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Research Article

Integrative Review on the Importance of ERAS (Enhanced Recovery After Surgery) Protocols: Surgical and Anesthetic Integration and Patient Safety in the Operating Room.

Gustavo Couto Gomes[1], Gabriel Leonardo Saraiva[2], Mariana Ribeiro Gonçalves [2], Daniel Freitas dos Santos [2], Talita Renata Quirino Lopes[2], Douglas Hipólito Carvalho[1], Larissa Lauretto[3], Délio Tiago Martins Malaquias[2], Mauricio Martinez Puglia[2],Thalita Pinheiro Morel Alineri[3], Liliana Martins Occulate[4], José Carlos Ferreira da Silva[2], Maria Victoria Moncada Xavier[5], Giovana Casarini Yamashiro[1], Guilherme Pio Vilela[1], Ana Paula Mendes de Oliveira Kachar[2], Filipe Jabur Lot Garcia[2], Rubens Rodrigues Tudela[6], Regilane da Silva Batista[2], Robson Ferreira Izaias[2], Roselene de Oliveira Carvalho[2], Silvia Alves da Silva Carvalho[2], Marco Aurélio Silva Couto[2], Rafaela Ribeiro Bari[2], Carlos Henrique Batista Figueiredo de Mendonça[7], Ana Paula Figueiredo Silva [8], Anna Júlia Coutinho Costa[8], Ana Laura Nogueira Ervilha[8], Thiago Augusto Rochetti Bezerra[9].

Affiliations

[1] Nove de Julho University (UNINOVE), São Bernardo do Campo Campus, São Paulo, Brazil.
[2] Ribeirão Preto University (UNAERP), Guarujá Campus, São Paulo, Brazil.
[3] University of Western São Paulo (UNOESTE), Guarujá Campus, São Paulo, Brazil.
[4] Central University of Paraguay, School of Medicine, Ciudad del Este, Paraguay.
[5] Faceres University Center (FACERES), São José do Rio Preto, São Paulo, Brazil.
[6] São Judas Tadeu University, Cubatão Campus, São Paulo, Brazil.
[7] Federal University of Roraima (UFRR), Boa Vista, Roraima, Brazil.
[8] São José dos Campos School of Medical Sciences – Humanitas (FCMSJC), São José dos Campos, São Paulo, Brazil.
[9] Ribeirão Preto School of Medicine, University of São Paulo (FMRP-USP), Ribeirão Preto, São Paulo, Brazil.

Abstract

ERAS (Enhanced Recovery After Surgery) Protocols have established themselves as an evidence-based approach aimed at optimizing perioperative care, focusing on the integration of surgical, anesthetic, and multidisciplinary practices and promoting patient safety. This study aimed to analyze the importance of ERAS protocols in surgical and anesthetic integration and their impact on patient safety in the operating room through a review of the scientific literature. This is an integrative review conducted in accordance with PRISMA recommendations, searching national and international databases using descriptors related to ERAS, patient safety, anesthesia, and perioperative care. The included studies show that the implementation of ERAS Protocols is associated with a reduction in intraoperative and postoperative adverse events, decreased use of opioids, better pain control, less variability in care, and a stronger culture of safety. The standardization of procedures, multimodal analgesia, rational use of anesthetic drugs, individualized fluid management, adequate monitoring, and multidisciplinary integration stand out as central components of ERAS. In addition, the protocols have demonstrated applicability in various surgical specialties, with adaptations according to the clinical and organizational context. It is concluded that ERAS protocols are an effective strategy for improving patient safety and the quality of perioperative care, reinforcing the need for their systematic and sustained implementation in health services.

Keywords: Enhanced Recovery After Surgery; Patient Safety; Anesthesia; Perioperative Care; Clinical Protocols.

***Corresponding Author:** **Thiago Augusto Rochetti Bezerra,** Ribeirão Preto School of Medicine, University of São Paulo (FMRP-USP), Ribeirão Preto, São Paulo, Brazil. **Email:** rochetti.sef@gmail.com.
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INTRODUCTION

According to Ljungqvist, Scott, and Fearon (2017), Enhanced Recovery After Surgery (ERAS) protocols are an innovative model of perioperative care based on robust scientific evidence and aimed at reducing surgical stress, optimizing functional recovery, and promoting patient safety. These protocols propose a multimodal and integrated approach, ranging from preoperative preparation to postoperative rehabilitation.

According to Do Vale and Do Vale (2019), the implementation of ERAS in major surgical procedures has proven to be an effective strategy for increasing safety in the operating room, mainly through the standardization of clinical practices, reduction of variability in care, and strengthening of communication between the surgical and anesthetic teams. Such standardization is considered one of the pillars for the prevention of intraoperative adverse events.

According to Feldman, Lee, and Fiore Jr. (2015), the evaluation of outcomes associated with ERAS protocols should transcend traditional indicators, such as length of hospital stay, incorporating parameters related to patient safety, quality of recovery, and care experience. This perspective broadens the understanding of ERAS as an instrument for qualifying surgical care.

