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Authors' Affiliation:
[1]Medical University of Lodz, Al. Tadeusza Kościuszki 4, 90-419 Łódź, Poland, E-mail: szubert.gabriela@gmail.com, https://orcid.org/0009-0006-8481-9620
[2]Medical University of Lodz, Al. Tadeusza Kościuszki 4, 90-419 Łódź, Poland, E-mail: martaa.ciszewskaa@gmail.com, https://orcid.org/0009-0006-3844-3335
[3]Department of Hematology, Copernicus Memorial Hospital, 93-513 Lodz, Poland, E-mail: kacper.kopec1@stud.umed.lodz.pl, https://orcid.org/0009-0006-5318-0772
[4]Medical University of Lodz, Al. Tadeusza Kościuszki 4, 90-419 Łódź, Poland, E-mail: mgasinskafranas@gmail.com, https://orcid.org/0009-0000-9254-3149

***Corresponding author:**
Gabriela Szubert, Medical University of Lodz, Al. Tadeusza Kościuszki 4, 90-419 Łódź, Poland, E-mail: szubert.gabriela@gmail.com, https://orcid.org/0009-0006-8481-9620

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Enhanced Recovery After Surgery Protocols in Oncologic Surgery: Current Evidence and Clinical Outcomes – A Systematic Review

Gabriela Szubert[1]*, Marta Ciszewska[2], Kacper Kopeć[3], Małgorzata Gasińska-Franas[4]

ABSTRACT

Unfortunately, cancer remains one of the leading causes of morbidity and mortality worldwide. Surgical resection plays a crucial role, especially in the case of solid tumors. This poses a significant challenge for oncological surgeons, as many patients undergoing cancer surgery are elderly and suffer from numerous comorbidities, malnutrition, and anemia, which lead to complications despite the success of the tumor removal procedure itself. These complications most often involve postoperative complications and prolonged hospitalization. In the past, prolonged fasting, delayed mobilization, and, as a result, longer hospital stays were used to improve the health of cancer patients. However, recent evidence has shown that these procedures are inappropriate and can even negatively impact recovery without providing clear clinical benefits. This paper discusses the enhanced recovery after surgery (ERAS) protocols developed by the ERAS Society and cites scientific evidence demonstrating improvements in the health of patients who have undergone these procedures.

Keywords: ERAS, enhanced recovery, oncologic surgery, and cancer surgery.

1. INTRODUCTION

Cancer is still one of the main causes of illness and death around the world. Surgery remains a key part of treatment for many solid tumors. Many patients who undergo cancer surgery are older and often have other diseases, poor nutritional status, or reduced physical strength. Because of this, complications after surgery, long hospital stays, and slow recovery are common problems.

For many years, care around the time of surgery in cancer patients was based on traditional routines. These included long periods without food, staying in bed for a long time after surgery, and extended hospitalization. These methods were used mainly to ensure patient safety. However, with time, it became clear that such practices can slow recovery and lengthen hospital stays without clear benefits.

Enhanced Recovery After Surgery (ERAS) was developed as a better alternative to traditional care. Instead of focusing on single actions, ERAS combines several

proven methods used before, during, and after surgery. These include good patient education before surgery, effective pain control, early movement, and quick return to eating and drinking. The success of ERAS depends not only on these individual steps but also on good cooperation between the entire medical team, including surgeons, anesthesiologists, nurses, and other healthcare staff (Gustafsson et al., 2019).

In recent years, enhanced recovery after surgery protocols have been increasingly adopted across surgical specialties. The ERAS Society has published procedure-specific guidelines offering recommendations for perioperative care across several different oncologic fields, including colorectal, upper gastrointestinal, gynecologic, and hepatopancreatobiliary surgery. Since the implementation of enhanced recovery pathways, numerous clinical studies, as well as systematic reviews and meta-analyses, have reported shorter hospital stays and lower rates of postoperative complications, without compromising oncological outcomes. Faster postoperative recovery may also allow earlier initiation of adjuvant treatment, which is an important factor in the overall management of cancer patients (Ljungqvist et al., 2017).

Despite growing evidence supporting enhanced recovery after surgery in oncologic practice, its implementation remains inconsistent. Factors influencing this outcome may include potential measures, individual differences among patients, and the implementation of each protocol component. In addition, questions remain regarding how enhanced recovery pathways should be adapted for complex oncologic procedures and for patients receiving neoadjuvant therapies.

