TITU MAIORESCU" UNIVERSITY OF MEDICINE AND PHARMACY, BUCHAREST

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DOCTORAL THESIS

THE IMPORTANCE OF THE ERAS PROTOCOL IN COLORECTAL ONCOLOGIC SURGERY

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TABLE OF CONTENTS

CURRENT STATE OF KNOWLEDGE

Colorectal cancer (CRC) represents a major public health concern, with a steadily increasing incidence over recent decades, particularly in developed and developing countries. Globally, CRC is the third most common form of cancer and the second leading cause of cancer-related mortality, with an estimated death toll exceeding 900,000 cases annually [1]. In Romania, epidemiological trends mirror this upward trajectory, with many cases still being diagnosed in advanced stages, despite the presence of nascent screening programs.

The pathogenesis of colorectal cancer is multifactorial, involving genetic predispositions (such as Lynch syndrome and familial adenomatous polyposis) [2–5], environmental factors (high-protein diet, low fiber intake, alcohol and tobacco consumption) [6–8], as well as pre-existing inflammatory bowel diseases. Screening through colonoscopy and fecal immunochemical tests has significantly reduced mortality, although the effectiveness of these methods largely depends on population participation rates and healthcare system infrastructure [9–11].

The standard treatment for colorectal cancer is surgical, with or without the addition of neoadjuvant or adjuvant therapy, depending on tumor location and staging [3, 4, 12]. Modern oncological surgery is based on principles such as en bloc resection with safe oncological margins, complete mesocolic excision (CME), and minimally invasive techniques, which provide comparable oncological outcomes along with clear postoperative benefits.

Despite surgical and technological advancements, postoperative complications continue to affect patient outcomes adversely. Prolonged ileus, wound infections, anastomotic leaks, and pulmonary complications remain limiting factors for optimal recovery. Moreover, hospital stays are often extended and inconsistent, negatively impacting both healthcare costs and patient satisfaction.

In this context, the concept of Enhanced Recovery After Surgery (ERAS) has emerged as a groundbreaking model of perioperative care. Initially developed in colorectal surgery, the ERAS protocol integrates evidence-based interventions applied in a standardized manner before, during,

and after surgery. Its primary objective is to minimize surgical stress and systemic inflammation, reduce complications, and accelerate physiological recovery while shortening hospital stays.

ERAS components include preoperative counseling, nutritional and physical status optimization, avoidance of prolonged fasting, preoperative carbohydrate loading, regional anesthesia, minimization of drains and unnecessary catheters, early oral intake, and mobilization within the first 24 hours postoperatively. The protocol requires active involvement from a multidisciplinary team - surgeon, anesthesiologist, nutritionist, nursing staff, psychologist, kinetotherapist - and relies on strict adherence to each step.

Numerous international multicenter studies have confirmed the effectiveness of ERAS in reducing postoperative complications, shortening hospital stay by 2–4 days, and lowering readmission rates, without compromising oncological safety. Furthermore, a significant reduction in opioid consumption has been observed, contributing to faster return of bowel function and improved patient comfort.

In Romania, full implementation of the ERAS protocol remains uneven. The absence of institutional protocols, resistance to change, and the need for specialized training limit its widespread adoption. Nonetheless, interest in ERAS is growing, and the collection of local clinical data is becoming essential to support a paradigm shift in surgical care.

The present study aligns with this direction, aiming to provide an applied analysis of the impact of ERAS protocol implementation in colorectal oncologic surgery, through an objective comparison between two distinct patient cohorts: one managed with conventional methods and the other treated according to ERAS principles.

PERSONAL CONTRIBUTIONS

The present work represents the result of a retrospective, comparative clinical study conducted within a tertiary-level surgical unit, aiming to evaluate the impact of implementing the Enhanced Recovery After Surgery (ERAS) protocol in colorectal oncologic surgery.

The study included a cohort of 231 patients diagnosed with colorectal cancer and surgically treated by teams leaded by the same main surgeon between January 2016 and December 2023. The patients were divided into two distinct groups:

- **Pre-ERAS group** (n=147): managed according to traditional perioperative care principles;
- **ERAS group** (n=84): treated following ERAS program guidelines.

The primary objective of the study was to compare clinical and functional outcomes between the two groups, with a focus on:

- incidence of postoperative complications,
- length of hospital stay,
- time to return of bowel function,
- need for postoperative analgesia,
- hospital readmission rate.

The analysis was structured into two separate studies, each addressing a specific dimension of the ERAS protocol's impact. Study 1 involved a descriptive analysis of the overall patient cohort, including demographic data, comorbidities, tumor location, types of surgical interventions, and postoperative outcomes. Study 2 assessed clinical and biological outcomes comparatively, based on the application or omission of the ERAS protocol. Emphasis was placed on bowel function recovery, complication rates, inflammatory markers, and healthcare resource utilization. Each stage of the research included detailed statistical analysis, and the interpretations were formulated in correlation with current literature.

The thesis concludes with a synthesis of the findings, along with a discussion of methodological limitations and directions for future research.

Study 1

Descriptive Analysis of Patients Undergoing Surgical Treatment for Colorectal Cancer

Introduction and methodology

In order to evaluate the impact of the Enhanced Recovery After Surgery (ERAS) protocol in colorectal oncologic surgery, we conducted a retrospective, analytical study within a general surgery department of a university-affiliated clinical hospital over eight years (January 2016 – December 2023). The primary aim was to compare clinical, postoperative, and functional outcomes between two groups of oncologic patients, based on the type of perioperative care received: conventional versus ERAS.

A total of 231 patients with histopathologically confirmed colorectal cancer who underwent curative surgical intervention were included in the analysis. The cohort was divided into two subgroups:

- **Pre-ERAS group:** 84 patients treated between 2016–2019 with standard perioperative care;
- **ERAS group:** 147 patients treated between 2020–2023 according to ERAS principles, following implementation of the protocol in our unit.

Inclusion criteria were: diagnosis of colorectal adenocarcinoma, complete preoperative staging, and elective surgical treatment. Exclusion criteria included emergency surgeries, patients with multiple metastases at the time of intervention, and those undergoing palliative procedures. Data were collected from patient medical records, operative reports, and hospital admission registries.

Statistical analysis was performed using SPSS version 26. Depending on variable distribution, appropriate statistical significance tests were applied (Chi² test, t-test, Mann–Whitney test). The level of significance was set at $p < 0.05$.

Results and discussion

General characteristics of the study population

The sex distribution of the 231 patients was relatively balanced: in the pre-ERAS group, there were 64 women (47.8%) and 70 men (52.2%), while in the ERAS group, there were 44 women (45.4%) and 53 men (54.6%). The differences between the two groups were not statistically significant.