According to Scott et al. (2015), the pathophysiological foundations of ERAS are directly related to the modulation of the inflammatory and metabolic response to surgical trauma, requiring precise integration between surgical and anesthetic strategies. In this context, anesthetic practice plays a central role in maintaining homeostasis and preventing intraoperative complications.

According to Kaye et al. (2020), the rational use of anesthetic and analgesic drugs within ERAS protocols, such as dexmedetomidine, contributes significantly to the control of postoperative pain, reduction in opioid consumption, and decrease in the incidence of adverse events, reinforcing the impact of anesthesiology on the safety of surgical patients.

According to Beverly et al. (2017), multimodal analgesia, an essential element of ERAS protocols, is associated with better clinical outcomes, including a lower incidence of nausea, vomiting, respiratory depression, and delayed mobilization. The effectiveness of these strategies depends directly on the coordination between surgeons, anesthesiologists, and nursing staff.

According to Grant et al. (2018), the performance of dedicated surgical teams trained to strictly comply with ERAS protocols is associated with better clinical outcomes and greater intraoperative safety, especially in more complex surgeries. The organization of teamwork emerges as a determining factor for the success of the model.

According to Nilsson, Gruen, and Myles (2020), postoperative recovery should be understood as a collective and interdisciplinary process, in which coordination between different health professionals is essential. In this sense, ERAS protocols promote an environment conducive to structured communication and shared decision-making.

According to Pilkington et al. (2023), the development of surgical safety checklists specific to ERAS contributes to greater adherence to evidence-based recommendations and a reduction in care failures. These operational tools reinforce the culture of safety within the operating room.

According to Lovegrove et al. (2024), healthcare professionals' perception of ERAS protocols is predominantly positive, especially with regard to improving patient safety and quality of care. However, the authors point out that organizational and training barriers still pose challenges to the full implementation of the model.

According to Fu et al. (2025), contemporary anesthetic practices aligned with ERAS principles have promoted significant advances in perioperative safety through individualized hemodynamic management, adequate monitoring, and optimized anesthetic recovery, which are fundamental aspects for reducing intraoperative risks.

According to Nogueira et al. (2025), the effectiveness of ERAS protocols has been demonstrated in different surgical specialties, highlighting their broad applicability and potential as a strategy for continuous improvement in patient safety. These findings reinforce the need for dissemination and consolidation of ERAS in health services.

According to Mithany et al. (2023), ERAS represents an evolution in surgical care by integrating science, innovation, and safety, promoting a patient-centered and results-oriented care model. This approach contributes to the sustainability of health systems by reducing complications and associated costs.

According to Harrison et al. (2021), the integration between the Perioperative Surgical Home model and ERAS protocols enhances the benefits related to safety and quality of care, especially in patients with greater clinical complexity, by promoting continuity of care and multidisciplinary alignment.

According to Bugada et al. (2016), the future prospects for ERAS point to its expansion and adaptation to different surgical contexts, incorporating new technologies, anesthetic strategies, and collaborative models of care, which reinforces its relevance in the current patient safety scenario.

Given this context, this study is justified, with the objective of analyzing the importance of ERAS protocols in the integration of surgical and anesthetic practices and their impact on patient safety in the operating room, contributing to the consolidation of scientific knowledge on the subject and supporting the qualified implementation of these protocols in different care settings, as evidenced in the literature analyzed.

OBJECTIVES

General Objective

To analyze the importance of ERAS (Enhanced Recovery After Surgery) Protocols in the integration of surgical and anesthetic practices and their impact on patient safety in the operating room, in light of the scientific evidence available in the literature.

Specific Objectives

- To evaluate the main components of ERAS Protocols related to patient safety in the perioperative period.
- To analyze the role of integration between surgical, anesthetic, and multidisciplinary teams in the implementation of ERAS Protocols.
- To identify anesthetic and surgical strategies associated with the reduction of intraoperative and postoperative adverse events in the context of ERAS.
- To describe the main clinical outcomes related to patient safety associated with the adoption of ERAS Protocols.
- Systematize scientific evidence regarding the applicability of ERAS Protocols in different surgical specialties.

Justification

Patient safety in the operating room remains one of the main challenges of contemporary health systems, especially in view of the increasing complexity of surgical procedures and the growing number of patients with multiple comorbidities. In this context, failures in communication, standardization of procedures, and integration between care teams are critical factors in the occurrence of preventable adverse events.

ERAS protocols emerge as an evidence-based strategy capable of promoting integration between surgical and anesthetic practices, reducing variability in care, and strengthening the culture of safety. Although their effectiveness is widely described in terms of reducing hospital stay and improving functional recovery, an in-depth analysis of their specific impact on patient safety in the operating room is still necessary, especially from the perspective of multidisciplinary care.

