WEP Warwick Evans Publishing

International Journal of Public Health and Medical Research

ISSN: 3006-7707 (Print), ISSN: 3006-3752 (Online) | Volume 2, Number 2, Year 2024
DOI: https://doi.org/10.62051/ijphmr.v2n2.04
Journal homepage: https://wepub.org/index.php/IJPHMR/index

Evaluating the Impact of Enhanced Recovery After Surgery (ERAS) on Postoperative Outcomes in Pancreatic Cancer Patients: A Historical Control Study

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ABSTRACT

Objective: This study evaluates the impact of the Enhanced Recovery After Surgery (ERAS) program on postoperative outcomes in patients undergoing pancreatic cancer surgery. It compares traditional perioperative care with ERAS-based interventions, focusing on key rehabilitation indicators such as postoperative intestinal function recovery, length of hospital stays, medical costs, and the incidence of complications. Methods: A total of 74 patients were studied, with 37 receiving traditional perioperative care and 37 managed under the ERAS protocol. Data collection included intraoperative indicators such as operation time, fluid input, blood loss, and postoperative recovery measures like first ambulation, pain scores, and complications. Results: The ERAS group demonstrated significantly faster recovery of gastrointestinal function, earlier mobilization, and reduced postoperative pain within the first 12 hours compared to the control group ($p<0.05$). The incidence of postoperative complications was lower in the ERAS group (13.51% vs. 37.84%, $p=0.0166$). Furthermore, the ERAS protocol led to a shorter length of hospital stay and lower total medical costs ($p<0.0001$). Conclusion: The implementation of the ERAS protocol for pancreatic cancer surgery significantly improves recovery outcomes, reduces complications, and lowers healthcare costs. These findings support the broader adoption of ERAS protocols in pancreatic cancer management to optimize clinical and economic outcomes.

KEYWORDS

Enhanced Recovery After Surgery (ERAS); Pancreatic cancer; Postoperative outcomes; Rehabilitation; Perioperative care

1. INTRODUCTION

Pancreatic cancer remains a major oncological challenge due to its high mortality and complex treatment protocols (Philouze et al., 2020). It ranks as the seventh leading cause of cancer-related deaths globally, with a steadily increasing incidence, particularly in developed countries, due to aging populations, smoking, obesity, and diabetes. The asymptomatic nature of early-stage pancreatic cancer often leads to late-stage diagnoses, limiting surgical options, which are currently the only curative approach. However, surgery often results in high complication rates and prolonged hospital stays.

Traditional perioperative care for pancreatic cancer surgery focuses on preoperative preparation (Gianotti et al., 2018), surgical techniques, and postoperative recovery. Despite advances, these approaches still contribute to long hospital stays and high complication rates ("2023 Alzheimer's Disease Facts and Figures," 2023). Enhanced Recovery After Surgery (ERAS) protocols, or fast-track surgery, have been developed as a multidisciplinary approach to improve surgical outcomes (Irani et

al., 2022). ERAS aims to reduce the physiological and psychological stress associated with surgery by optimizing anesthesia, employing minimally invasive techniques, and encouraging early mobilization and nutrition (Bansal et al., 2022).

ERAS protocols have shown success in various surgical specialties, significantly reducing hospital stays, complications, and healthcare costs (Zhao et al., 2023). However, their application in pancreatic cancer surgery remains underexplored. This study seeks to address this gap by evaluating the effects of ERAS on postoperative outcomes in pancreatic cancer surgery (Galvin et al., 2020), focusing on key indicators such as complications, length of hospital stay, readmission rates, and overall survival. In summary, the implementation of ERAS protocols in pancreatic cancer surgery is hypothesized to improve postoperative outcomes, reduce complications, and enhance the overall recovery process, advancing the standard of care in this challenging area of oncology (Irani et al., 2022).

2. STUDY OBJECTIVES

2.1. General Objective

To evaluate the impact of a fast-track perioperative nursing program on the postoperative outcomes of patients undergoing pancreatic cancer surgery and to provide a reference for the implementation of the Enhanced Recovery After Surgery concept in clinical practice in China.