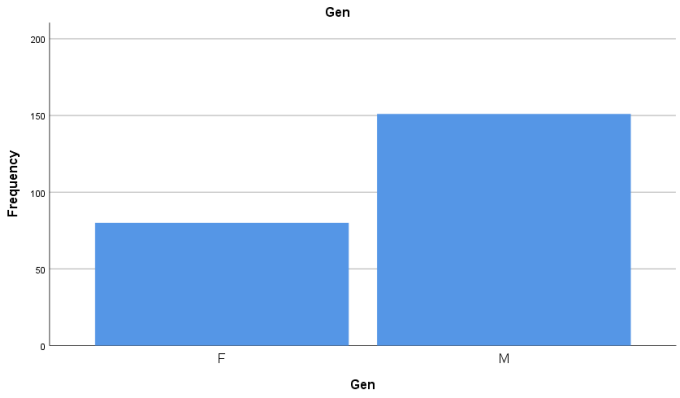

Figure 1. Sex distribution (F – female; M – male)

The mean age of patients was 67.47 years in the pre-ERAS group and 66.16 years in the ERAS group, with no statistically significant difference (p=0.353). Age distribution by decade confirmed a relatively homogeneous representation between subgroups, with a predominance of patients aged 60–79 years.

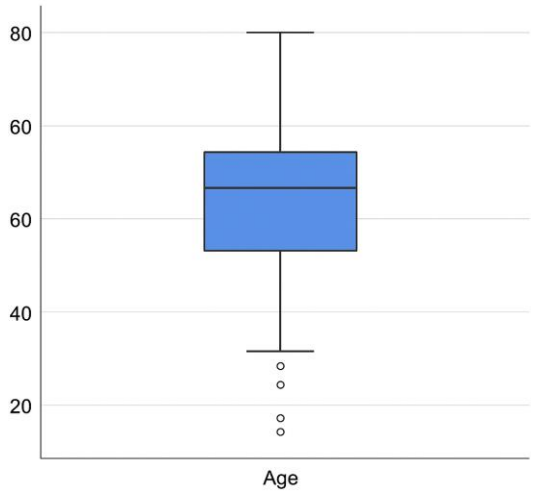

Figure 2. Age distribution

Regarding comorbidities, the analysis revealed a high prevalence of arterial hypertension, observed in 90 patients (67.2%) in the pre-ERAS group and 62 patients (63.9%) in the ERAS group (p=0.613). Diabetes mellitus was present in 25.4% of pre-ERAS patients and 24.7% of ERAS patients (p=0.901). Ischemic heart disease, obesity, and COPD were comparable between the groups, with no statistically significant differences.

The presence of multiple comorbidities (≥2 associated chronic diseases) was recorded in 52 patients (38.8%) in the pre-ERAS group and 35 patients (36.0%) in the ERAS group, with no significant difference (p=0.681), supporting the comparative validity of the two cohorts.

Tumor location

In the analyzed cohort (n=231), the anatomical distribution of colorectal tumors showed a predominance of rectal lesions (39%), followed by those located in the sigmoid colon (19.9%) and ascending colon (7.8%). Tumors located at the hepatic flexure (6.1%) and splenic flexure (5.2%) were less frequent, while other locations—such as the cecum (5.2%), descending colon (1.7%), and rectosigmoid junction (7.4%)—had lower prevalence.

This distribution reflects the typical pattern of colorectal carcinogenesis, in which segments with longer intestinal transit time, such as the rectum and sigmoid colon, are more prone to the development of adenocarcinomas.

The statistical comparison of the three major regions (right colon, left colon, rectum) revealed no significant differences between the ERAS and pre-ERAS groups ($p = 0.862$), indicating adequate homogeneity in tumor distribution. This aspect is essential for the validity of interpreting the impact of surgical interventions and perioperative care protocols on postoperative outcomes.

Rectal localization accounted for approximately 40% of cases in both groups, confirming the known epidemiological profile of colorectal cancer, in which the rectal segment is highly prevalent and presents particular therapeutic implications, including indications for neoadjuvant chemoradiotherapy, total mesorectal excision (TME) techniques, and sphincter-preserving approaches.

Preoperative biological parameters

The preoperative biological parameters analyzed in the study cohort included hemoglobin, leukocyte count, blood glucose, urea, creatinine, and total serum proteins. These data were used to characterize the general condition and preoperative biological risk.

The values indicated a significant proportion of patients with moderate anemia, hypoproteinemia, and minor hydro-electrolyte imbalances, consistent with the oncological status and average age of the analyzed cohorts.

Including these investigations in the preoperative assessment allowed for better individualization of perioperative care and contributed to anticipating possible postoperative complications.

Postoperative biological parameters

Postoperative biological parameters were monitored on days 2 and 4 after surgery, aiming to evaluate systemic inflammatory response, blood loss, and metabolic changes induced by surgical stress.

Postoperative leukocytosis peaked on day 2 (mean: 9.85 $x10^3/\mu L$), followed by a decrease on day 4 (mean: 8.98 $x10^3/\mu L$), suggesting a transient inflammatory response with a tendency toward resolution. C-reactive protein (CRP) peaked at 104.87 mg/L on day 2, decreasing to 66.09 mg/L by day 4, paralleling the favorable evolution in most cases.

Hemoglobin showed a slight postoperative decline, reflecting intraoperative blood loss and volume dilution, while serum albumin decreased from a preoperative mean of 3.95 g/dL to 3.10 g/dL on postoperative day 4, indicating an early catabolic response.

A mild decrease in total protein, serum iron, and ferritin levels completed the postoperative metabolic profile, indicating acute-phase activation and inflammation-associated iron redistribution.

Types of surgical procedures, surgical approach, and duration

Surgical interventions were individually tailored according to tumor location, clinical stage, and the biological status of each patient. The most frequent procedures included right hemicolectomy, left hemicolectomy, sigmoidectomy, low anterior resection, and abdominoperineal amputation, along with atypical segmental resections.

Most patients were operated on using a laparoscopic approach (78.4%), while open surgeries accounted for 21.6% of cases, reflecting the preference for minimally invasive techniques in modern colorectal surgery [13].