Thus, this study is justified by the need to critically synthesize the available evidence on the importance of ERAS protocols in promoting patient safety, contributing to the improvement of care practices, supporting managers and health professionals, and strengthening the qualified implementation of these protocols in different surgical settings.

METHODOLOGY

Type Of Study

This is an integrative literature review, conducted in accordance with the recommendations of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Alternatively, the methodology can be adapted for systematic review, through prior definition of methodological quality criteria and bias risk analysis.

PICOS Strategy

The research question was formulated according to the PICOS strategy, as described below:

- P (Population): Adult and pediatric patients undergoing surgical procedures in a hospital setting.
- I (Intervention): Implementation of ERAS (Enhanced Recovery After Surgery) protocols, with a focus on surgical and anesthetic integration.
- C (Comparison): Conventional perioperative care or absence of structured surgical recovery protocols.
- O (Outcomes): Patient safety in the operating room, reduction of adverse events, perioperative complications, quality of recovery, and adherence to safe practices.
- S (Study design): Observational studies, clinical trials, narrative reviews, systematic reviews, and clinical guidelines.

Guiding question:

What is the importance of ERAS protocols in the integration of surgical and anesthetic practices and their impact on patient safety in the operating room?

Sources of information and search strategy

The search was conducted in the PubMed/MEDLINE, Scopus, Web of Science, Embase, and SciELO databases, using controlled and uncontrolled descriptors combined by Boolean operators:

("Enhanced Recovery After Surgery" OR ERAS) AND
("Patient Safety" OR "Surgical Safety") AND
("Anesthesia" OR "Perioperative Care")

Inclusion criteria

- Studies published in Portuguese or English;
- Articles addressing ERAS protocols associated with patient safety;
- Studies involving surgical and anesthetic integration;
- Publications available in full.

Exclusion criteria

- Duplicate studies;
- Articles that did not directly address patient safety;
- Isolated case reports, editorials, and letters to the editor;
- Publications without access to the full text.

Study selection

The selection was carried out in three stages:

1. Reading of titles;
2. Reading of abstracts;
3. Evaluation of full texts for eligibility.

The selection process was described using a PRISMA flowchart, covering identification, screening, eligibility, and inclusion of studies.

Data analysis and synthesis

The data extracted included: author, year of publication, type of study, surgical specialty, ERAS strategies implemented, patient safety outcomes, and main conclusions. The synthesis of the results was performed in a descriptive and thematic manner, according to the proposed objectives.

Ethical considerations

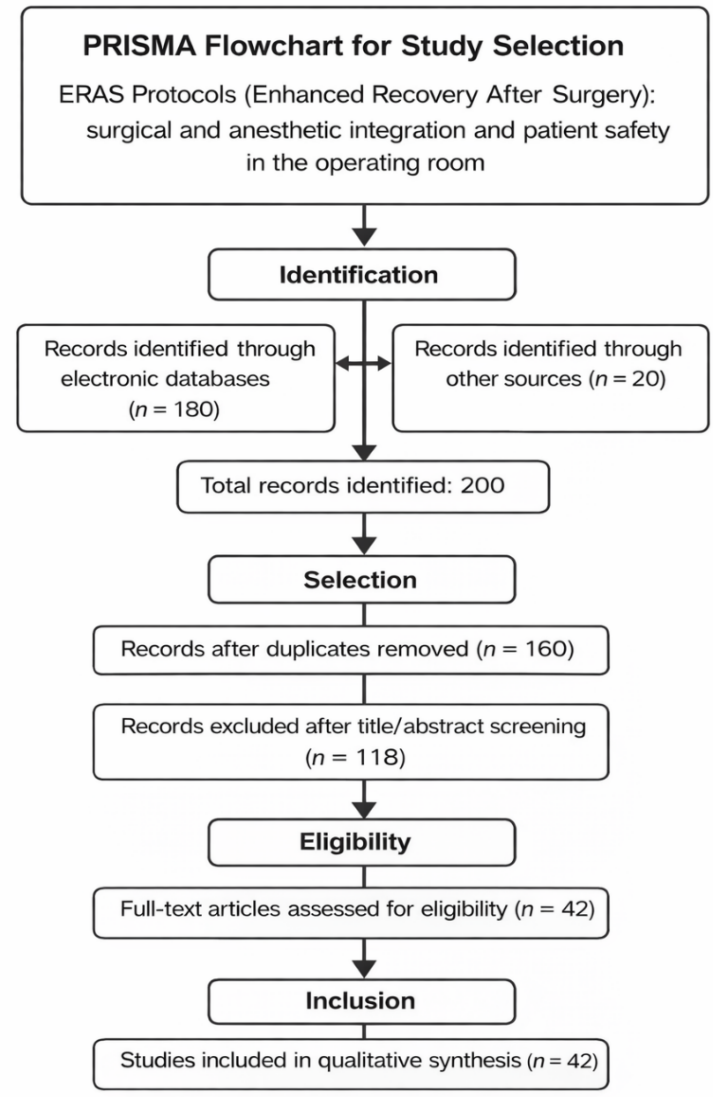
As this was a literature review study, there was no need to submit it to a Research Ethics Committee, in accordance with current national guidelines.