The aim of this review is to provide an overview of current evidence on the use of enhanced recovery after surgery protocols in oncologic surgery, with a focus on clinical outcomes, practical challenges related to implementation, and potential directions for future development.

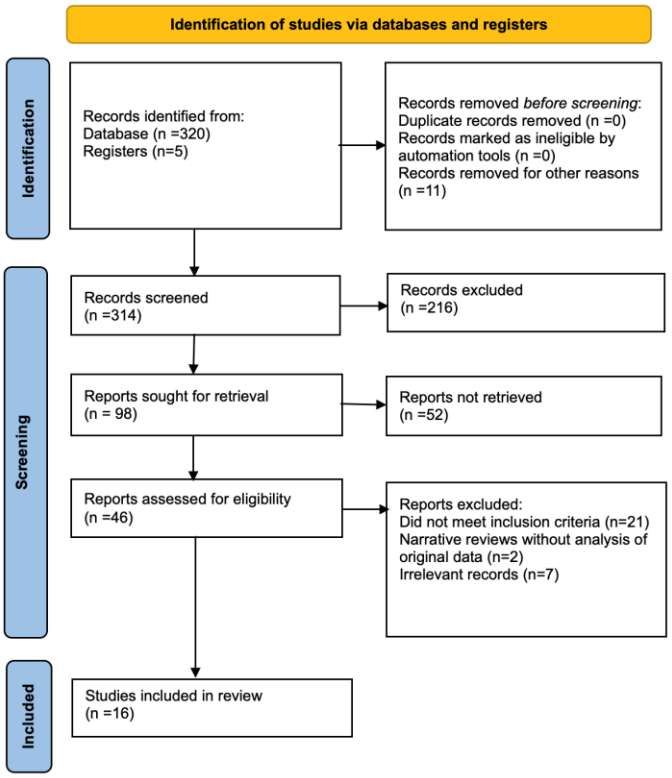

Figure 1. PRISMA chart

2. REVIEW METHODS

The literature review was conducted using major database PubMed. In our database search, we used keywords such as: ERAS, enhanced recovery, oncologic surgery, and cancer surgery. Clinical trials, meta-analyses, reviews, and international guidelines were prioritized. Articles published in English between 2014 and 2024 were included. What is more conference abstracts, case reports, and studies written that were not directly associated with ERAS protocols were excluded from analysis as shown in PRISMA diagram (Figure 1).

3. RESULTS & DISCUSSION

Principles of Enhanced Recovery After Surgery Protocols

Enhanced recovery after surgery (ERAS) protocols are used to improve perioperative care by reducing surgical-related stress and supporting faster postoperative recovery. The main idea of ERAS is not based on a single intervention but on a combination of perioperative elements applied before, during, and after surgery. These protocols have been developed and standardized by the ERAS Society and are currently used in many surgical fields, including oncologic surgery (Gustafsson et al., 2019; Ljungqvist et al., 2017).

ERAS protocols are designed to improve patient outcomes by optimizing perioperative management and by encouraging early return to normal physiological function. In oncologic patients, this may be particularly important, as many of them present with comorbidities, reduced physical condition, or nutritional deficiencies before surgery.

Preoperative optimization and patient education

Preoperative care is an important part of ERAS protocols and aims to prepare the patient for surgery both physically and mentally. Patient education and counseling are recommended to explain the surgical procedure, the expected postoperative course, and the importance of early mobilization and nutrition after surgery. A better understanding of the treatment process may help patients to actively participate in their recovery. Key components of enhanced recovery pathways include nutritional support for malnourished patients and preoperative carbohydrate loading to reduce insulin resistance (Ljungqvist et al., 2017).

