trajectories.

Moreover, future research should focus on identifying the specific components of ERAS protocols that most significantly contribute to improved outcomes. By identifying which elements are most effective, clinicians can

tailor interventions to maximize benefits for patients. For example, elements such as early mobilization, multimodal pain management, and early enteral nutrition may have varying impacts on different patient populations. Further investigation into these components could refine protocols, ensuring they are optimized to meet the unique needs of specific groups, such as elderly patients or those with significant comorbidities.

Another important direction is the standardization of ERAS protocols. Variability in implementation can result in inconsistent outcomes; therefore, developing standardized guidelines that can be adapted to different settings while preserving core principles would be beneficial. Research on the barriers to implementing ERAS in various healthcare environments, including resource-limited settings, could provide valuable insights. A recent systematic review by Ayinde et al. (2024) identified key challenges such as training deficiencies, resource limitations, and a lack of multidisciplinary collaboration, while proposing solutions like improved team coordination and targeted education to address these issues [37]. Additionally, Lovegrove et al. (2024) highlighted the importance of clinician and facility-level education in promoting ERAS adoption, particularly among nurses, and suggest that improving ERAS knowledge could enhance implementation and patient outcomes. Their findings emphasize the need for targeted educational strategies and collaborative efforts to address barriers and facilitators in ERAS adoption [38].

Finally, exploring the integration of technology and telemedicine into ERAS protocols presents a promising avenue for future research. Investigating how digital health tools can enhance patient education, monitoring, and support during the perioperative period may improve adherence to ERAS protocols and patient outcomes. Furthermore, the use of artificial intelligence to personalize treatment plans could offer tailored interventions that better meet individual patient needs, potentially leading to enhanced recovery and outcomes.

Exploring these future research avenues will offer crucial insights for optimizing ERAS protocols in colorectal surgery and adapting them to various clinical settings, thereby advancing patient care and improving recovery strategies.

Conclusion

The findings provide compelling evidence for the efficacy of ERAS protocols in colorectal surgery, illustrating notable improvements in patient outcomes, including reduced hospital stays, faster gastrointestinal and nutritional recovery, fewer postoperative complications, enhanced immune function, and increased patient comfort. Future research should prioritize larger, multicenter trials that both standardize and personalize ERAS protocols, while also incorporating pragmatic trials to evaluate their implementation in real-world clinical settings. Investigations into long-term outcomes, including the sustained impact on patient quality of life and functional recovery, are crucial to fully understand the enduring benefits of these protocols. Addressing these gaps will enable the medical community to advance the application of ERAS protocols, ultimately leading to improved surgical care and patient recovery in the field of colorectal surgery.

Abbreviations

ERAS	Enhanced Recovery After Surgery
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
MeSH	Medical Subject Headings
RCT	Randomized Controlled Trials
RoB	Risk of Bias
VAS	Visual Analogue Scale
ERP	Enhanced Recovery Program
HRQoL	Health-Related Quality of life
MIS	Minimally Invasive Surgery
LOS	Length of Stay
NGT	Nasogastric Tube
FTS	Fast-Track Surgery
CRP	C-Reactive Protein
IL	6-Interleukin-6
TNF α	Tumor Necrosis Factor alpha
IgG	Immunoglobulin G
IgA	Immunoglobulin A
C3	Complement Component 3
C4	Complement Component 4

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Author contributions

VK was responsible for the conceptualization, development of ideas, data extraction, interpretation of findings, preparation of tables and figures, and drafting of the manuscript. VK also ensured the accuracy of all content and coordinated revisions throughout the writing process. NU handled data analysis and interpretation of results. SG and AI contributed to the screening of studies and the removal of duplicates. ZA was responsible for data collection and ensured the accuracy and completeness of the extracted data. OA contributed to data collection and the verification of references. IM provided invaluable guidance and supervision throughout the study. She contributed by generating ideas, offering strategic direction, making critical revisions to the manuscript, and conducting quality assessments of the studies included in the review.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

All authors have provided their consent for publication of this manuscript.

Competing interests

The authors declare no competing interests.