2.2. Specific Objectives

(1) To determine the participant's demographic profile in terms of:

A. Age

B. Sex

C. Height

D. Weight

E. Clinical Diagnosis

(2) To identify the key postoperative rehabilitation indicators for patients undergoing pancreatic cancer surgery under a Enhanced Recovery After Surgery program.

(3) To compare the traditional perioperative surgical nursing plan and the Enhanced Recovery After Surgery perioperative nursing plan in terms of:

A. Perioperative stress response of patients

B. Pain and discomfort of patients

C. Patient satisfaction

D. Recovery of intestinal function after surgery

E. Early ambulation

F. Analgesic effect

G. Occurrence of postoperative complications

H. Length of hospitalization

3. REVIEW OF RELATED LITERATURE

Pancreatic cancer is one of the most aggressive malignancies, with high mortality rates due to its often-late diagnosis (Steffel et al., 2021). Factors such as smoking, obesity, diabetes, and genetic mutations (e.g., BRCA1 and BRCA2) contribute to the risk, and most cases are diagnosed at an advanced stage. Global incidence rates have been increasing, especially in developed countries, primarily driven by aging populations and lifestyle factors. Current treatment options include surgery, chemotherapy, and radiation. However, surgery remains the only potentially curative treatment, though limited to early-stage patients. The complexity of surgeries like the Whipple procedure, coupled with high rates of postoperative complications, underscores the need for improved perioperative care.

Enhanced Recovery After Surgery (ERAS) protocols, initially developed for colorectal and other gastrointestinal surgeries, have shown promise in reducing recovery time and improving outcomes across various surgical disciplines. ERAS focuses on reducing the body's stress response to surgery through optimized anesthesia (Rodriguez et al., 2024), early mobilization, multimodal pain management, and early oral intake. These measures have been linked to lower complication rates, faster recovery of gastrointestinal function, and reduced length of hospital stay. However, the application of ERAS in pancreatic cancer surgery is relatively new and underexplored, creating an opportunity to evaluate its effectiveness in this context (Regmi et al., 2024).

In previous studies, ERAS has demonstrated significant benefits in various surgical settings. For instance, early mobilization and reduced opioid use have been shown to improve postoperative recovery, reducing risks like deep vein thrombosis and delayed bowel function. Nutritional support, a key component of ERAS, plays an important role in maintaining gut integrity and promoting faster recovery. By minimizing fluid overload and using goal-directed therapy for fluid management, ERAS also reduces risks associated with traditional perioperative care, such as pulmonary complications and renal dysfunction (Isselbacher et al., 2022). The integration of these practices leads to a holistic improvement in patient outcomes, including better pain management and lower healthcare costs.

Despite the growing evidence supporting ERAS, its specific application in pancreatic surgery faces challenges. The complexity of pancreatic cancer surgeries, combined with the aggressive nature of the disease, presents unique hurdles that ERAS protocols must address. Additionally, long-term outcomes, such as survival rates and quality of life, remain under-researched in the context of ERAS. Current studies often focus on short-term recovery metrics, leaving gaps in understanding the broader, long-term benefits of these protocols. Furthermore, the implementation of ERAS in pancreatic cancer surgery requires multidisciplinary collaboration, involving surgeons, anesthesiologists, rehabilitation teams, and patients themselves. While the potential benefits are clear, challenges such as institutional readiness and resource allocation must be considered for widespread adoption.

In conclusion, while ERAS protocols have shown substantial promise in various types of surgeries, their application in pancreatic cancer surgery remains a developing field (Sundaresan et al., 2021). Continued research is needed to refine these protocols for pancreatic cancer patients, with a focus on long-term outcomes and broader clinical implementation. Additionally, the inclusion of economic analyses, such as reduced hospitalization costs, will further support the integration of ERAS into standard care for complex surgeries like pancreatic cancer resection.

4. METHODS

This study employed a historical control design to assess the impact of the Enhanced Recovery After Surgery (ERAS) protocol on postoperative outcomes in patients undergoing pancreatic cancer surgery. The study was conducted at the Second Hospital of Lanzhou University, a tertiary hospital with advanced surgical facilities. Patients were divided into two groups: 37 patients who received

traditional perioperative care (control group, from September 2022 to July 2023), and 37 patients who were treated using the ERAS protocol (experimental group, from August 2023 to June 2024).