Anemia is a factor that requires particular attention. It is very common in cancer patients because of risks such as vitamin B12 and iron deficiencies, blood loss from the underlying disease, or chronic inflammation. As a result, anemia can lead to perioperative complications and increased mortality (Muñoz et al., 2017). Therefore, it is recommended to optimally correct deficiencies before the planned surgery. Although perioperative blood component transfusions may seem like a good solution, these can negatively affect patient survival. In a retrospective study of 23,388 patients undergoing colorectal surgery, 7.9% received blood component transfusions, which was associated with increased surgical site infections and septic shock (Mazzeffi et al., 2017). Furthermore, in orthopedic surgery, Smilowitz NR, Oberweis BS, Nukala S et al. reported that the 4-year mortality rate in patients following blood component transfusions increased by 10% (Smilowitz et al., 2016). According to the American Society of Anesthesiologists' recommendations, the minimum hemoglobin concentration should be between 60 and 80 g/L. Considering the above, it is important to ensure that anemia is corrected well in advance of the planned procedure (American Society of Anesthesiologists Task Force on Perioperative Blood Management, 2015).

Intraoperative strategies

In enhanced recovery after surgery protocols, intraoperative care focuses on limiting surgical trauma and maintaining stable physiological conditions. Compared with open surgery, these approaches are generally associated with less postoperative pain, a lower inflammatory response, and faster functional recovery (Gustafsson et al., 2019; Nicholson et al., 2014).

Another key component of ERAS is anesthetic management. Standardized anesthetic techniques, including the use of short-acting agents and multimodal, opioid-sparing analgesia, are encouraged to reduce postoperative nausea, ileus, and sedation. Regional anesthesia techniques, such as epidural or spinal analgesia, are commonly incorporated into ERAS protocols and help attenuate the endocrine stress response and improve postoperative pain control (Ljungqvist et al., 2017; Nicholson et al., 2014).

Intraoperative fluid management is another important element of ERAS protocols. Both excessive fluid administration and hypovolemia have been associated with adverse postoperative outcomes. In most cases, crystalloid fluid therapy at a dose of 1–4 ml/kg/h is recommended to maintain body homeostasis. The goal of this protocol is to provide individualized, goal-oriented fluid therapy, maintaining a near-zero fluid balance between preoperative and postoperative fluid levels. By doing this, the risk of postoperative complications, particularly delayed gastrointestinal recovery, is reduced (Gustafsson et al., 2019; Thiele et al., 2015).

Postoperative care

Postoperative care is a key element of ERAS protocols and focuses on quickly returning the patient to normal function as fast as possible. Appropriate pain management is crucial, as poor pain control can delay patient ambulation and prolong recovery time.

Multimodal pain management is the recommended way to follow by ERAS protocols, with limited opioid use. This approach reduces the risk of opioid-related adverse events while ensuring effective pain relief (Ljungqvist et al., 2017; Nicholson et al., 2014). Postoperative analgesia is a key factor in ensuring a faster patient recovery. Avoiding opioids and using multimodal analgesia is key,

leading to a faster return of bowel function and, with that, earlier patient mobilization (Gustafsson et al., 2019; Ljungqvist et al., 2017). Treatment primarily involves paracetamol and nonsteroidal anti-inflammatory drugs instead of opioids. Gustafsson et al. reported that techniques such as spinal analgesia or intravenous lidocaine infusions have been shown to reduce opioid consumption while at the same time maintaining adequate analgesia (Gustafsson et al., 2019).

Early mobilization after cancer surgery is strongly recommended within the ERAS program. Complications of prolonged bed rest include loss of muscle mass. There is also an increased risk of thromboembolism and three times the risk of pulmonary complications. Studies evaluating ERAS implementation show that structured early mobilization protocols are associated with reduced postoperative morbidity and shorter hospital stays (Gustafsson et al., 2019; Nicholson et al., 2014).

Another principle of the ERAS protocol is early resumption of oral nutrition. Studies have confirmed that early resumption of oral nutrition is safe in most cases. However, prolonged fasting does not benefit patient health. It is associated with a faster recovery of bowel function, fewer infectious complications, and shorter hospital stays (Greco et al., 2014; Nicholson et al., 2014). Oral fluid intake should typically be encouraged within 4 hours of surgery. This applies if the patient is not reporting nausea and upon awakening (Gustafsson et al., 2019).

Overall, postoperative ERAS interventions act synergistically to reduce surgical stress and support early recovery. Consistent application of these measures within a multidisciplinary framework is required to achieve optimal outcomes in patients undergoing oncologic surgery (Gustafsson et al., 2019; Ljungqvist et al., 2017).