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References

1. Ris F, Yeung T, Hompes R, Mortensen NJ. Enhanced reality and intraoperative imaging in colorectal surgery. Clin Colon Rectal Surg. 2015;28(3):158–64. https://doi.org/10.1055/s-0035-1555007.
2. Daghmouri MA, Chaouch MA, Oueslati M, Rebai L, Oweira H. Regional techniques for pain management following laparoscopic elective colonic resection: a systematic review. Ann Med Surg. 2021;72:103124. https://doi.org/10.1016/j.amsu.2021.103124.
3. ERAS® Society. Colorectal. Available from: https://erassociety.org/specialty/colorectal/. Accessed 2024 Jul 20.
4. Singh SM, Liverpool A, Romeiser JL, Thacker J, Gan TJ, Bennett-Guerrero E. Types of surgical patients enrolled in enhanced recovery after surgery (ERAS) programs in the USA. Perioper Med (Lond). 2021;10(1):12. https://doi.org/10.1186/s13741-021-00185-5.
5. Nygren J, Ljungqvist O, Thorell A. Enhanced recovery after surgery: ERAS. In: Surgical Patient Care. Springer; 2017. pp. 349–361. Available from: https://link.springer.com/chapter/10.1007/978-3-319-41503-7_22
6. Jain SN, Lamture Y, Krishna M. Enhanced recovery after surgery: exploring the advances and strategies. Cureus. 2023;15(10). https://doi.org/10.7759/cureus.47237.
7. Ljungqvist O, Francis N, Urman RD. Enhanced recovery after surgery: a complete guide to optimizing outcomes. Cham, Switzerland: Springer; 2020.
8. Turaga AH. Enhanced recovery after surgery (ERAS) protocols for improving outcomes for patients undergoing major colorectal surgery. Cureus. 2023;15(7):e41755. https://doi.org/10.7759/cureus.41755.
9. Mui J, Cheng E, Salindera S. Enhanced recovery after surgery for oncological breast surgery reduces length of stay in a resource-limited setting. ANZ J Surg. 2024;94(6):1096–101. https://doi.org/10.1111/ans.18901.
10. Kifle F, Kenna P, Daniel S, Maswime S, Biccard B. A scoping review of enhanced recovery after surgery (ERAS), protocol implementation, and its impact on surgical outcomes and healthcare systems in Africa. Perioper Med (Lond). 2024;13(1):86. https://doi.org/10.1186/s13741-024-00435-2.
11. Tolmay S, Rahiri JL, Snoep K, Fewster G, Kee R, Lim Y, Watson B, Richter KK. Lessons following implementation of a colorectal enhanced recovery after surgery (ERAS) protocol in a rural hospital setting. ANZ J Surg. 2024;94(5):910–6. https://doi.org/10.1111/ans.18838.
12. Song JH, Kim M. Clinical outcomes and future directions of enhanced recovery after surgery in colorectal surgery: a narrative review. Ewha Med J. 2024;47(4):e69. https://doi.org/10.12771/emj.2024.e69.
13. Kannan V. Enhanced Recovery After Surgery vs. Standard Care: A Systematic Review of Patient Outcomes in Colorectal Surgery. PROSPERO. 2024. https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=583074. Accessed 15 Sep 2024.
14. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Moher D. Updating guidance for reporting systematic reviews: development of the PRISMA 2020 statement. J Clin Epidemiol. 2021;134:103–12.
15. Stahel PF, Clavien PA, Smith WR, Moore EE. Redundant publications in surgery: a threat to patient safety? Patient Saf Surg. 2008;2:6. https://doi.org/10.1186/1754-9493-2-6.
16. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):210.
17. Sterne JA, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng HY, Corbett MS, Eldridge SM, Emberson JR, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JP. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366. https://doi.org/10.1136/bmj.l4898.
18. Forsmo HM, Pfeffer F, Rasdal A, Østgaard G, Mohn AC, Körner H, Erichsen C. Compliance with enhanced recovery after surgery criteria and preoperative and postoperative counselling reduces length of hospital stay in colorectal surgery: results of a randomized controlled trial. Colorectal Dis. 2016;18(6):603–11. https://doi.org/10.1111/codi.13253.
19. Bednarski BK, Nickerson TP, You YN, Messick CA, Speer B, Gottumukkala V, Manandhar M, Weldon M, Dean EM, Qiao W, Wang X, Chang GJ. Randomized clinical trial of accelerated enhanced recovery after minimally invasive colorectal cancer surgery (RecoverMI trial). Br J Surg. 2019;106(10):1311–8. https://doi.org/10.1002/bjs.11223.
20. Shetiwy M, Fady T, Shahatto F, Setit A. Standardizing the protocols for enhanced recovery from colorectal cancer surgery: are we a step closer to ideal recovery? Ann Coloproctol. 2017;33(3):86–92. https://doi.org/10.3393/ac.2017.33.3.86.
21. Taupyk Y, Cao X, Zhao Y, Wang C, Wang Q. Fast-track laparoscopic surgery: a better option for treating colorectal cancer than conventional laparoscopic surgery. Oncol Lett. 2015;10(1):443–8. https://doi.org/10.3892/ol.2015.3166.