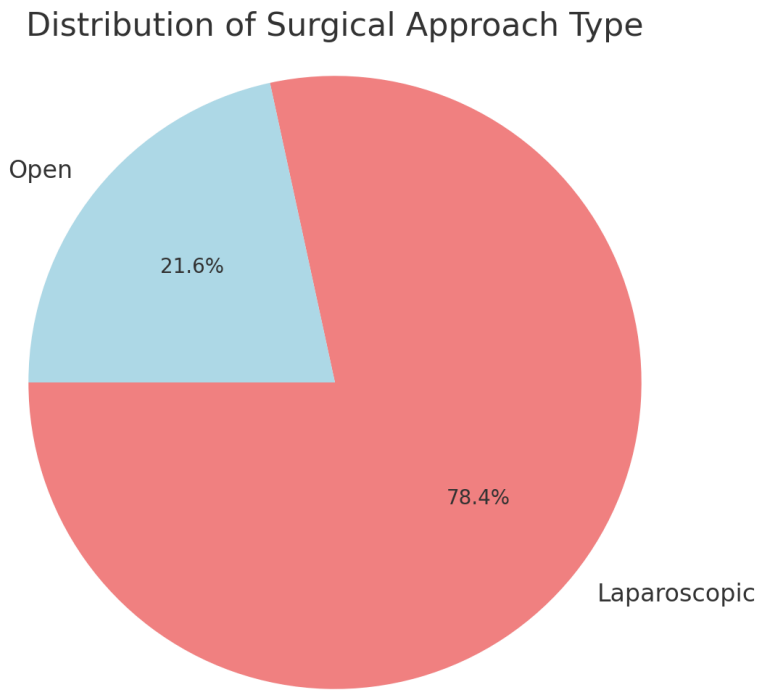

Figure 3. Distribution of surgical approach type in the treatment of colorectal cancer

The distribution of surgical procedure durations in the analyzed cohort revealed a mean operative time of 261.68 minutes, with a standard deviation of 79.67 minutes. Most procedures fell within the 200–300 minute range, suggesting a moderate to high level of surgical complexity, characteristic of major oncological interventions in a tertiary care center.

Operative times exceeding 300 minutes were associated with advanced-stage cases or technically demanding procedures, such as extended resections or challenging minimally invasive approaches. The data distribution showed a slight right skew, indicating the presence of exceptionally long procedures, potentially influenced by patient comorbidities or intraoperative challenges.

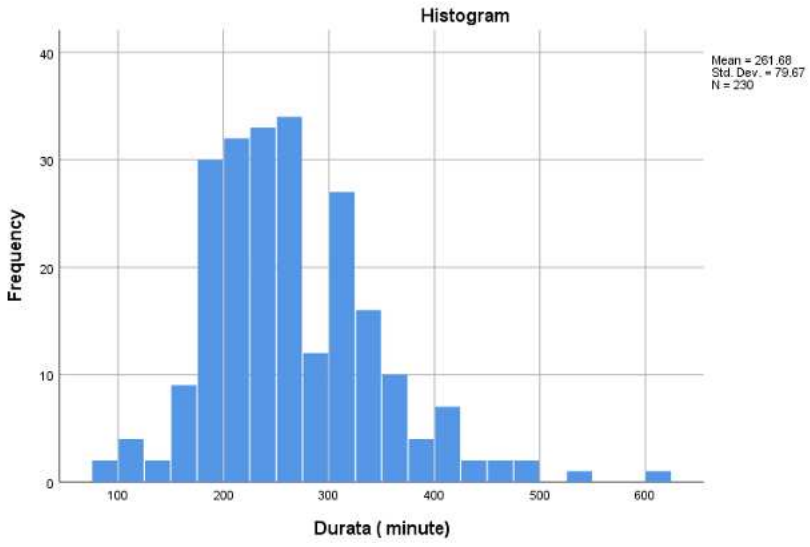

Figure 4. Distribution of surgical procedure duration in the treatment of colorectal cancer.

Duration of surgery is a significant factor in determining postoperative risk and may justify additional measures, such as the use of protective ileostomies in selected cases.

Postoperative course: return of bowel function, mobilization, and oral feeding

In the analyzed cohort (n = 231), functional postoperative recovery was assessed by monitoring the return of bowel function, active mobilization, and resumption of oral intake.

Most patients passed flatus within the first 3 postoperative days, and bowel movements resumed on average by postoperative day 4. Nasogastric aspiration was not used postoperatively in any patient, reflecting adherence to ERAS principles by avoiding unnecessary invasive procedures and promoting patient comfort.

Patient mobilization was initiated within the first 48 hours postoperatively in most cases, depending on general condition, level of cooperation, and type of surgery. The urinary catheter was removed early (day 1 or 2) in 79.2% of patients (n=183), following ERAS guidelines, contributing to a reduced risk of urinary tract infections and facilitating early ambulation.

Oral intake was reintroduced based on individual tolerance, supported by the fact that 97.8% of patients (n=226) received adequate postoperative nutritional support.

Postoperative complications

Postoperative complications were classified according to the Clavien–Dindo system and were identified in 76 of the 231 patients (32.9%). The most frequent complications were: postoperative anemia (14.7%), transient ileus (9.1%), wound infections (3.9%), and urinary retention (3.5%). Anastomotic fistula occurred in 8 patients (3.5%), and pulmonary complications were observed in 5 patients (2.2%).

Most events were classified as minor (grade I–II), while major complications (grade III–IV) were rare and associated with the need for reintervention or extended ICU stay.

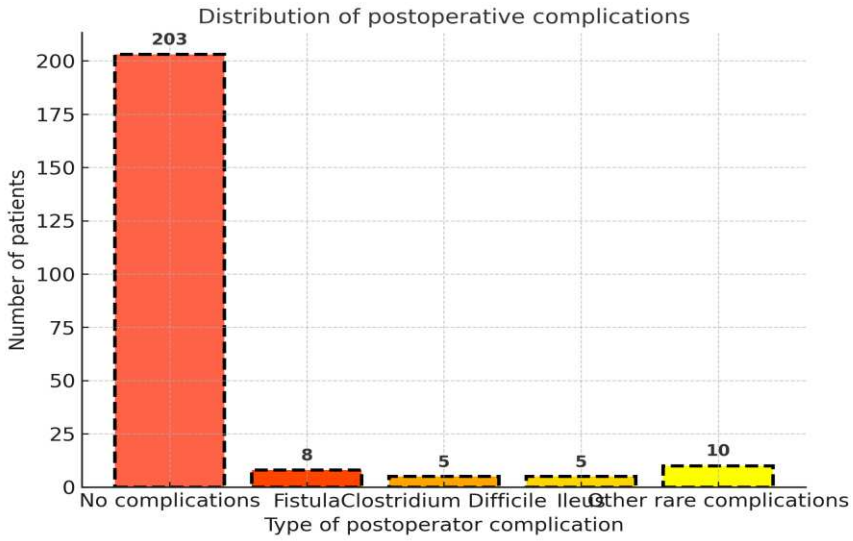

Figure 5. Distribution of postoperative complications

Length of hospital stay and ICU monitoring

The average length of hospital stay was 7.26 days, ranging from 4 to 55 days. The distribution showed that:

- 65% of patients had a hospital stay between 4 and 7 days (optimal recovery),
- 22% stayed between 8 and 14 days (delayed recovery or minor complications),
- 13% remained hospitalized for more than 14 days (major complications such as fistulas or prolonged ileus).