Colorectal cancer surgery

Over time, the ERAS Society developed standardized recommendations for perioperative care for patients undergoing colorectal resection. These guidelines describe the most important elements of ERAS management, such as patient preparation for surgery (prehabilitation), early mobilization, effective pain management, and rapid return to oral nutrition. However, it is important to emphasize that the guidelines themselves do not provide direct data on clinical outcomes (Gustafsson et al., 2019).

Clinical outcomes of ERAS implementation in colorectal cancer surgery have therefore been evaluated in prospective and retrospective studies. In one study, the ERAS protocol was applied to patients undergoing laparoscopic resection for stage IV colorectal cancer. The authors reported acceptable postoperative complication rates and shorter recovery period. Importantly, the use of ERAS did not negatively affect oncological safety in this group of patients (Pędziwiatr et al., 2015).

The effect of ERAS on the length of hospital stay has also been assessed in clinical cohorts. In a study comparing enhanced recovery pathways with conventional perioperative care, patients managed within an ERAS program had a significantly shorter hospital stay. At the same time, no increase in major postoperative morbidity was observed in the ERAS group (Miller et al., 2014).

Hepatopancreatobiliary cancer surgery

Recent clinical studies show that selected elements of ERAS can be safely used in patients undergoing liver and pancreatic surgery. Pancreatic surgery is especially difficult to manage with ERAS because patients often develop complications after the operation, such as delayed stomach emptying or pancreatic fistula. Available clinical studies indicate that selected ERAS elements can be safely applied in hepatopancreatobiliary surgery (Melloul et al., 2020). These elements mainly include early mobilization, multimodal analgesia, and early initiation of enteral nutrition. Their use has not been associated with an increase in major postoperative complications when compared with conventional perioperative care (Gustafsson et al., 2019; Melloul et al., 2020).

Length of hospital stay and readmission rates

The most commonly reported outcomes in this protocol are the length of hospital stay. Usually, a shorter hospitalization reflects faster functional recovery and, with that, more efficient postoperative care.

Across multiple clinical studies and meta-analyses, ERAS implementation has been associated with a significant reduction in hospital length of stay compared with standard perioperative care. In colorectal cancer surgery, most studies report a reduction in hospital stay of approximately 2 to 4 days, depending on institutional practice and baseline length of hospitalization (Gustafsson et al., 2019; Pędziwiatr et al., 2015; Zhang et al., 2020). Importantly, if the decision to discharge early from the hospital is based on the patient's current condition and performance status, and not solely on the number of days after surgery, this procedure is safe for the patient. Studies show that patients treated according to ERAS principles have a similar or even lower number of rehospitalizations than those receiving traditional care (Ljungqvist et al., 2017; Zhang et al., 2020).

Similar findings have been reported in other oncologic procedures. Such as hepatopancreatobiliary surgery, including pancreatic resections, ERAS protocols have been associated with a modest but consistent reduction in length of hospital stay, typically ranging from 1 to 3 days, without an increase in readmissions or postoperative mortality (Melloul et al., 2020; Zhang et al., 2020).

Time to functional recovery and adjuvant therapy

Several studies show that ERAS protocols help patients recover faster after surgery and return more quickly to further cancer treatment. In gynecologic oncology, the use of ERAS increased the number of patients who were able to start adjuvant chemotherapy within 28 days after surgery compared with earlier, traditional care (Tankou et al., 2021).

A recent systematic review also found that ERAS programs improve the timely start and completion of adjuvant chemotherapy in different types of cancer surgery. The authors concluded that patients treated according to ERAS, especially when the protocol is followed closely, return to planned cancer treatment sooner and recover better overall than those receiving conventional care (Zhang et al., 2020).

Healthcare costs

Studies show that the primary source of savings for hospitals is a reduction in hospital stays for patients treated with ERAS protocols. These measures resulted in a reduction in hospitalization costs, reaching approximately 15-30% compared to traditional perioperative care. Nelson et al. reported significant savings resulting from a 2-3 day reduction in hospital stay, without an increase in readmissions or complications (Nelson et al., 2016).

Other cancer surgeries have shown similar financial benefits. In a randomized controlled trial, patients who underwent radical cystectomy and followed the protocol had much shorter hospital stays and about 20% lower treatment costs than those receiving standard care. Not only this, but other review papers also show similar conclusions across various areas of oncological surgery. Hospital stays are usually reduced by 1 to 4 days, resulting in significant cost savings, especially for hospitals with many patients (Zhang et al., 2020).

