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IMPLEMENTATION OF ENHANCED RECOVERY AFTER SURGERY (ERAS) FOR SPINE SURGERY

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Abstract

Enhanced Recovery After Surgery (ERAS) is a multimodal and multidisciplinary protocol aimed at optimizing perioperative care by minimizing surgical stress, maintaining physiological function, and accelerating recovery. Despite its widespread application in various surgical fields, the implementation of ERAS in spine surgery remains relatively limited in literature. This study aims to review and elaborate the implementation of ERAS specifically for spine surgery, encompassing pre-hospital to post-discharge components. The research method employed is a narrative review supported by comparative retrospective and randomized controlled trial findings. The components discussed include preoperative education, nutritional optimization, smoking and alcohol cessation, multimodal analgesia, anesthetic protocols, intraoperative thermoregulation, fluid and blood management, postoperative physiotherapy, and continuous monitoring. Findings suggest that ERAS application in spine surgery can significantly reduce pain levels, length of hospital stay, postoperative complications, and preoperative anxiety. Furthermore, early mobilization, nutritional care, and pain management contribute to better patient outcomes and overall cost efficiency. This review emphasizes the need for ERAS customization based on surgery type and patient profile. The implications of this study highlight the importance of multidisciplinary collaboration in standardizing ERAS implementation for spinal procedures and advocate for further clinical studies to evaluate its long-term effectiveness and patient satisfaction across diverse populations.

Keywords: ERAS, multidisciplinary, surgery, spine

Introduction

Enhanced Recovery After Surgery (ERAS) is a paradigm shift in perioperative care in the form of a multimodal, multidisciplinary, patient-centered approach, evidence based with the aim of improving clinical outcomes and efficiency of perioperative care by reducing surgical stress, maintaining physiological function and accelerating recovery process (Kleppe & Greenberg, 2018; Meng et al., 2017). The ERAS concept includes 3

main principles, consist of preconditioning patients before surgery, providing the best treatment during surgery, and postoperative rehabilitation.(Angus, Jackson, Smurthwaite, Carrasco, Mohammad, Verma, & Siddique, 2019)

ERAS has been implemented in various surgical procedures, such as bariatric surgery, cardiac, breast, plastic surgery, colorectal, esophageal, head-neck, liver, gynecological, neurosurgery, orthopedic, pancreatic, thoracic, and urological surgeries . Spine and spinal cord surgery is one of surgical procedures that frequently conducted where cases of pain and spinal abnormalities often encountered in health facilities especially in aging population (Ljungqvist et al., 2017; Smith et al., 2020). Spine surgery also represents a typically invasive intervention with a protracted recovery phase that often requires rehabilitation and intensive postoperative pain management. The complexity varies from minimally invasive methods, single-stage decompression to complex multi-level extensive reconstructions (Grasu, Cata, Dang, & Tatsui, 2018a; Wainwright et al., 2016). The care provided is dependent on age of population, clinical innovation and continuous technological advances. ERAS has been shown to lessen likelihood of complications, decrease length of stay (LOS), and improve pain scores postoperatively (Ali et al., 2019; Webster & Osborne, 2015; Wongkietkachorn et al., 2018). Decreased length of hospital stay, complications, and readmissions show the economic benefit of ERAS regimens. In addition, complications after spine surgery have been reported to be present in 16.4% to as high as 80% of cases for complex spine surgery (Debono, Wainwright, Wang, et al., 2021; Grasu, Cata, Dang, Tatsui, et al., 2018; Yan et al., 2021). Opportunities for improved outcomes and decreased complication rates also make spine surgery an appropriate setting for ERAS development (Angus, Jackson, Smurthwaite, Carrasco, Mohammad, Verma, & others, 2019).