The application of ERAS principles contributed to the reduction of hospital stay duration in uncomplicated cases through early mobilization, prompt reintroduction of nutrition, and the avoidance of unnecessary tubes and drains.

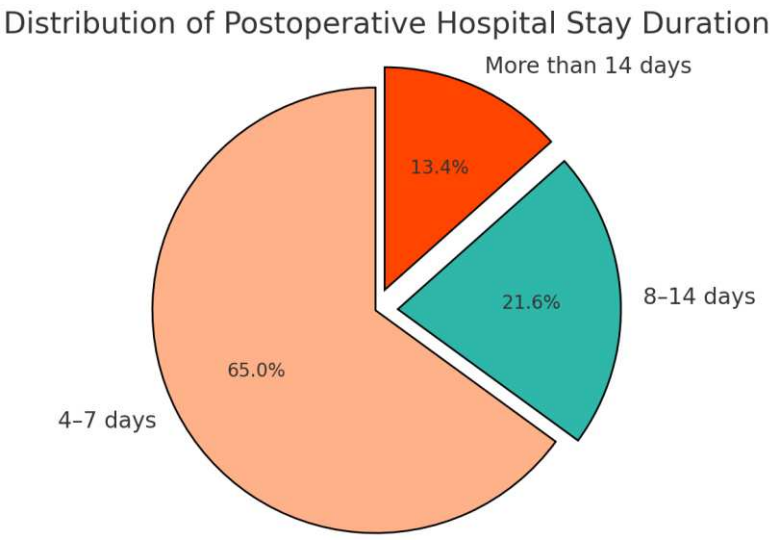

Figure 6. Distribution of hospitalization duration

Admission to the intensive care unit (ICU) was required for 54 patients (23.4%). The majority were admitted for short periods of 1–3 days, while only 5 patients (2.1%) required prolonged care (more than 4 days), due to severe postoperative complications. These findings confirm the effectiveness of selective postoperative monitoring and modern enhanced recovery strategies.

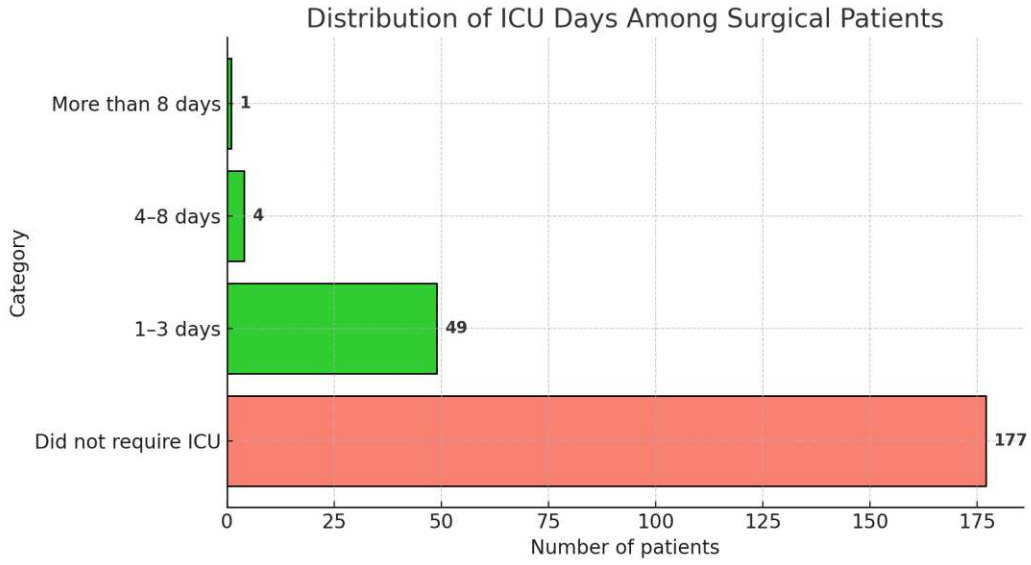

Figure 7. Distribution of ICU stay duration

Conclusions

The descriptive analysis of the cohort of 231 patients with colorectal cancer revealed a balanced distribution by sex and age, a high prevalence of cardiovascular and metabolic comorbidities, as well as a predominance of tumors located in the rectum and left colon. The surgical procedures varied, reflecting the practice in a tertiary-level oncologic surgery unit, with a majority of laparoscopic approaches.

The evaluation of pre- and postoperative biological parameters helped outline a characteristic metabolic and inflammatory profile of the postoperative oncologic patient, highlighting the importance of early monitoring in guiding therapeutic management.

Postoperative complications were frequent but mostly minor, and the average length of hospital stay was 7.26 days. The low number of prolonged intensive care unit admissions confirms the effectiveness of standardized surgical management and the application of ERAS principles.

The data obtained provide a solid foundation for further comparison between conventional care and the ERAS protocol, contributing to a better understanding of the biological and clinical status of patients before the systematic implementation of an enhanced recovery program.

Study 2

Assessment of the impact of ERAS protocol implementation on postoperative recovery, complications, and healthcare resource utilization

Introduction and methodology

Following the descriptive analysis of the oncologic patient cohorts (Study 1), this study aimed to comparatively evaluate the impact of full ERAS protocol implementation on postoperative **outcomes in colorectal surgery.** While the first stage focused on demographic and clinico-biological characteristics, the present study concentrates on the differences between the fully implemented ERAS group and the non-ERAS group regarding functional recovery parameters, postoperative complications, biological status, and hospital resource utilization.

The general objective is to demonstrate, through quantitative methods, that systematic application of ERAS principles leads to faster recovery, a reduction in complications, and more efficient use of medical resources. The working hypothesis assumes that early mobilization, early feeding, multimodal analgesia, and avoidance of unnecessary tubes and drains contribute to reduced systemic inflammation and improved postoperative prognosis.

The working hypothesis of this study was that complete and systematic implementation of the Enhanced Recovery After Surgery (ERAS) protocol in oncologic colorectal surgery significantly improves postoperative outcomes compared to conventional care. It is assumed that coordinated application of ERAS elements—early mobilization, oral feeding, multimodal analgesia, and avoidance of unnecessary catheterization and drainage—reduces perioperative physiological stress and systemic inflammation, positively impacting functional recovery, complication rates, and hospital stay duration.

The study was conducted as a prospective and retrospective observational analysis on a cohort of 231 patients diagnosed with colorectal cancer and operated with curative intent between January 2016 and December 2023 in the 1st Department of General Surgery at the Central Military

Emergency University Hospital "Dr. Carol Davila" in Bucharest, Romania. Patients were divided into two subgroups:

- **ERAS Group**: 147 patients (63.6%) operated between 2020–2023, in whom the protocol was fully implemented;
- **Pre-ERAS Group**: 84 patients (36.4%) treated between 2016–2019, where ERAS principles were either partially applied or absent.

