



## Enhanced Recovery Program Implementation and Hospital Cost in Colorectal, Pancreatic and Liver Surgery

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### Abstract

Enhanced Recoveries after Surgery (ERAS) programs are an evidence-based multimodal and multidisciplinary approach to perioperative care for surgical patients. Initially developed in colorectal surgery, ERAS programs have been generalized to a growing number of surgical specialties. ERAS protocol implantation resulted in improved clinical outcomes, decreased complication rates and reduced hospital stay length with significant hospital cost savings moreover; high compliance to ERAS protocols was associated with increasingly improved outcomes. Reviewing the current published reports, the aim of this review is to assess the impact of ERAS program implementation on the hospital cost in colorectal, pancreatic and liver surgery.

**Keywords:** ERAS programs; Abdominal surgery; Hospital costs; Liver surgery

### Introduction

The ERAS is a multimodal approach to perioperative care for patients planned for a surgical procedure [1]. ERAS protocols are developed on the basis of evidence-based clinical practices [2]. Aiming to improve outcomes and increase the potential for patient recovery, the ERAS programs include a standardized and comprehensive perioperative management based on published consensus and guidelines of the ERAS society [3]. Therefore, the ERAS process care mainly includes preoperative optimization of patient conditions, fluid volume control, minimally invasive surgical techniques, and pain control with reducing narcotic use, early oral feeding and early mobility [4]. Several ERAS studies highlighted the important benefits of ERAS programs in major surgical procedures [5], including decreased hospital stay length and reduced postoperative complications [6-8]. This standardized care process has been generalized to a growing list of surgical subspecialties with improved clinical outcomes [9]. Additionally, multiple publications recently reported that ERAS programs could lead to reduced costs in various surgeries [10-12]. Reviewing the current published reports, the aim of this review is to assess the impact of ERAS program implementation on the hospital cost in colorectal, pancreatic and liver surgery.

### ERAS Principles

Enhanced Recovery after Surgery (ERAS) is a multimodal and multidisciplinary strategy to surgical perioperative care, and it is rested on evidence-based published protocols and guidelines. The ERAS process care includes mainly preoperative optimization of patient conditions, early oral feeding, fluid management, minimally invasive surgical technique use, pain control and early mobility [4]. The ERAS implementation involves a multidisciplinary team including surgeons, anesthetists, an ERAS coordinator, and the care unit personnel [4,13].

### Preoperative setting

The preoperative setting is divided into pre, intra and post-admission phases. The ERAS care process focuses before surgery on optimizing conditions with nutritional assessment and supplementation if necessary, reducing alcohol consumption, ceasing smoking, managing comorbidities and providing surgical information/counseling [14]. As a part of ERAS protocols, stoma education could help patients to be able to anticipate their post-surgery care and subsequent daily life changes, resulting in decreasing stay length [15]. Oral intake of clear liquids two hours before surgery is strongly recommended without increasing the risk of aspiration [4,13]. Additionally, preoperative fasting results in increased insulin resistance and post-operative stress [16]. Moreover, the preoperative administration of a carbohydrate-rich drink induces insulin release in type 2 diabetes with promoting anabolism [17], decreases gastrointestinal discomfort reducing postoperative nausea and antiemetic use [18]. Bowel preparations, thromboembolic, infection and

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Received Date: 31 Mar 2020

Accepted Date: 09 May 2020

Published Date: 13 May 2020

#### Citation:

Boukerrouche A. Enhanced Recovery Program Implementation and Hospital Cost in Colorectal, Pancreatic and Liver Surgery. *World J Surg Surgical Res.* 2020; 3: 1222.

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nausea prophylaxis are also recommended in the preoperative setting [14].

### Intraoperative phase

The use of minimally invasive techniques to reduce surgery stress, strict control of glycemia, optimal management of fluid volemia, reducing surgical drain use, avoiding the use of nasogastric tube [4,13]. In addition, standardized resuscitation approaches could avoid volemia variation-related consequences [19]. The use of neuraxial anesthesia and anatomical anesthetic is highly recommended by ERAS programs, resulting in reducing narcotic use [20]. In addition, patients who received Peripheral Nerve Blocks (PNBs), reported less pain 72 h after surgery promoting a shorter stay length and increased physical therapy [20]. Also, the combined use of PNB with narcotics was associated with lower pain scores a long-lasting effect postoperatively [21].

### Postoperative phase

Early ambulation, early oral feeding, early return to function are highly recommended postoperatively and should be accomplished using multimodal pain control with reducing narcotic use which results in decreasing nausea/vomiting and ileus [4,13]. Furthermore, early oral feeding within 42 h after the operation is associated with reduced mortality and no increase in anastomotic leak risk [22,23]. Additionally, postoperative protein intake leads to achieving an anabolic metabolism with reduced post-surgical recovery time. In fact, a high protein diet (>60% of daily protein requirements) on postoperative days 0-3 was associated with reduced stay length in elective surgery [24]. Overall, successful implementation of the ERAS protocols depends on a multidisciplinary team with the importance of collaboration, communication, and staff education to ease program implementation [25]. Also, patient and family education is so important for successful implementation.