The application of ERAS in spine surgery and the literature discussing it has not widely available. The purpose of this review article is to discuss the application of ERAS in spine surgery (Gerbershagen, Aduckathil, Wijck, et al., 2013). The novelty of this research lies in its comprehensive and integrative analysis of Enhanced Recovery After Surgery (ERAS) protocols specifically tailored for spine surgery, which has been underrepresented in current literature (Grasu, Cata, Dang, & Tatsui, 2018b; Venkata & Dellen, 2018). While previous studies such as those by Elsarrag et al. (2019) and Debono et al. (2021) have addressed individual components or specific procedural implementations of ERAS, this study presents a holistic synthesis across all perioperative phases—pre-hospital to post-discharge—accompanied by practical recommendations and protocol customization based on patient condition. Unlike the study by Grasu et al. (2018), which focused narrowly on metastatic tumor patients, or the limited lumbar/cervical comparisons in Venkata & van Dellen (2018), this research proposes a structured and adaptable ERAS guideline for various spine procedures and patient

demographics, including nutritional, psychological, anesthetic, and rehabilitative considerations (Gerbershagen, Aduckathil, Van Wijck, et al., 2013).

Method

This study utilizes a narrative review method based on a qualitative descriptive approach. The research collected and synthesized relevant data from various primary and secondary sources, including journal articles, systematic reviews, and clinical guidelines, particularly focusing on the ERAS protocol in spine surgery. The study does not involve new primary data collection but integrates and compares findings from retrospective cohort studies, randomized controlled trials (RCTs), and systematic literature to form a comprehensive analysis.

The data population in this review consists of scholarly articles and clinical studies that examine the ERAS implementation in surgical disciplines, with a focus on spinal procedures. The sample was selected using purposive sampling, focusing on studies published between 2013 and 2023 that provided empirical evidence or recommendations regarding ERAS in spine surgery. Inclusion criteria involved studies with clearly described ERAS components and outcome metrics such as length of stay, pain intensity, readmission rate, and complication frequency. Articles without full-text access or insufficient methodological clarity were excluded.

Data collection was conducted using digital databases including PubMed, ScienceDirect, and Cochrane Library. The instrument for analysis involved a thematic matrix that categorized ERAS components into preoperative, intraoperative, and postoperative phases. Validity and reliability were ensured through cross-checking findings with existing systematic reviews and expert consensus. The review procedure included structured summarization, critical appraisal, and integration of results using Microsoft Word and Mendeley. The final synthesis was analyzed qualitatively through content analysis, focusing on identifying patterns, inconsistencies, and clinical implications of ERAS implementation in spine surgery.

Results and Discussion

A. ERAS Components

ERAS has several components ranging from pre-hospital, pre-operative, intraoperative, post-operative, post-discharge care, to continued quality improvement team activities.