Inclusion Criteria: Patients aged 18 to 80 years, diagnosed with primary pancreatic cancer, and who had not received prior chemotherapy or radiotherapy were included. Patients were required to have a Nutritional Risk Screening (NRS2002) score below 3 and no severe organ dysfunction.

Exclusion Criteria: Patients undergoing emergency or palliative surgery, those with distant metastasis, or facing financial constraints were excluded to ensure uniformity in care and avoid external socioeconomic biases.

The ERAS protocol consisted of a series of perioperative interventions aimed at reducing surgical stress and accelerating recovery. Key elements included preoperative nutritional optimization, multimodal pain management, and early mobilization. The traditional group followed standard perioperative care with a focus on preoperative fasting and delayed mobilization.

Data Collection: Data points included intraoperative metrics (operation time, fluid input, and blood loss) and postoperative recovery measures (time to first ambulation, gastrointestinal function, pain levels, and postoperative complications). Pain was assessed using the Visual Analogue Scale (VAS), and patient satisfaction was measured with a postoperative satisfaction questionnaire. Economic indicators, such as total hospitalization costs and length of stay, were also tracked to evaluate the cost-effectiveness of the ERAS protocol.

5. STATISTICAL ANALYSIS OF DATA

Data will be analyzed using SPSS version 27.0. Descriptive statistics will be used to summarize the demographic and clinical characteristics of the patients. For comparative analyses, an independent t-test will be applied for normally distributed data. If the assumption of homogeneity of variances is violated, the Welch t-test will be used. In cases where the data are not normally distributed, the Mann-Whitney U test will be employed.

6. RESULTS

Table 1. Demographic data of the two groups of patients

Variable	Statistical description Category	Experimental group (N=37)	Control group (N=37)
Age (years)	Mean±SD	58.65 ±10.44	57.48 ±11.29
Sex	Male	27 (72.97)	25 (67.57)
	Female	10 (27.03)	12 (32.43)
Height (cm)	Mean±SD	164.18 ±4.36	165.14 ±5.95
Weight (kg)	Mean±SD	63.19 ±3.96	62.15 ±3.84
Tumor diameter (cm)	Mean±SD	3.45 ±2.32	3.45 ±2.52
Operation time (min)	Mean±SD	305.62 ±26.15	312.35 ±28.02
Method of operation (count)	Pyloric-preserving pancreaticoduodenectomy (PPPD)	6 (16.22)	8 (21.62)
	Segmental pancreatectomy	5 (13.51)	3 (8.11)
	Pancreaticoduodenectomy (PD)	19 (51.35)	18 (48.65)
	Pancreaticocaudectomy	7 (18.92)	8 (21.62)
SA classification (count)	Level III	26 (70.27)	24 (64.86)
	Level II	11 (29.73)	12 (32.43)
	Level I	0 (0.00)	1 (2.70)
*p-value < 0.05			

Table 2. Postoperative indicators of patients undergoing pancreatic cancer surgery

Indicators Statistical description	Experimental group (N=37)	Control group (N=37)	Method	Statistic	P-value
First in-bed activity (days)	2.33 ±0.58	2.67 ±0.55	Independent Sample t-test	-2.53	0.0136*
Mean±SD					
First bedside activity (days)	2.57 ±0.51	4.03 ±5.58	Mann Whitney	398.00	0.0020*
Mean±SD					
Gastric tube removal time (days)	3.67 ±1.22	4.78 ±1.50	Independent Sample t-test	-3.49	0.004*
Mean±SD					
Abdominal drainage tube removal time (days)	7.41 ±3.21	11.02 ±5.53	Welch’s t-test	-3.43	0.001*
Mean±SD					
*p-value < 0.05					

Table 3A. Analysis of differences in patients' perioperative stress response

Indicators Statistical description	Experimental group (N=37)	Control group (N=37)	Method	Statistic	P-value
Intraoperative blood loss	288.05 ±249.13	302.92 ±307.87	Mann Whitney	682.00	0.9827
Mean±SD					
Intraoperative fluid volume	1585.50 ±494.50	1650.17 ±517.84	Independent Sample t-test	-0.55	0.5844
Mean±SD					
Urine volume	481.33 ±310.97	540.32 ±432.85	Mann Whitney	681.50	0.978
Mean±SD					
*p-value < 0.05					