RESULTS

Figure 1 shows the PRISMA flowchart for the process of identifying, selecting, and determining the eligibility and inclusion of studies that comprised this review on the importance of Enhanced Recovery After Surgery (ERAS) protocols in surgical and anesthetic integration and patient safety in the operating room. This flowchart summarizes, in a systematic and standardized manner, all the methodological steps adopted for the selection of studies, from the initial search in the databases to the final definition of the set of articles included in the qualitative synthesis. The use of the PRISMA method ensures greater transparency, reproducibility, and methodological rigor in conducting the review by explaining the criteria used in each phase of the screening process, as well as the number of studies excluded and included in each stage.

Thus, the flowchart provides a clear and objective visualization of the methodological path adopted, contributing to the understanding of the robustness of the study selection and the reliability of the findings presented.

Figure 1. PRISMA flowchart – Selection of studies included in the review on the importance of Enhanced Recovery After Surgery (ERAS) protocols in surgical and anesthetic integration and patient safety in the operating room (adapted from PRISMA 2020).



As shown in Figure 1, 200 records were initially identified, 180 from electronic databases and 20 from other sources. After removing duplicates, 160 records underwent screening, in which 118 studies were excluded after reading titles and abstracts because they did not meet the eligibility criteria. In the subsequent stage, 42 full-text articles were evaluated, all of which were considered eligible and included in the final qualitative synthesis, comprising the body of evidence analyzed in this review.
Table 1 summarizes the main components of the Enhanced Recovery After Surgery (ERAS) Protocols related to patient safety in the perioperative period, as described in the scientific literature. The organization of the studies allows the identification of key strategies adopted throughout the preoperative, intraoperative, and postoperative phases, as well as their impacts on the prevention of adverse events, the standardization of procedures, and multidisciplinary integration in the surgical environment.

Table 1. Main components of ERAS protocols related to patient safety in the perioperative period.

Author(s)	Year	Type of study	ERAS component	Perioperative phase	Contribution to patient safety
Ljungqvist, Scott, and Fearon	2017	Narrative review	Multimodal standardization of care	All	Reduction in care variability and surgical stress
Do Vale and Do Vale	2019	Descriptive study	Structured protocols and team communication	Intraoperative	Prevention of process failures and adverse events
Scott et al.	2015	Narrative review	Control of the inflammatory response to surgical trauma	Intraoperative	Decreased metabolic and hemodynamic complications
Beverly et al.	2017	Narrative review	Multimodal analgesia	Postoperative	Reduction in opioid use and associated adverse events
Kaye et al.	2020	Narrative review	Rational use of anesthetic drugs	Intra- and post-operative	Improved pain control and clinical stability
Grant et al.	2018	Observational study	Surgical teams dedicated to ERAS	All	Increased adherence to protocol and reduction in human error
Nilsson, Gruen, and Myles	2020	Narrative review	Integrated multidisciplinary approach	All	Improved communication and decision-making
Pilkington et al.	2023	Methodological study	Surgical safety checklist ERAS	Intraoperative	Reduction of omissions in critical stages of care
Lovegrove et al.	2024	Cross-sectional study	Staff engagement and perception	All	Strengthening safety culture
Fu et al.	2025	Narrative review	Individualized anesthetic monitoring and management	Intraoperative	Minimization of risks and adverse events
Nogueira et al.	2025	Observational study	Systematic implementation of ERAS	All	Overall reduction in perioperative complications
Mithany et al.	2023	Narrative review	Patient-centered care model	All	Increased safety and quality of care

Source: Authors

The analysis presented in **Table 1** shows that ERAS protocols incorporate multiple components directly related to patient safety throughout the perioperative period. Strategies such as standardization of procedures, multimodal analgesia, rational use of anesthetic drugs, and individualized monitoring play a central role in preventing adverse events and reducing surgical complications. In addition, multi tegration and the use of structured tools, such as safety checklists, stand out as fundamental elements for improving communication between teams and strengthening the culture of safety in the operating room. Together, the findings reinforce that the effectiveness of ERAS protocols is directly associated with their systematic implementation and team engagement, consolidating them as a robust strategy for promoting patient safety in the perioperative context.
Table 2 systematizes the evidence on the role of integration between surgical, anesthetic, and multidisciplinary teams in the implementation of ERAS (Enhanced Recovery After Surgery) protocols. The summary highlights how structured communication, process standardization, teamwork, and clinical practice support tools (such as checklists) influence protocol adherence and patient safety in the perioperative period.

Table 2. Multidisciplinary integration in the implementation of ERAS protocols and implications for patient safety.