The following were evaluated:

- Postoperative functional parameters (return of flatus, bowel movement, mobilization, oral feeding);
- Postoperative complications (minor and major, according to the Clavien–Dindo classification);
- Biological markers (leukocyte count, C-reactive protein, ESR);
- Resource utilization (transfusions, drains, opioid use, antibiotic therapy, ICU admission);
- Length of hospital stay.

Data were collected from medical records, surgical reports, and postoperative progress charts. Statistical analysis was performed using SPSS v.26, with the application of t-Student, Chi^2, and Mann–Whitney tests according to data distribution. The threshold for statistical significance was set at $p < 0.05$.

Results and discussion

Characteristics of the studied population

The two groups were statistically balanced in terms of demographic, clinical, and surgical characteristics. No significant differences were observed in average age (67.47 vs. 66.16 years), sex distribution (balanced M/F ratio), presence of comorbidities (hypertension, diabetes mellitus, ischemic heart disease, COPD), tumor staging, or anatomical location of the lesions.

The distribution of surgical procedures (right and left hemicolectomies, sigmoidectomies, rectal resections) was also comparable, with no statistically significant variations, validating the assumption of cohort homogeneity. Thus, the differences observed in outcomes can be more reliably attributed to the implementation of the ERAS protocols.

Figure 1. Sex distribution of patients included in the study

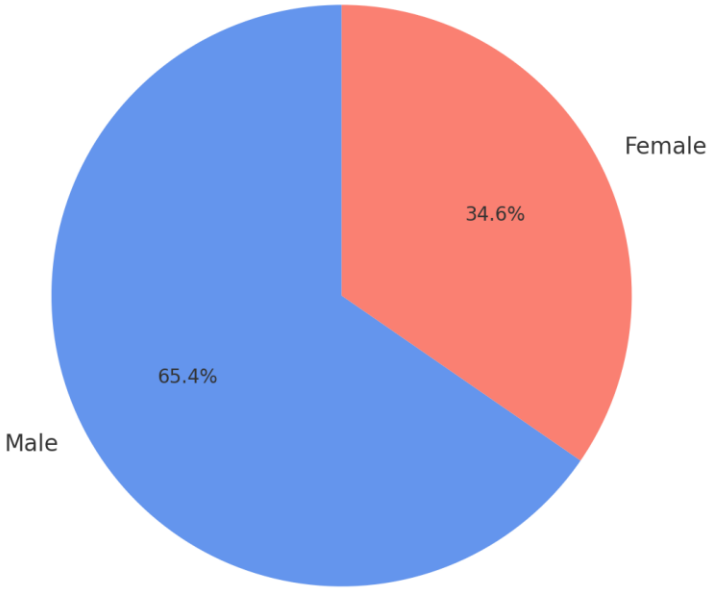

Figure 8. Sex distribution of the patients included in the study.

Postoperative recovery and resumption of physiological functions

The implementation of the ERAS protocol had a significant impact on the accelerated recovery of postoperative physiological functions, through the standardization of measures such as early mobilization and the avoidance of unnecessary invasive devices.

Early removal of the urinary catheter was achieved within the first two postoperative days in 85.7% of patients in the ERAS group, compared to 67.9% in the non-ERAS group (p=0.001). This measure was applied differently depending on the type of resection: on postoperative day 1 for colon surgeries and on day 2 for rectal procedures. In the non-ERAS group, catheterization was maintained for a longer period, which increased the risk of urinary tract infections and delayed mobilization.

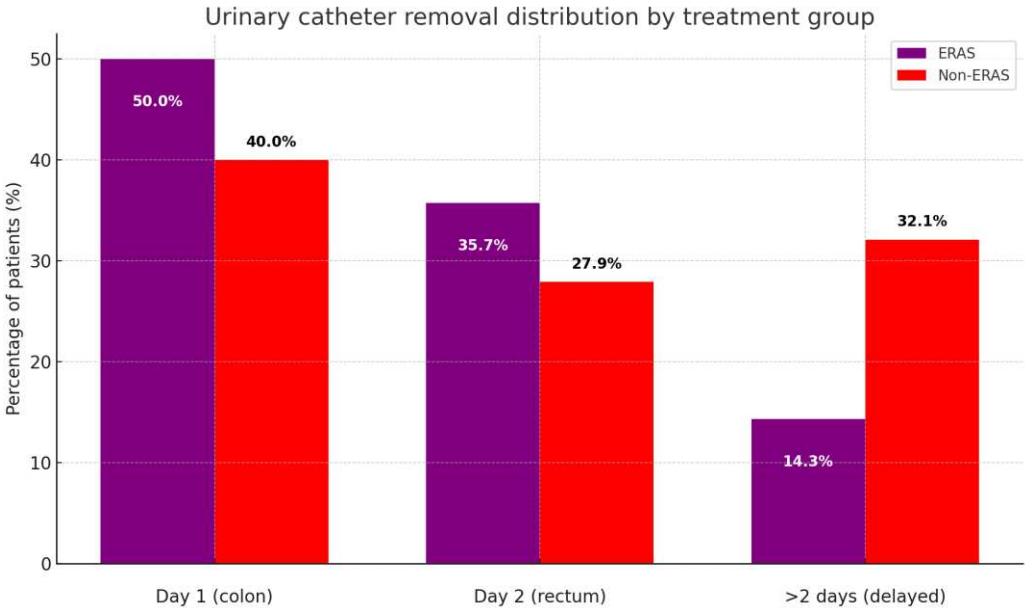

Figure 9. Comparison of urinary catheter removal between ERAS and Non-ERAS groups

Peritoneal drainage was completely avoided in the ERAS group, in accordance with modern principles of surgical care. In contrast, 48.8% of patients in the non-ERAS group required postoperative drainage ($p<0.001$), with no significant benefits observed in the prevention of complications.

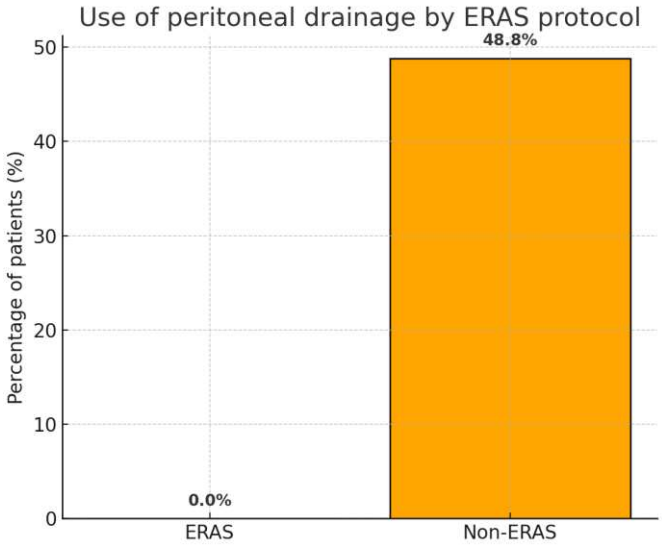

Figure 10. Use of peritoneal drainage according to the ERAS protocol

Nasogastric aspiration was not used in either group, contributing to reduced postoperative discomfort and earlier resumption of oral feeding.