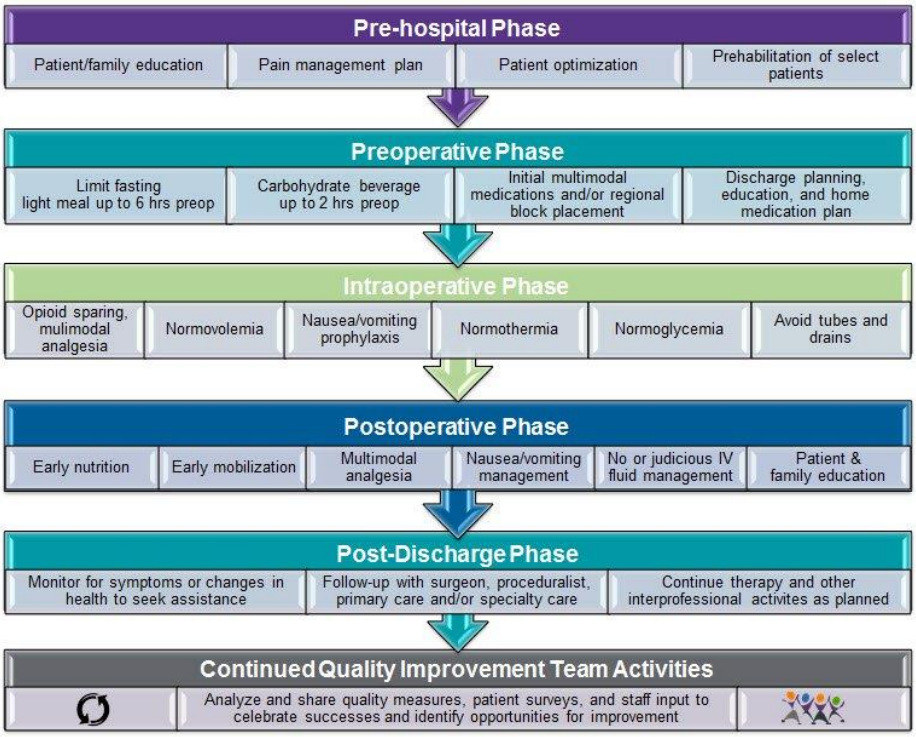

Figure 1. ERAS Components (Elsarrag *et al.*)(Elsarrag et al., 2019)

ERAS protocol aims to comprehensively optimize patient's condition so they can achieve the best conditions for surgery. Detailed information on pain management and other post-operative care after the patient is discharged from hospital should be provided to the primary health care facility. Preoperative education is also an important component and should inform the patient about length of hospital stay, discharge criteria, and motivation to reduce patient anxiety.

A retrospective analytical study was conducted to compare patients who undergo elective lumbar or cervical surgery before and after implementation of the ERAS protocol in 1,579 preprotocol and 151 postprotocol subjects. The ERAS protocol includes extensive patient counseling, minimization of opioid use, early mobilization, and reduced blood transfusions. The results of the study showed reduced duration of hospitalization and complication rate 90 days post-operatively in post-protocol patients. Subgroup analysis showed no significant difference between outcome measurements in patients undergoing cervical spine surgery, while patients undergoing lumbar surgery with ERAS had a shorter duration of hospitalization and fewer complications in the 90-day post-operative.

Another retrospective study evaluated the efficacy of the Enhanced Recovery Program After Spine Surgery (ERSS) in 56 patients undergo spine surgery for

metastatic tumors. Techniques used included preoperative education, multimodal pain and anxiety management, carbohydrate administration with fasting restriction, euvolemia, normothermia, use of minimally invasive techniques whenever possible, and other elements. Postoperatively, the method emphasizes early ambulation, rehabilitation, and oral feeding. Compared with patients in the pre-protocol group, subjects in the ERSS group achieved slightly better average pain control. However, there was no significant difference in the postoperative 30-day return to hospital, complications, and length of stay (6.3 vs 6.8 days, p = 0.590).

B. ERAS For Spine Surgery

The number of spine surgeries is increasing every year varying in duration of surgery, complication rates, postoperative pain and recovery. Spine surgery is often associated with very high levels of pain on the first postoperative day. Lumbar fusion, lumber fusion and complex spinal reconstruction are 3 of the 6 most painful procedures so ERAS protocol is expected to give a better outcome.[10] Several things that must be emphasized in spine surgery, including:

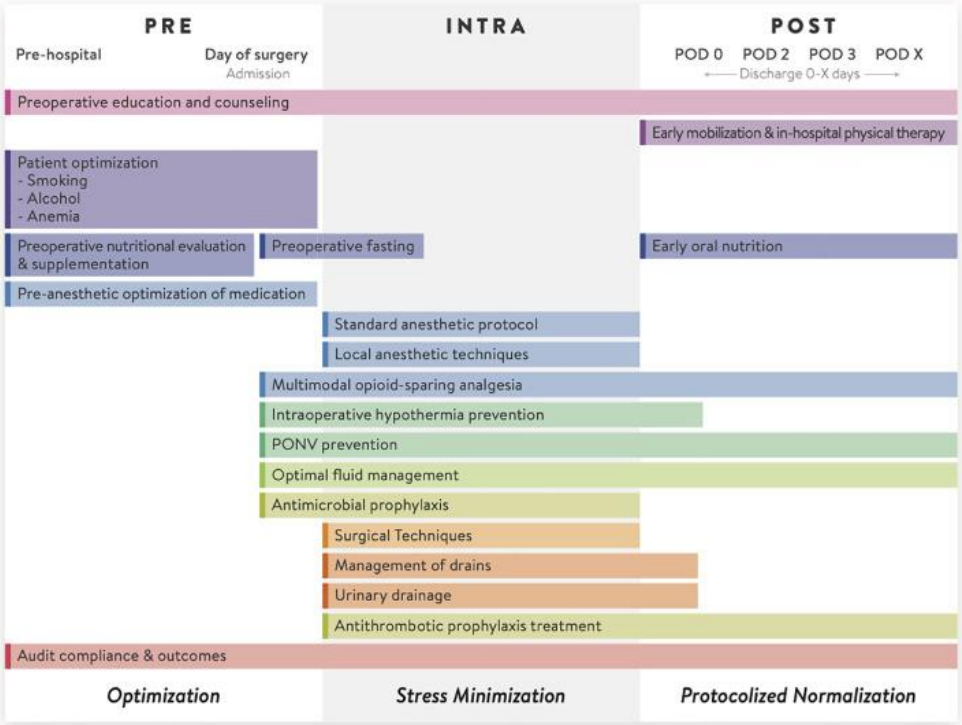

Figure 2. ERAS protocol summary for lumbar fusion (Debono *et al.*)(Debono, Wainwright, & Wang, 2021)

1. **Pra operative**

Patient education and counseling

Education is an important point of ERAS. It can be given verbally or written. Patients should be provided with detailed information about surgery, length of stay in hospital, discharge criteria and detailed information regarding recovery. Preoperative education significantly reduces preoperative anxiety. Especially since most lumbar surgeries give uncertain results. This can trigger preoperative anxiety leading to fear and anxiety.

Prehabilitation

Poor preoperative physical status is a risk factor for postoperative complications and prolonged disability. Prehabilitation is a process in a series of care that take place from the time of diagnosis until the beginning of acute management (surgery, chemotherapy, radiotherapy), including physical, nutritional, psychological assessments to determine the functional level. baseline, identify the disorder, and carry out interventions aimed at improving physical and psychological health in order to reduce the incidence and/or severity of the disorder in the future. Prehabilitation has a positive impact on the restoration of functional capacity and can reduce postoperative complications.

Nutritonal supplementation

Preoperative nutritional status is important to assess because preoperative malnutrition increases postoperative morbidity and mortality. Patients with malnutrition are advised to receive nutritional supplementation (recommended oral administration) 7-10 days before surgery. Multimodal nutrition protocols including supplementation of protein, nutrients, and carbohydrates before and after lumbar spine surgery can reduce the duration of hospitalization, risk of infection, incidence of electrolyte imbalances, and higher postoperative albumin levels. (Debono, Wainwright, & Wang, 2021)

Preoperative Smoking and Alcohol Cessation

Smoking has a negative impact both perioperatively and postoperatively. Perioperative complications include the risk of cardiopulmonary complications, pseudoarthrosis, and worsening functional outcome. Smoking cessation 4 weeks before surgery is considered effective in reducing complications. Nicotine replacement therapy and effective counseling can be done to help patients quit smoking. This habit can be continued until post-surgery time to reduce the risk of recurrence of postoperative lumbar disc herniation.

In addition to smoking, alcohol consumption can also increase the risk of complications after spine surgery such as pseudoarthrosis, postoperative infection,

ileus, delirium, bleeding, and deep vein thrombosis. Cessation of alcohol consumption 4-8 weeks before surgery can reduce post-operative complications, but has not been shown to reduce mortality.