Author(s)	Year	Type of study	Focus of integration	Perioperative stage	Key findings related to implementation/safety
Ljungqvist, Scott, and Fearon	2017	Narrative review	Integration of practices and standardization of care	All	ERAS relies on multidisciplinary coordination and standardized routines to reduce variability and risks
Do Vale and Do Vale	2019	Descriptive study	Communication between teams and safety	Intraoperative	Surgical-anesthetic integration improves predictability of care and reduces process failures
Nilsson, Gruen, and Myles	2020	Narrative review	Teamwork and recovery	All	Postoperative recovery is the result of coordinated, h y action; an integrated team improves safety and continuity of care
Grant et al.	2018	Observational study	Dedicated teams (ERAS teams)	All	Dedicated teams increase protocol adherence, reduce inconsistencies, and promote better outcomes
Grant et al.	2019	Observational study	Compliance with measures influenced by anesthesia	Intra- and post-operative	Greater multidisciplinary compliance with ERAS processes is associated with better care performance and reduced length of stay
Pilkington et al.	2023	Methodological study	ERAS safety checklist	Intraoperative	Structured checklist improves communication, reduces omissions, and increases adherence to critical ERAS steps
Lovegrove et al.	2024	Cross-sectional study (survey)	Perception/engagement of clinicians	All	Positive perceptions of ERAS; implementation requires training, team alignment, and institutional support
Alawadi et al.	2016	Qualitative/ observational study	Barriers and facilitators	All	Implementation is influenced by organizational culture, resources, and professional adherence; integration is decisive
Harrison et al.	2021	Review/essay	ERAS and Perioperative Surgical Home Integration	All	Integrated models strengthen coordination and improve care for complex patients, with an impact on safety
Fu et al.	2025	Narrative review	Anesthetic integration into perioperative care	Intra- and post-operative	Anesthetic practices aligned with ERAS require coordination with surgery and nursing to optimize safety and recovery.
Mágulas et al.	2024	Review/descriptive study	Anesthesia safety and prevention of adverse events	Intraoperative	Preventive strategies depend on protocols, communication, and trained staff to reduce adverse events
Methangkool, Cole, and Cannesson	2020	Commentary/short review	Anesthesia safety	Intraoperative	Continuous improvement in safety requires processes, culture, and interprofessional collaboration
Liu	2024	Descriptive study	Safety management by nursing	Intraoperative	Operating room nurses play a central role in coordination, checks, and failure prevention
Tiago	2025	Applied study (nursing)	Preoperative consultation	Preoperative	Integration of preoperative nursing care reduces infection risk and improves perioperative planning
Andrade	2023	Applied study	Communication and quality of care	Pre- and intraoperative	Effective communication is central to quality and safety; it promotes alignment between teams
Mithany et al.	2023	Narrative review	ERAS model and organizational change	All	ERAS requires process integration and institutional adherence; interprofessional coordination sustains safety gains

Source: Authors

As summarized in Table 2, the literature indicates that the effective implementation of ERAS protocols depends directly on structured multidisciplinary integration, involving alignment between surgery, anesthesia, and nursing at all stages of the perioperative period.

It is evident that dedicated teams, standardized routines, and compliance with process measures increase adherence to the protocol and reduce variations in care, promoting safety and consistency of care. Additionally, tools such as ERAS-specific checklists function as operational mechanisms for communication and prevention of omissions at critical stages, reducing the risk of adverse events.

Studies also point out that institutional and cultural barriers can compromise implementation, reinforcing the need for continuous training, organizational support, and clinical leadership to sustain integration and consolidate a culture of safety in the operating room.

Table 3 presents a summary of the main anesthetic and surgical strategies described in the context of Enhanced Recovery After Surgery (ERAS) protocols associated with the reduction of intraoperative and postoperative adverse events. The systematization includes pharmacological and non-pharmacological interventions, process measures, and safety tools that, when implemented in an integrated manner, contribute to minimizing complications, optimizing recovery, and strengthening the culture of perioperative safety.

Table 3. Anesthetic and surgical strategies in ERAS associated with the reduction of intraoperative and postoperative adverse events