Table 3B. Analysis of Differences in Postoperative Pain and Discomfort in Patients (Pain Scores at Rest)

IndicatorsStatistical description	Experimental group (N=37)	Control Group (N=37)	Method	Statistic	P-value
2h after surgery (score)	2.13 ±0.62	2.49 ±0.66	Independent Sample t-test	-2.40	0.019*
Mean±SD					
12h after surgery (score)	2.01 ±0.64	2.34 ±0.76	Independent Sample t-test	-1.99	0.0499*
Mean±SD					
24h after surgery (score)	1.64 ±0.52	1.62 ±0.82	Welch’s t-test	0.12	0.9027
Mean±SD					
48h after surgery (score)	1.45 ±0.42	1.47 ±0.62	Mann Whitney	630.50	0.5629
Mean±SD					
*p-value < 0.05					

Table 3C. Analysis of differences in patient satisfaction

IndicatorsStatistical description	Experimental group (N=37)	Control Group (N=37)	Method	Statistic	P-value
Patient satisfaction (score)	73.46 ±8.94	67.65 ±8.04	Mann-Whitney	451.00	0.012*
Mean±SD					
*p-value < 0.05					

Table 3D. Analysis of differences in postoperative intestinal function recovery in patients

Indicators Statistical description	Experimental group (N=37)	Control Group (N=37)	Method	Statistic	P-value
Time to first flatus (days)	3.05 ±1.21	5.38 ±1.56	Independent Sample t-test	-7.21	< 0.001*
Mean±SD					
Time to first defecation (days)	4.48 ±1.34	6.25 ±1.69	Mann Whitney	307.50	< 0.001*
Mean±SD					
Time to first water intake (days)	3.22 ±1.22	5.19 ±0.81	Welch's t-test	-8.18	< 0.001*
Mean±SD					
*p-value < 0.05					

Table 3E. Analysis of differences in patients' early postoperative ambulation

Indicators Statistical description	Experimental group (N=37)	Control Group (N=37)	Method	Statistic	P-value
Time to first ambulation (days)	1.56 ±0.38	2.03 ±0.77	Mann Whitney	434.50	0.007
Mean±SD					
*p-value < 0.05					

Table 3F. Analysis of Differences in Postoperative Analgesic Effect in Patients (Pain Scores During Coughing)

Indicators Statistical description	Experimental group (N=37)	Control group (N=37)	Method	Statistic	P-value
2h after surgery (score)	2.24 ±0.64	2.84 ±0.91	Independent Sample t-test	-3.26	0.0018*
Mean±SD					
12h after surgery (score)	1.95 ±0.52	2.71 ±1.03	Mann Whitney	368.50	<0.001*
Mean±SD					
24h after surgery (score)	1.85 ±1.09	1.87 ±1.23	Mann Whitney	651.00	0.7212
Mean±SD					
48h after surgery (score)	1.55 ±0.92	1.82 ±1.46	Mann Whitney	653.00	0.7375
Mean±SD					
*p-value < 0.05					

Table 3G. Analysis of differences in postoperative complications among patients

Indicators Statistical description	Experimental group (N=37)	Control Group (N=37)	Method	Statistic	P-value
Total postoperative complications, n(%)			Chi-square test	5.74	0.0166*
NO	32 (86.49)	23 (62.16)			
YES	5 (13.51)	14 (37.84)			
Delayed gastric emptying, n(%)			Fisher's exact test	-	0.1148
NO	37 (100.00)	33 (89.19)			
YES	0 (0.00)	4 (10.81)			
Pancreatic leakage, n(%)			Fisher's exact test	-	1.0000
NO	36 (97.30)	35 (94.59)			
YES	1 (2.70)	2 (5.41)			
Anastomotic leakage, n(%)			Fisher's exact test	-	1.0000
NO	36 (97.30)	36 (97.30)			
YES	1 (2.70)	1 (2.70)			
Intra-abdominal infection, n(%)			Fisher's exact test	-	1.0000
NO	37 (100.00)	36 (97.30)			
YES	0 (0.00)	1 (2.70)			
Nausea and vomiting, n(%)			Fisher's exact test	-	1.0000
NO	36 (97.30)	35 (94.59)			
YES	1 (2.70)	2 (5.41)			
Other complications, n(%)			Fisher's exact test	-	1.0000
NO	35 (94.59)	34 (91.89)			
YES	2 (5.41)	3 (8.11)			
*p-value < 0.05					