Preoperative fasting and carbohydrate treatment

In operating room, the patient should be in euvolemic condition. Preoperative fluid and electrolyte deficits can be prevented by avoiding prolonged fasting, and giving carbohydrate drinks up to 2 hours before induction. Based on a recent study, there was no difference in the pH of gastric contents in patients who did preoperative fasting and patients who consumed clear fluid 2 hours before surgery. Surgical trauma elicits a variety of neuroendocrine responses that can trigger catabolic states. This accelerates protein breakdown and insulin resistance which can lead to postoperative hyperglycemia and other physiological disorders. Preoperative oral carbohydrate administration can reduce the incidence of insulin resistance and postoperative catabolic conditions.

Preoperative medication

Preoperative anxiety is a common event and increases the use of analgesics and antianxiety. Benzodiazepines increase neurocognitive impairment and also have a sedative effect. Preoperative administration of acetaminophen and NSAIDs can reduce postoperative pain, opioid use, and lower costs.[13] Doses of acetaminophen, NSAIDs, and gabapentinoids should ideally be adjusted according to age, renal function, and other comorbidities.[11] Postoperative nausea and vomiting (PONV) can cause dehydration, impaired nutritional intake, insertion of a nasogastric tube, increase length of stay, and increase the cost of hospitalization. PONV prophylaxis should be considered in all patients with administration of antiemetic drugs. If PONV persists, multimodal approach treatment with different drug is recommended.

Anemia management

Preoperative anemia was associated with increased transfusions, length of stay, infection, morbidity, and readmission. In spine surgery, anemic patients undergoing complex spine surgery need to be given oral iron supplementation, iron infusion, or erythropoietin to achieve a target hemoglobin of 13 g/dL (130 g/L).

2. Intraoperative recommendations

Prophylaxis antibiotic administration

Spine surgery does not have specific guidelines regarding the use of antibiotics. Administration of broad-spectrum antibiotics such as cefazolin 30 minutes before surgery incision and repeated every 4 hours performed on spine surgery. Chlorhexidine can be given before surgery and has a better long term effect during surgery for spine surgery.

Standard anesthetic protocol

The use of short-acting general anesthetics, reduce the need for opioids, and avoidance of benzodiazepines are recommended because they can speed up the recovery process with minimal residual effects. The use of epidural anesthesia, combined with general anesthesia, can reduce blood loss. A multimodal approach with spinal and regional anesthetic techniques, regional blockade, and wound infiltration can be used to reduce opioid consumption and increase analgesic efficacy.

Preventing intraoperative hypothermia

General and neuraxial anesthetics impair thermoregulation by inhibiting vasoconstriction and shivering, causing a redistribution of temperature from the center to the peripher, resulting in more heat loss than heat production. Reliable temperature monitoring should be performed and patient should be warmed actively to prevent hypothermia by various methods such as heating and humidification of anesthetic gases, use of warm irrigation and intravenous fluids and forced air warming blankets. Intraoperative hypothermia is closely associated with increased blood loss, cardiac complications, chills, infection at the surgical site, and increased length of stay.

Fluid and blood management

Patients undergoing spinal surgery are at risk of excessive blood loss, and the administration of transfusions carries a risk of immunological reactions, transmission of infection, or even transfusion-associated acute lung injury (TRALI). In addition, there is a risk of spinal epidural hematoma which can lead to spinal cord compression or cauda equina. Fluid management is also important in the ERAS protocol. Patients should be hydrated for up to 2 hours before induction of anesthesia with clear fluids containing carbohydrates. Fluid overload can be associated with the occurrence of ileus.

Urine drainage

Prolonged use of urinary catheter postoperatively increases the risk of urinary tract infections, surgical site infections, and urinary retention. In elective short segment spinal fusion surgery with or without decompression, the use of urinary catheters should be avoided. If some circumstances require the use of a catheter, it should be removed few hours after surgery. Continuous monitoring of patient's urine is useful for early detection of post-operative urinary retention.