Author(s)	Year	Type of study	Strategy (anesthetic/ surgical)	Timing	Potentially reduced adverse events/complications
Scott et al.	2015	Narrative review	Modulation of surgical stress and patho-physiological control	Intra- and post-operative	Hemodynamic instability, metabolic/inflammatory complications
Thiele et al.	2016	Consensus (ASER/ POQI)	Evidence-based perioperative fluid management	Intra	Volume overload, hypotension, kidney injury, cardiopulmonary complications
Beverly et al.	2017	Narrative review	Multimodal analgesia and opioid reduction	Post	Nausea/vomiting, respiratory depression, ileus, excessive sedation
Kaye, Alan David et al.	2020	Narrative review	Dexmedetomidine in ERAS protocols (analgesia/sedation)	Intra- and post-operative	Hyperalgesia/excessive opioid use, delirium, autonomic instability (depending on patient profile)
Kaye, Alan et al.	2020	Narrative review	Clinical pharmacology applied to ERAS (rational use of drugs)	Intra- and post-operative	Adverse drug reactions, inadequate analgesia, opioid-related events
Fu et al.	2025	Narrative review	Optimized monitoring and anesthetic management for recovery	Intra	Hemodynamic events, hypoxemia, delayed anesthetic recovery
Methangkool, Cole, and Cannesson	2020	Short review	Continuous improvement of anesthesia safety (processes/technology/ culture)	Intra	Preventable adverse anesthetic events and process failures
Pilkington et al.	2023	Methodological study	ERAS-specific surgical safety checklist	Intra	Critical omissions, process errors, communication failures, and checking
Grant et al.	2019	Observational cohort	Compliance with anesthesia-influenced process measures	Intra- and post-operative	Prolonged hospitalization, perioperative complications related to non-adherence
Grant et al.	2018	Observational	Dedicated teams and standardization in the operating room	All	Human errors, variability in care, complications associated with inconsistent processes

Low et al.	2019	Guideline (ERAS Society)	ERAS guidelines for esophagectomy (perioperative package)	All	Pulmonary complications, infections, delayed recovery, and readmissions
Ashok et al.	2020	Review/narrative study	ERAS in esophageal cancer resection (components applied)	Intra- and post-operative	Infectious and respiratory complications and delayed mobilization
Batchelor et al.	2019	Guideline (ERAS/ ESTS)	ERAS in lung surgery (recommendations)	Intra- and post-operative	Respiratory complications, poorly controlled pain, prolonged hospitalization
Thorell et al.	2016	Guideline (ERAS Society)	ERAS in bariatric surgery	Intra- and post-operative	Thromboembolism, metabolic complications, PONV, ileus, and cardiopulmonary events
Bogani et al.	2021	Narrative review	ERAS in gynecologic oncology	Intra- and post-operative	Infectious and thromboembolic complications, poorly controlled pain, and readmission
Wang, Chang, and Grossman	2017	Applied study	ERAS in lumbar arthrodesis (recovery pathway)	Intra- and post-operative	Severe pain, delayed mobilization, functional complications, and prolonged hospitalization
Wainwright, Immins, and Middleton	2016	Narrative review	ERAS in major spine surgery	Intra- and post-operative	Complications related to immobility, pain, and prolonged hospitalization
Khozenko et al.	2021	Narrative review	Role of anesthesia in neurological ERAS	Intra- and post-operative	Neurofunctional complications, pain, hemodynamic instability
Belouaer et al.	2023	Observational study	ERAS implementation in neurosurgery	All	Perioperative complications and process failures related to lack of standardization
Jolly et al.	2024	Narrative review	Design of ERAS protocols in neurosurgery	All	Complications and adverse events due to low adherence, gaps in care, and variability
Riga et al.	2023	Review/study	ERAS in arthroplasty/ orthopedics (joint replacement)	Intra- and post-operative	Thromboembolism, functional complications, pain, readmission
Rove, Edney, and Brockel	2018	Narrative review	ERAS in pediatrics (multidisciplinary care)	All	Complications related to pain, immobility, and prolonged recovery

Source: Authors

Table 3 shows that ERAS strategies associated with the reduction of intraoperative and postoperative adverse events focus on three main areas: (1) anesthetic and analgesic optimization, (2) standardization of processes and operational safety, and (3) specific guidelines by specialty.

In terms of anesthesia, multimodal analgesia and rational use of drugs stand out, contributing to reducing adverse events related to opioids and improving postoperative recovery. Furthermore, consolidated recommendations on perioperative fluid management and recovery-oriented monitoring/anesthesia are highlighted as relevant measures to reduce hemodynamic instability and cardiorespiratory complications.

On the operational side, the use of checklists, the presence of dedicated teams, and compliance with process measures emerge as critical factors in reducing communication failures and omissions in essential stages of care. Finally, guidelines and studies applied in different specialties (esophagectomy, lung surgery, bariatric surgery, gynecological oncology, spine surgery, neurosurgery, orthopedics, and pediatrics) reinforce that ERAS packages adapted to the surgical context increase safety and reduce complications, provided they are implemented with multidisciplinary integration and consistent adherence to the protocol.

Table 4 systematizes the scientific evidence on the applicability of ERAS (Enhanced Recovery After Surgery) Protocols in different surgical specialties. The summary includes guidelines, observational studies, and reviews that describe the adaptation of ERAS to specific contexts, highlighting central components, implementation factors, and implications for patient safety and perioperative recovery.