These standardized interventions led to faster functional recovery, lowering the risk of ileus, urinary complications, and device-associated infections, thereby significantly improving patient comfort and safety in the immediate postoperative period.

Postoperative complications

The implementation of the ERAS protocol was associated with a significant reduction in postoperative complications compared to conventional care ($p<0.001$). In the ERAS group, 98.6% of patients experienced no complications during hospitalization, compared to 69% in the non-ERAS group.

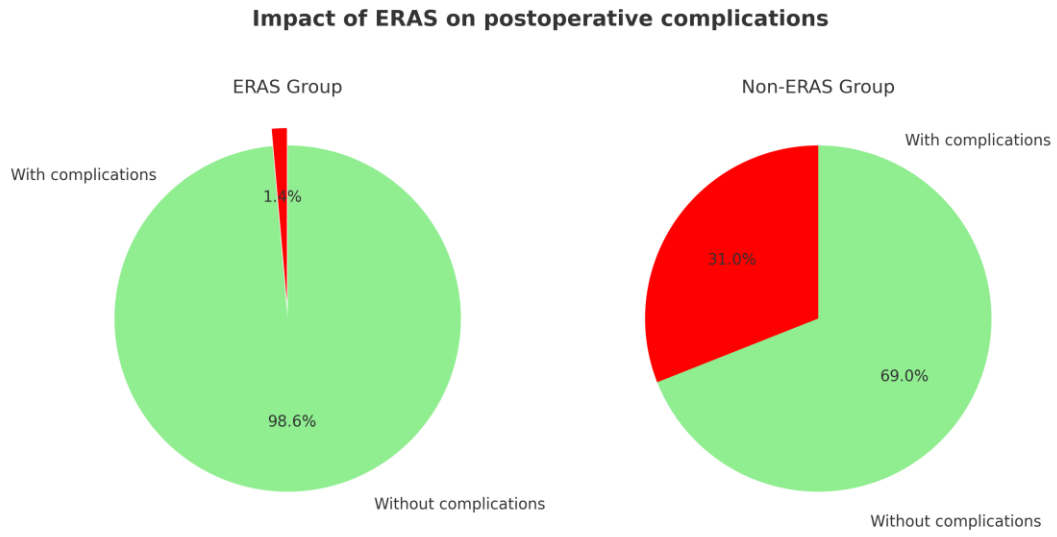

Figure 11. Impact of ERAS on Postoperative Complications

Among in-hospital complications, anastomotic fistula had an incidence of 9.5% in the non-ERAS group, while no cases were recorded in the ERAS group. Postoperative ileus was reported in 2.4% of non-ERAS patients and 0.7% in the ERAS group. *Clostridium difficile* infections occurred exclusively in the non-ERAS group (6%), as did hemoperitoneum and wound suppuration (1.2% and 2.4%, respectively).

Complications occurring after discharge were significantly less frequent in the ERAS group, where the readmission rate was 0%, compared to 2.4% in the non-ERAS group. Additionally, a postoperative death was reported only in the non-ERAS group.

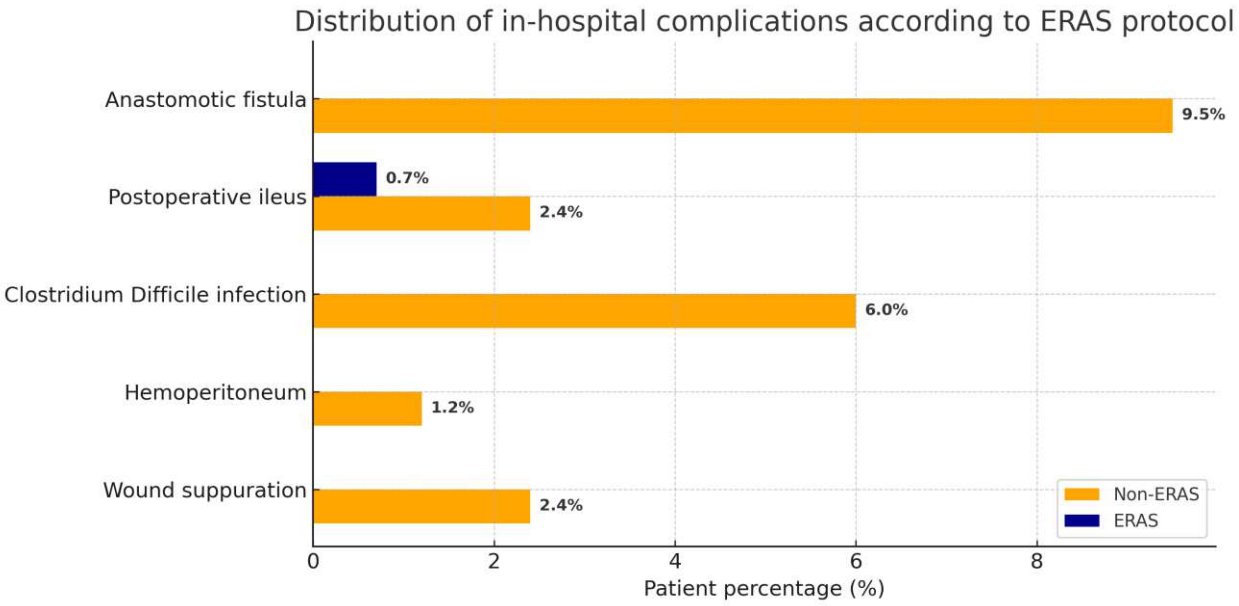

Figure 12. Distribution of in-hospital complications: comparison between ERAS and non-ERAS groups

Statistical analysis (Chi² test) confirmed a significant association between the implementation of the ERAS protocol and the reduction of postoperative complications, supporting its effectiveness in improving perioperative safety and the prognosis of oncologic patients.

Correlation of ERAS with hematologic and nutritional parameters

The implementation of the ERAS protocol included systematic interventions aimed at correcting anemia and nutritional status both pre- and postoperatively, with direct effects on postoperative recovery.