22. Ostermann S, Morel P, Chalé JJ, Bucher P, Konrad B, Meier RPH, Ris F, Schiffer ERC. Randomized controlled trial of enhanced recovery program dedicated to elderly patients after colorectal surgery. Dis Colon Rectum. 2019;62(9):1105–16. https://doi.org/10.1097/DCR.0000000000001442.
23. Forsmo HM, Pfeffer F, Rasdal A, Sintonen H, Körner H, Erichsen C. Pre- and postoperative stoma education and guidance within an enhanced recovery after surgery (ERAS) programme reduces length of hospital stay in colorectal surgery. Int J Surg. 2016;36:121–6. https://doi.org/10.1016/j.ijsu.2016.10.031.
24. Li Q, Du L, Lu L, Tong Y, Wu S, Yang Y, Hu Q, Wang Y. Clinical application of enhanced recovery after surgery in perioperative period of laparoscopic colorectal cancer surgery. J Laparoendosc Adv Surg Tech A. 2019;29(2):178–83. https://doi.org/10.1089/lap.2018.0708.
25. Abd ElRahman EM, Kharoub MS, Shora A, Emara NA, Balbaa MA. Early outcome of enhanced recovery programs versus conventional perioperative care in elective open left side colonic carcinoma surgery: analysis of 80 cases. Indian J Surg Oncol. 2020;11(3):372–7. https://doi.org/10.1007/s13193-020-01074-x.
26. Mari G, Crippa J, Costanzi A, Mazzola M, Rossi M, Maggioni D. ERAS protocol reduces IL-6 secretion in colorectal laparoscopic surgery: results from a randomized clinical trial. Surg Laparosc Endosc Percutan Tech. 2016;26(6):444–8. https://doi.org/10.1097/SLE.0000000000000324.
27. Feng J, Li K, Li L, Wang X, Huang M, Yang J, Hu Y. The effects of fast-track surgery on inflammation and immunity in patients undergoing colorectal surgery. Int J Colorectal Dis. 2016;31(10):1675–82. https://doi.org/10.1007/s00384-016-2630-6.
28. Iqbal MT, Jutt AU, Arbi FM. Comparison of the outcomes of enhanced recovery after surgery (ERAS) vs conventional care in elective colorectal surgery. J Ayub Med Coll Abbottabad. 2024;36(1):19–24. https://doi.org/10.55519/JAMC-01-12478.
29. Li N, Wei S, Qi Y, Wei W. The effects of enhanced recovery after surgery on wound infection, complications, and postoperative hospital stay in patients undergoing colorectal surgery: a systematic review and meta-analysis. Int Wound J. 2023;20:3990–8. https://doi.org/10.1111/iwj.14287.
30. Zhang W, Wang F, Qi S, Liu Z, Zhao S, Zhang N, Ping F. An evaluation of the effectiveness and safety of the enhanced recovery after surgery (ERAS) program for patients undergoing colorectal surgery: a meta-analysis of randomized controlled trials. Videosurgery Miniinv. 2023;18(4):565–77. https://doi.org/10.5114/wiitm.2023.131426.
31. Azhar H, Hafeez MH, Ahmed SZ, Waseem T. Enhanced recovery after surgery (ERAS) versus traditional care in patients hospitalized for colorectal surgery: a meta-analysis. Arch Surg Res. 2021;2(4):12–23. https://doi.org/10.48111/2021.04.04.
32. Wang Y, Zhao GH, Zhao J, Yang H, Lin J. A pooled analysis of fast track procedure vs. conventional care in laparoscopic colorectal cancer surgery. Int J Clin Exp Med. 2017;10(3):5778–87.
33. Zhao J-H, Sun J-X, Gao P, Chen X-W, Song Y-X, Huang X-Z, Xu H-M, Wang Z-N. Fast-track surgery versus traditional perioperative care in laparoscopic colorectal cancer surgery: a meta-analysis. BMC Cancer. 2014;14:607. https://doi.org/10.1186/1471-2407-14-607.
34. Althobaiti TS, Alkhamash MO, Almalki AS, Alkhwildi JA, Abdulaziz YA, Alanazi AA, Qasem AA, Rashid AT, Zaben AK, Mohammed AM, Tuwayjir AT. Enhanced recovery program (ERAS) and colorectal surgery: a systematic review and Meta-analysis. Ann Med Health Sci Res. 2020;10:1089–94.
35. Ahmed A, Khalid S, Sharif G, Ahmed HH, Khattak IA, Memon SK. Efficacy of enhanced recovery after surgery (ERAS) protocols in emergency colorectal surgery: a meta-analytical comparison with conventional care in terms of outcomes and complications. Cureus. 2024;16(10):e71630. https://doi.org/10.7759/cureus.71630.

36. Sauro KM, Smith C, Ibadin S, Thomas A, Ganshorn H, Bakunda L, Bajgain B, Bisch SP, Nelson G. 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(6):e2417310. https://doi.org/10.1001/jamanetworkopen.2024.17310.
37. Ayinde BO, Chokshi P, Adhikari S, Jaimalani A, Yeritsyan A, Surve AV, Khan S. Challenges and elements hindering the adoption of enhanced recovery after surgery (ERAS) protocols in colorectal surgery and their resolutions: a systematic review. Cureus. 2024;16(6):e63222. https://doi.org/10.7759/cureus.63222.
38. Lovegrove J, Tobiano G, Chaboyer W, Carlini J, Liang R, Addy K, Gillespie BM. Clinicians' perceptions of enhanced recovery after surgery (ERAS) protocols to improve patient safety in surgery: a national survey from Australia. Patient Saf Surg. 2024;18(1):18. https://doi.org/10.1186/s13037-024-00397-w.

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