Table 4. Applicability of ERAS Protocols in different surgical specialties: summary of evidence

Author(s)	Year	Type of study	Specialty/ Procedure	Scope of applicability of ERAS	Main reported contributions
Ljungqvist, Scott, and Fearon	2017	Narrative review	General (multispecialty)	Basic ERAS model	Consolidates principles and multimodal rationale applicable to various surgeries
Scott et al.	2015	Narrative review	Gastrointestinal	ERAS in GI surgery	Bases adaptation on pathophysiological mechanisms and processes
Low et al.	2019	Guideline (ERAS Society)	Esophagectomy	Perioperative package	Specific recommendations for safe care and optimal recovery
Ashok et al.	2020	Narrative review	Esophageal cancer (resection)	ERAS implementation	Describes components applied and recovery/safety gains
Batchelor et al.	2019	Guideline (ERAS/ ESTS)	Lung surgery	ERAS for lung surgery	Standardizes practices and reinforces prevention of respiratory complications
Thorell et al.	2016	Guideline (ERAS Society)	Bariatric surgery	ERAS in bariatric surgery	Recommendations for optimizing care and reducing perioperative complications
Grant et al.	2018	Observational	Colorectal surgery	ERAS in colorectal surgery	Dedicated teams and standardization associated with better outcomes
Grant et al.	2019	Observational	Colorectal surgery	Anesthetic process measures	Adherence to measures correlates with better healthcare performance
Martins	2025	Protocol/applied study	Colorectal cancer surgery	Optimized recovery protocol	Adaptation of ERAS to the colorectal oncology context
Nogueira et al.	2025	Observational	General surgery	ERAS implementation	Evidence of expanded applicability and effectiveness in clinical practice
Bogani et al.	2021	Narrative review	Gynecologic oncology	ERAS in GO	Describes adaptation and benefits in oncological perioperative care
Carter-Brooks et al.	2018	Observational	Urogynecology	Specific ERAS pathway	Demonstrates subspecialty-targeted implementation and associated outcomes
Wang, Chang, and Grossman	2017	Applied study	Spine (lumbar arthrodesis)	ERAS pathway for lumbar fusion	Adapts ERAS to neuro/orthopedics with a focus on recovery and safety
Wainwright, Immins, and Middleton	2016	Narrative review	Spine (major surgery)	Large-scale ERAS	Discusses applicability and requirements for safe implementation
Robertson	2024	Book chapter	Column/ Neurosurgery	ERAS and checklists	Emphasizes checklists and clinical governance in spine pathways
Agarwal et al.	2021	Observational	Neurosurgery	Perception/adoption of ERAS	Points out challenges and opportunities for application in the neuro context
Khozenko et al.	2021	Narrative review	Neurosurgery	Role of anesthesia in ERAS	Discusses anesthetic adaptations for safety and neuro recovery
Belouaer et al.	2023	Observational	Neurosurgery	ERAS implementation	Describes implementation and implications for standardization of care
Jolly et al.	2024	Narrative review	Neurosurgery	Protocol design	Presents contemporary elements for building ERAS pathways
Riga et al.	2023	Review/study	Orthopedics (arthroplasty)	ERAS in joint replacement	Systematizes protocols for recovery and prevention of complications
Rove, Edney, and Brockel	2018	Narrative review	Pediatrics	ERAS in children	Evidence of the applicability and importance of multidisciplinary care
Zamora, Ghani, and Heiss	2022	Book chapter	Pediatric surgery	Quality and innovation	Discusses ERAS as the next generation of perioperative improvement

Source: Authors

Table 4 shows that ERAS protocols are highly applicable in multiple surgical specialties, with specific adaptations according to the patient's risk profile, the type of procedure, and the organizational particularities of the service.

The evidence includes consolidated guidelines for areas such as esophagectomy, lung and bariatric surgery, as well as studies and reviews that support implementation in colorectal surgery, general surgery, gynecologic oncology, urogynecology, orthopedics (arthroplasty), and pediatrics. In the field of spine and neurosurgery, there is growing scientific production focused on the design of pathways, the role of anesthesia, and the use of checklists, indicating the maturation of ERAS implementation in these scenarios.

Together, the studies suggest that the effectiveness and safety of ERAS depend on contextual adaptation and process standardization.

DISCUSSION

According to Ljungqvist, Scott, and Fearon (2017), ERAS (Enhanced Recovery After Surgery) protocols are consolidated as a structured, evidence-based approach to perioperative care, integrating surgical, anesthetic, and multidisciplinary practices with a focus on reducing surgical stress and promoting patient safety. The findings of this review corroborate this perspective, demonstrating that the strength of ERAS lies in the systematic articulation of multiple components capable of reducing variability in care and minimizing intraoperative and postoperative adverse events.

According to Do Vale and Do Vale (2019), the standardization of procedures is one of the fundamental pillars of ERAS protocols, especially in the context of operating room safety. The literature reviewed shows that structured clinical pathways reduce process failures, omissions in critical steps, and inconsistencies in decision-making, factors often associated with the occurrence of preventable adverse events, as also observed by Pilkington et al. (2023).

As discussed by Feldman, Lee, and Fiore Jr. (2015), the evaluation of ERAS results should go beyond classic indicators, such as length of stay, incorporating outcomes related to safety, quality of recovery, and patient experience. The studies included in this review reinforce this conceptual expansion by demonstrating that patient safety is a central outcome directly impacted by the proper implementation of ERAS protocols.