Hemoglobin: Hemoglobin levels were significantly higher in the ERAS group, both on postoperative day 2 (11.05 ± 1.5 g/dL vs. 10.57 ± 1.64 g/dL, p = 0.027) and day 4 (10.8 ± 1.24 g/dL vs. 10.4 ± 1.49 g/dL, p = 0.030), reflecting the effectiveness of anemia correction strategies. Avoiding preoperative blood transfusion—associated with increased oncologic risk—was a major objective of the protocol.

Iron administration and transfusion: On day 2, transfusion requirements were higher in the non-ERAS group (11.9%), while intravenous iron administration was low in both groups. By day 4, IV iron supplementation increased to 19% in both groups, while transfusion needs decreased

significantly in the ERAS group (2.0%), indicating improved efficiency in maintaining hematologic homeostasis.

Albumin: Serum albumin levels were significantly higher in the ERAS group on both day 2 (3.11 ± 0.48 g/dL vs. 2.89 ± 0.51 g/dL, $p = 0.001$) and day 4 (3.10 ± 0.50 g/dL vs. 2.83 ± 0.70 g/dL, $p = 0.001$). Higher albumin levels reflect better nutritional status and are associated with a lower rate of complications (infections, delayed wound healing).

These results highlight the benefits of ERAS in maintaining hematologic and nutritional balance, confirming the importance of an integrated perioperative management approach for optimizing the recovery of oncologic patients.

Minimally invasive surgery and its impact on postoperative outcomes

The ERAS protocol was implemented in a context where minimally invasive surgery was the predominant approach in the intervention group. Laparoscopic surgery was performed in 98.6% of patients in the ERAS group, compared to 42.9% in the non-ERAS group ($p < 0.001$), reflecting a significant difference in surgical strategy. This technique reduced surgical trauma, decreased systemic inflammation, and allowed for faster recovery of physiological functions postoperatively.

Pain management was optimized through multimodal strategies. The need for opioid analgesics was significantly lower in the ERAS group, due to the intraoperative administration of non-steroidal anti-inflammatory drugs (NSAIDs), the use of loco-regional blocks (including TAP block), and the avoidance of painful catheters. This effective pain control contributed to early mobilization and a reduced incidence of immobility-related complications.

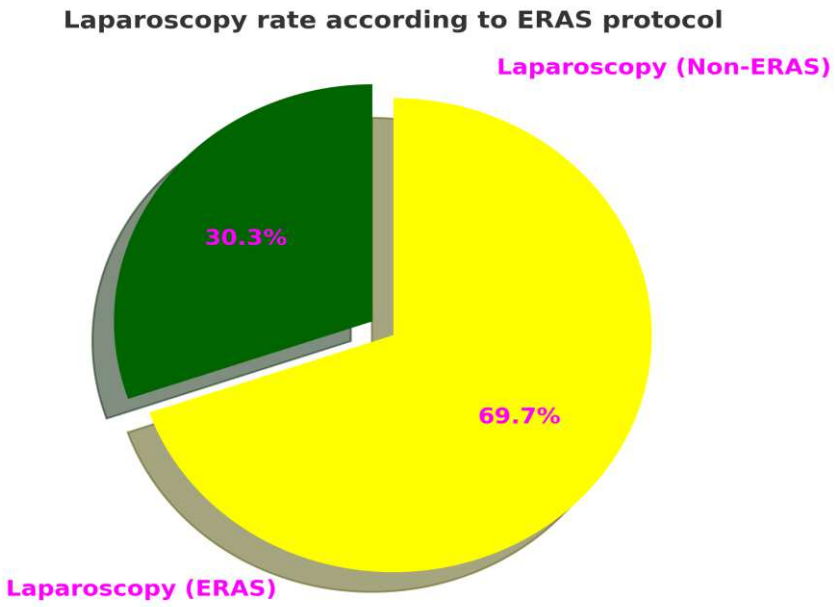

Figure 13. Frequency of laparoscopy use according to ERAS protocol

From the perspective of intraoperative management, all patients in the ERAS group benefited from measures to prevent hypothermia, including the use of warmed infusion solutions and thermal blankets (100%, $p<0.001$), with a favorable effect on the perioperative physiological response.

Additionally, abdominal drains were completely avoided in the ERAS group (0% vs. 48.8% in the non-ERAS group, $p<0.001$), in line with current best practice principles, reducing postoperative discomfort and the risk of associated infections.

These results highlight the effectiveness of integrating minimally invasive techniques and optimized intraoperative management within an ERAS protocol, with direct benefits on patient comfort, length of hospital stay, and overall clinical outcomes.

Optimizing the use of medical resources

The implementation of the ERAS protocol contributed to a more efficient use of perioperative resources, with significant benefits in terms of hospital stay duration, transfusion requirements, and opioid analgesic consumption.

The average length of hospital stay was significantly reduced in the ERAS group, with 5.51 ± 2.11 days compared to 10.33 ± 10.11 days in the non-ERAS group ($p < 0.001$). This difference correlated with early return of bowel function, rapid mobilization, and a lower incidence of complications.

The need for blood transfusion was lower in the ERAS group (4.1%) compared to the non-ERAS group (11.9%), due to optimized anemia treatment through intravenous iron and reduced intraoperative blood loss, although the difference did not reach the threshold for statistical significance ($p = 0.071$).