3. Postoperative recommendation

Postoperative analgesia

Adequate pain control is essential in the ERAS protocol. The key is to avoid opioids and apply multimodal analgesia in combination with spinal/epidural analgesia or transversus abdominis plane (TAP) block. Multimodal opioid sparring techniques for postoperative analgesia, including acetaminophen, NSAIDs, gabapentin, α-2 agonists, S-ketamine, magnesium sulfate, high-dose steroids, and infusion of local

anesthetics (epidural or intravenous) or Patient Controlled Analgesia (PCA) with morphine proven to be good for reducing post-spine surgery pain. This aims to motivate patients to be more enthusiastic about starting early mobilization. The combination of early mobilization and administration of thromboprophylaxis prevents deep vein thrombosis after spinal surgery.

PONV management

PONV can cause mild to moderate dehydration, increase postoperative intravenous fluid administration, increase length of stay, and cost of care. The use of volatile anesthetics, NO, and opioids can increase PONV. Antiemetic drug administration as prophylaxis based on assessment should be carried out.

Postoperative management of drains

Postoperative use of drains is closely associated with an increased risk of postoperative lumbar infection. Therefore, the use of a spinal drain postoperatively is not recommended in short segment lumbar fusion surgery.

Nutritional Care

Delay in starting an oral diet can increase the incidence of infection and could delay the recovery process. Foods and oral nutritional supplements should be given as early as possible after the surgery. A study has found that from 37 patients who underwent staged anterior and posterior spine reconstruction surgery, 84% were malnourished during hospitalization, 77% had a decline in serum albumin levels after both procedures and 92% had a significant decline in total lymphocyte count. Malnourished patients had higher rates of postoperative complications and significantly had a longer length of stay for the second surgical procedure (16.2 days vs. 12.4 days, $p < 0.05$).

Physiotherapy

Physiotherapy could improve and speed up postoperative outcomes, as well as reduce the duration of hospitalization. A Randomized Controlled Trial (RCT) study that was conducted on 60 lumbar fusion patients assessed the cost-effectiveness of pre-rehabilitation (pre-operative exercise) and early rehabilitation interventions. Patients were randomized to be assigned for initial rehabilitation and intervention or standard care. Patients in the intervention group achieved significantly faster recovery times than the standard care group, they were also discharged from the hospital earlier. The intervention group also experienced significantly reduced low back pain and pain intensity. Therefore, early mobilization and early physical therapy are recommended in post-spine surgery patients.(Debono, Wainwright, & Wang, 2021)

Continuous Monitoring

Continuous evaluation and feedback are needed to improve the outcome quality of post-spine surgery patients.(Debono, Wainwright, & Wang, 2021)

Conclusion

Enhanced Recovery After Surgery (ERAS) pada operasi tulang belakang merupakan protokol multimodal yang diterapkan dalam perawatan perioperatif oleh tim multidisipliner yang berfokus pada pasien, melibatkan tenaga medis rawat jalan, perawat pra-operatif, ahli anestesi, perawat bedah, perawat pemulihan pasca-operasi, perawat rawat inap, ahli gizi, terapis fisik, pekerja sosial, dan ahli bedah. Protokol ini terdiri dari berbagai komponen yang saling terintegrasi dengan tujuan utama mengurangi nyeri, lama rawat inap, morbiditas, dan kecemasan pra-operasi. Penelitian mendatang disarankan untuk meninjau hasil jangka panjang serta pengalaman pasien terhadap implementasi ERAS, khususnya terkait kualitas hidup, pemulihan fungsional, dan angka rawat ulang. Selain itu, studi komparatif terhadap efektivitas komponen ERAS pada berbagai jenis prosedur operasi tulang belakang dan kelompok pasien tertentu, seperti lansia atau pasien dengan komorbiditas, penting dilakukan untuk mengoptimalkan personalisasi protokol dan meningkatkan efisiensi biaya dalam berbagai konteks layanan kesehatan.

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