According to Scott et al. (2015), the pathophysiological basis of ERAS is related to the modulation of the inflammatory and metabolic response to surgical trauma, which requires close integration between surgical and anesthetic decisions. In this sense, the present review confirms that anesthesiology plays a strategic role within ERAS, no longer acting only as intraoperative support but becoming a central element in the prevention of complications and the promotion of safe recovery, as also pointed out by Khozenko et al. (2021).

According to Kaye et al. (2020), anesthetic strategies based on the rational use of drugs, including dexmedetomidine and other multimodal analgesia approaches, are associated with reduced opioid consumption, better pain control, and a lower incidence of adverse events, such as respiratory depression and delirium. These findings are reinforced by Beverly et al. (2017), who highlight multimodal analgesia as an essential component for postoperative safety in the context of ERAS.

According to Grant et al. (2018), the work of teams dedicated and specifically trained for the implementation of ERAS is associated with greater adherence to protocol recommendations and better clinical outcomes. This review shows that multidisciplinary integration, involving surgery, anesthesia, and nursing, is a determining factor in reducing human error and strengthening the culture of safety, as also discussed by Nilsson, Gruen, and Myles (2020).

According to Lovegrove et al. (2024), healthcare professionals' perception of ERAS protocols is largely positive, especially with regard to increased patient safety and improved quality of care. However, the authors emphasize that organizational barriers, such as resistance to change and resource limitations, can compromise the full implementation of the protocol, a finding also observed by Alawadi et al. (2016).

According to Fu et al. (2025), contemporary anesthetic practices aligned with ERAS principles, such as adequate monitoring and individualized hemodynamic management, contribute to minimizing intraoperative risks and optimizing anesthetic recovery. These elements reinforce the importance of surgical-anesthetic integration as a safety strategy in the operating room.

According to Methangkool, Cole, and Cannesson (2020), continuous improvement in anesthesia safety depends on a combination of well-defined processes, appropriate technology, and an organizational culture focused on safety. The use of specific checklists for ERAS, as described by Pilkington et al. (2023), emerges as an effective operational tool for reducing omissions and process errors in critical stages of surgical care.

The analysis of the applicability of ERAS in different surgical specialties demonstrates its versatility and potential for adaptation. Specific guidelines and studies point to consistent benefits in areas such as colorectal surgery, esophagectomy, lung surgery, bariatric surgery, gynecologic oncology, orthopedics, neurosurgery, and pediatrics, as evidenced by Low et al. (2019), Batchelor et al. (2019), Thorell et al. (2016), Bogani et al. (2021), and Rove, Edney, and Brockel (2018).

In the field of neurosurgery and spine surgery, recent studies indicate growth in the implementation of ERAS protocols, with specific adaptations focused on neurological safety and functional recovery, as discussed by Wang, Chang, and

Grossman (2017), Wainwright, Immins, and Middleton (2016), Belouaer et al. (2023), and Jolly et al. (2024). These findings reinforce that the effectiveness of ERAS depends more on the quality of implementation than on the type of surgical procedure.

Finally, as highlighted by Mithany et al. (2023) and Bugada et al. (2016), ERAS represents an evolution in surgical care by integrating science, innovation, and safety, promoting a patient-centered and outcome-oriented care model. This review reinforces that the consolidation of ERAS protocols as a cross-cutting patient safety strategy requires institutional support, clinical leadership, and continuous training of teams, ensuring its sustainability and positive impact on healthcare practice.

FINAL CONSIDERATIONS

The evidence synthesized in this review demonstrates that ERAS (Enhanced Recovery After Surgery) Protocols are a robust and effective strategy for improving perioperative care, with a direct impact on patient safety in the operating room. The integration of surgical, anesthetic, and multidisciplinary practices has proven to be a central element in reducing variability in care, preventing adverse events, and promoting safer and more efficient recovery.

The results indicate that components such as standardization of procedures, multimodal analgesia, rational use of anesthetic drugs, individualized fluid management, adequate monitoring, and the use of operational tools, such as specific checklists, contribute significantly to reducing intraoperative and postoperative complications. In addition, the coordinated action of multidisciplinary teams and the presence of teams dedicated to ERAS strengthen communication, shared decision-making, and a culture of safety in the surgical environment.

Analysis of the applicability of ERAS protocols in different surgical specialties highlights their versatility and potential for adaptation to various clinical contexts, from general and oncological surgeries to highly complex procedures, such as neurosurgery, spine surgery, and pediatric surgery. However, the literature also points to challenges related to the full implementation of ERAS, highlighting the importance of institutional support, clinical leadership, and continuous training of teams to ensure the sustainability of the model.

Thus, it is concluded that ERAS protocols represent a cross-cutting, evidence-based approach to promoting patient safety and should be encouraged as a priority strategy for improving the quality of perioperative care.

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