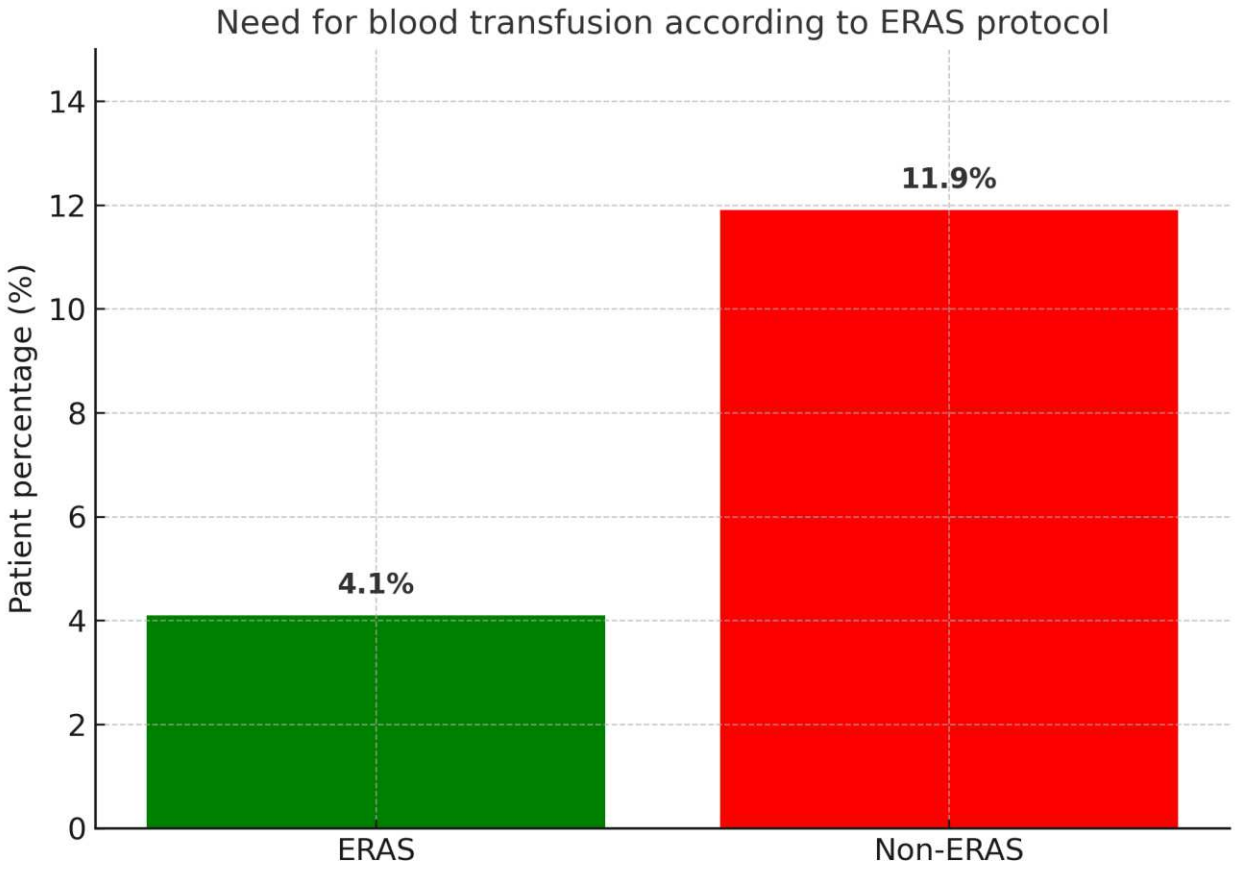

Figure 14. Blood transfusion in the studied population

All patients received multimodal analgesia, and opioid use was significantly reduced in the ERAS group. Techniques such as loco-regional blocks, intraoperative NSAID administration, and avoidance of painful catheters allowed for effective pain control and faster recovery.

The length of stay in the ICU was shorter in the ERAS group. Only 23.4% of patients required intensive care monitoring, mainly for 1–3 days. Prolonged ICU stays (more than 4 days) were rare, supporting the effectiveness of standardized perioperative care.

Additionally, the protocol contributed to a reduction in postoperative antibiotic duration, optimization of fluid therapy (primarily limited to the first postoperative day), and prevention of electrolyte imbalances.

Overall, the ERAS strategy demonstrated significant potential in reducing indirect hospitalization costs and optimizing resource utilization, without compromising patient safety or the quality of medical care.

Conclusions

The implementation of the ERAS protocol in colorectal oncologic surgery was associated with significant clinical benefits, as confirmed by the comparative analysis of the two study groups. The protocol led to a notable reduction in hospital stay duration, a lower incidence of postoperative complications, and decreased consumption of medical resources (opioids, antibiotics, transfusions).

Minimally invasive techniques, applied predominantly in the ERAS group, contributed to early return of bowel function, reduced postoperative pain, and earlier mobilization of patients. Avoiding invasive devices such as peritoneal drains and nasogastric tubes proved to be safe and beneficial for patient comfort and recovery.

Preoperative correction of anemia and optimization of nutritional status played an essential role in reducing transfusion needs and preventing infectious and wound-healing

complications. Moreover, early removal of urinary catheters and the use of multimodal non-opioid analgesia significantly improved functional recovery.

In conclusion, the standardized application of the ERAS protocol, tailored to the oncologic context and patient-specific factors, represents an effective strategy for improving perioperative outcomes and optimizing resource utilization in colorectal surgery.

GENERAL CONCLUSIONS AND PERSONAL CONTRIBUTIONS

The present study demonstrated that the implementation of the Enhanced Recovery After Surgery (ERAS) protocol is both feasible and beneficial in colorectal surgery in Romania, even within a healthcare system characterized by limited resources and resistance to change. Full application of ERAS measures led to a significant reduction in postoperative complications, hospital length of stay, and the need for medical resources such as drains, antibiotics, or opioids.

A key element of this endeavor was patient education and active involvement in the recovery process, through a standardized preoperative questionnaire and through nutritional and metabolic measures initiated in the preoperative phase. It was shown that minimally invasive interventions (especially laparoscopy), along with strategies such as early mobilization, avoidance of drains, and optimization of hematologic and nutritional status, significantly accelerate functional recovery and reduce complications.

This research made a concrete contribution by adapting and locally validating the ERAS protocol through a systematic evaluation of all perioperative stages, with rigorous classification of complications and analysis of their correlation with biological and clinical parameters. Additionally, the economic benefits of ERAS were highlighted through reduced hospital stay and decreased use of ICU resources.

The dissertation offers a model for implementing standardized care in oncologic surgery and opens new research directions regarding the extension of ERAS to other fields (e.g., hepatobiliary and pancreatic surgery), multicentric studies, and detailed economic evaluations. Thus, the thesis contributes to establishing a modern and effective standard of perioperative care in Romania.

LIMITATIONS OF THE STUDY AND RESEARCH PERSPECTIVES

The study highlighted the feasibility and benefits of ERAS implementation in colorectal surgery, as well as several limitations that must be considered. The main challenges were related to patient reluctance toward protocol-driven changes (early mobilization, avoidance of drains, early resumption of oral intake) and the hesitation of medical staff to fully adopt ERAS principles despite favorable scientific evidence. These barriers can be overcome through expanded medical education, dedicated training sessions, and better patient information.

Another important aspect is the single-center nature of the study, which limits the generalizability of the conclusions. For broader validation of the results, multicenter studies are recommended to assess ERAS implementation in various institutional settings.

A further challenge was the lack of specialized personnel, particularly physiotherapists, which impeded the standardized mobilization at 6 hours postoperatively—an essential component of the protocol. In the future, the integration of a dedicated and logistically supported program will be essential for full ERAS implementation.

Additional research is needed focusing on patients with severe comorbidities or the elderly, as well as extending the application of ERAS to other surgical specialties (hepatic, pancreatic, thoracic). In parallel, the development of accessible educational tools for patients (brochures, mobile apps, video materials) may increase compliance and understanding of the benefits of enhanced recovery.

Therefore, this study opens multiple research perspectives, emphasizing the need for an interdisciplinary approach that combines clinical, educational, and psychological interventions to ensure a comprehensive and sustainable implementation of the ERAS protocol in oncologic surgery.

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