## Cost-Effectiveness of ERAS Programs

The ERAS program is a multimodal and multidisciplinary management of perioperative care. Initially started developed in colorectal surgery, the ERAS programs were generalized to a growing list of surgical subspecialties. ERAS protocols implementation resulted in improving outcomes, decreased complication rates, and reduced hospital stay length [9].

High compliance with ERAS programs was associated with increasingly improved outcomes, reduced complications and shorter stay length [26,27]. The mean overall compliance to ERAS protocols ranged from 70% to 74% in abdominal digestive surgery including colorectal, pancreas, liver surgical procedures [28-32]. Median compliance of 60% has been reported in colorectal surgery [33]. In addition, specific compliance of 50% has been shown with predefined goals including tolerance of clear fluids on POD1, discharge from monitored care setting by POD2, ambulation in the room on POD1, and tolerance of solid diet by POD4 [34].

Instead of a positive impact on outcomes, complications and stay length, the ERAS programs were associated with effective cost savings. Systemic reviews including multiple studies and meta-analyses showed that ERAS programs were associated with cost savings, compared to standard care [35-38]. In fact, standardized care implementation through ERAS programs could lead to avoiding unnecessary and expensive exams, and investigations.

In colorectal surgery, studies have shown a significant cost

reduction in colorectal surgical procedures with the ERAS program implantation [10,39-42]. The gain was observed for specific costs including room-related and pharmacy costs [43].

A pancreatic surgical procedure, particularly, pancreatic head resection remains associated with high morbidity rates and poor long-term survival [44]. The ERAS program implementation has shown a reduced hospital stay length, no increase in readmission and mortality rates, and decreased complications surgery [45-50]. Economic gain has been reported after the complete implementation of ERAS programs in pancreatic surgery [51]. Moreover, standardized perioperative pathways have been revealed to decrease the overall costs in pancreatic head resection [46,47]. A significant cost saving following ERAS protocols implementation has been reported in pancreatic [11,52-58].

Recently implemented in liver surgery with publishing the ERAS guidelines in 2016 [59]. Instead of improved postoperative outcomes, reduced hospital stay length, and decreased complication rates, the ERAS program was associated with cost-saving in major hepatic surgical procedures [12,60]. Several studies (11 studies) including Randomized Controlled Studies (RCT) and cohort studies have reported a reduction in hospital costs following ERAS program implementation [61-68]. The cost reduction was significantly lower in the ERAS groups in both RCTs and cohort studies without a significant difference between the two types of study. Also, Furthermore, the significant hospital cost savings were similar for both open and laparoscopic surgical approaches, compared to standard care.

Almost of the studies explained the cost-effective saving after ERAS program implementation in colorectal, pancreatic and liver surgery by decreased complication rates and hospital stay length allowing cost and resource savings with specific gains in medication, laboratory and radiology and bed day costs [11,28,39,53-58,69,70]. Therefore, standardized protocols with high compliance have led to increasingly reduced unnecessary investigations such as laboratory tests or radiological imaging. Moreover, a reduced hospital stay length leads to more admissions and surgical procedures with increased revenue also called costs of opportunity [39,69,70]. Medication cost reduction was associated with ERAS programs, related to decreased use of drugs and postoperative medications secondary to the combined use of standardized clinical pathways and nursing care [71-74]. Additionally, the reduction was more significant in laboratory-associated costs (40.7%), pharmacy-related costs (54.1%), medical supply costs (21.5%) with a significant reduction in therapy-related costs [61-68,75,76].

Anesthesia and Operating Room (OR) costs were considered as the second absolute gain in ERAS programs [77]. Median operative and anesthesia times were reduced related in part to the increased surgical and anesthetic experience of the medical team, leading to shorter operating and anesthesia times with the ERAS programs. Indeed, the use of a standardized anesthesia protocol with intravenous fluid restriction through ERAS programs may have contributed to reducing costs.

Overall, ERAS programs were associated with a significant decrease in financial burden including nursing care, medication, laboratory tests, pathology, and housing [74]. Interestingly, studies assessing ERAS-related costs did not find any increase in cost after ERAS program implementation [10,28,30,34,40,43]. Most studies reporting cost-saving following ERAS programs were retrospective and cost was assessed as a secondary outcome. Therefore, further

studies, especially randomized prospective trials are highly needed for more accurate cost-saving after ERAS protocol implementation. In addition, including data of specific surgical procedures (e.g. colectomy, low anterior resection, distal pancreatectomy, or pancreatoduodenectomy, extended hepatectomy) can contribute to more accurate the ERAS-related cost savings in these specific operations.

In summary, the ERAS program implementation was associated with cost savings in colorectal, pancreatic and liver surgical procedures, compared to standard perioperative are management. However, further randomized controlled trials are highly warranted to more accurate the potential economic benefit of ERAS programs in different surgical specialties.

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