Implementation Challenges and Limitations

Adherence to ERAS protocols

The biggest problem in the hospital setting is poor adherence to the recommendations contained in the assisted recovery protocol after surgery. Studies have shown that protocol compliance above 70-80% is associated with a significant reduction in hospital stay and postoperative complication rates. At the same time, low adherence negates most of the clinical benefits for the patient (Gustafsson et al., 2019; Ljungqvist et al., 2017).

Patient selection and clinical heterogeneity

Cancer patients are a highly heterogeneous group. Many studies on assisted recovery protocols after cancer surgery focus on patients in relatively good clinical condition and do not adequately reflect the proportion of patients with comorbidities, malnutrition, or those who have already received neoadjuvant treatment. This makes it difficult to directly extrapolate these findings to larger patient populations in other areas of cancer surgery (Gustafsson et al., 2019; Melloul et al., 2020).

Organizational barriers

Another common problem with implementing this protocol is the lack of a dedicated staff team. Close cooperation is needed between doctors, nurses, physiotherapists, and other hospital staff, for ERAS to work well. However, staff shortages and administrative problems often limit this collaboration (Gustafsson et al., 2019; Ljungqvist et al., 2017).

Future perspectives

Looking to the future, protocols for enhanced recovery after cancer surgery will continue to individualize patient care. Instead of using a single protocol, greater attention will be paid to patient-specific parameters such as comorbidities, age, and nutritional status (Gustafsson et al., 2019; Ljungqvist et al., 2017).

Furthermore, this protocol will need to be integrated with the new oncological therapies the patient will receive. Due to the increased use of neoadjuvant chemotherapy and radiotherapy, it will be necessary to adapt the protocol to the patient's specific needs,

tailored to their health status (Melloul et al., 2020; Santa Mina et al., 2014). Table 1 provides an overview of the key studies included in this review and highlights their main clinical outcomes.

Table 1: Summary of key studies on ERAS in oncologic surgery

Surgical field	Study type	Main ERAS components	Key findings
Colorectal oncology	Systematic reviews and meta-analyses	Early feeding, multimodal analgesia, early mobilization	Shorter length of hospital stay and reduced postoperative complications
Gynecologic oncology	Prospective cohort studies	Standardized perioperative care, early mobilization	Reduced hospitalization without increased readmissions
Hepatopancreatobiliary surgery	Observational studies and reviews	Selected ERAS elements	Feasible and safe implementation in selected patients
Urologic oncology	Randomized and comparative studies	Full ERAS protocols	Reduced length of stay and lower healthcare costs

4. CONCLUSION

Enhanced recovery after surgery protocols have become an important element of cancer care after surgical procedures. This review demonstrates that their use offers numerous benefits. Primarily, they reduce the number of postoperative complications, shorten hospital stays, and thus lower treatment costs. What is important is that all this is achieved while still maintaining patient safety and comfort. Despite these advantages, ERAS protocols should always be tailored to the patient's individual needs and capabilities. Precise implementation of all enhanced recovery elements and good cooperation among the entire medical team are crucial. Only then the best treatment outcomes can be achieved.

In summary, enhanced recovery protocols in cancer surgery are safe and highly effective compared with traditional care. They should be considered standard practice and, in the future, further developed and adapted to modern cancer therapies.

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Authors' Contributions

Conceptualization: Gabriela Szubert, Marta Ciszewska
Methodology: Kacper Kopeć, Małgorzata Gasińska-Franas
Formal Analysis: Gabriela Szubert, Marta Ciszewska
Sources: Małgorzata Gasińska-Franas, Kacper Kopeć
Visualization: Małgorzata Gasińska-Franas, Kacper Kopeć
Investigation: Kacper Kopeć, Małgorzata Gasińska-Franas
Supervision: Gabriela Szubert, Marta Ciszewska
Validation: Kacper Kopeć, Małgorzata Gasińska-Franas
Writing – Review & Editing: Gabriela Szubert, Marta Ciszewska
Project administration: Gabriela Szubert, Marta Ciszewska
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Informed consent

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Ethical approval

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Data and materials availability
All data associated with this study will be available based on reasonable request to the corresponding author.

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