Table 3H. Analysis of differences in postoperative hospital stay and costs (economic indicators)

Indicators Statistical description	Experimental group (N=37)	Control Group (N=37)	Method	Statistic	P-value
Postoperative hospital stay (days)	15.55 ±5.11	21.15 ±5.18	Independent Sample t-test	-4.68	<0.001*
Mean±SD					
Total postoperative hospitalization cost (10,000 yuan)	2.47 ±0.43	3.65 ±0.49	Independent Sample t-test	-11.03	<0.001*
Mean±SD					
*p-value < 0.05					

7. ANALYSIS AND DISCUSSION

7.1. Analysis and Discussion of Demographic Profile

The demographic characteristics of both the ERAS and control groups are balanced in terms of age, gender, height, weight, and clinical diagnosis. This balance eliminates potential confounding variables, ensuring that observed differences in outcomes can be attributed to the ERAS intervention rather than baseline patient characteristics.

7.2. Postoperative Rehabilitation Indicators

Patients in the ERAS group showed significantly faster recovery compared to the control group. Key rehabilitation indicators, such as the time to first in-bed activity and bedside activity, were notably reduced. Early mobilization, a core feature of the ERAS protocol, contributed to this accelerated recovery and minimized the risks of postoperative complications such as venous thromboembolism.

7.2.1. Perioperative Stress Response

The perioperative stress response, measured by intraoperative blood loss, fluid input, and urine output, did not differ significantly between the two groups. This suggests that the ERAS protocol does not increase physiological stress during surgery, maintaining stable fluid management and minimizing surgical trauma.

7.2.2. Pain Management

Pain management was significantly better in the ERAS group, with lower pain scores reported at 2 and 12 hours post-surgery. The multimodal analgesia used in the ERAS protocol reduced the need for opioids, leading to fewer side effects and contributing to faster recovery.

7.2.3. Patient Satisfaction

The ERAS group reported higher satisfaction levels than the control group. This improvement was driven by faster recovery times, better pain control, and enhanced communication during the perioperative period. Patients in the ERAS group felt more comfortable and engaged in their recovery process, which contributed to higher satisfaction scores.

7.2.4 Recovery of Intestinal Function After Surgery

Gastrointestinal recovery was significantly faster in the ERAS group, with earlier times to first flatus and defecation compared to the control group. Early enteral feeding, combined with reduced opioid use, played a critical role in restoring normal bowel function and reducing the risk of ileus.

7.2.5. Early Ambulation

Patients in the ERAS group were able to ambulate earlier, which is critical for reducing complications such as deep vein thrombosis and pulmonary embolism. Early ambulation also accelerates overall recovery and reduces the length of hospital stay, a key goal of the ERAS protocol.

7.2.6. Analgesic Effect

The ERAS group demonstrated superior analgesic effects, particularly during the first 12 hours post-surgery. Pain scores during coughing were lower in the ERAS group, thanks to the multimodal analgesia approach, which minimizes the use of opioids while maintaining effective pain control. This led to improved mobility and overall patient comfort.

7.2.7. Postoperative Complications

The ERAS group experienced a significantly lower incidence of postoperative complications (13.51%) compared to the control group (37.84%). Although individual complications such as delayed gastric

emptying and pancreatic leakage did not always reach statistical significance, the overall trend of fewer complications reinforces the effectiveness of the ERAS protocol.

7.2.8. Economic Impact: Hospitalization Time and Costs

ERAS significantly reduced the length of hospital stay, with patients in the ERAS group being discharged earlier than those in the control group. This reduction in hospital stay, combined with fewer complications, also led to lower overall medical costs, demonstrating the economic benefits of ERAS alongside its clinical advantages.

8. CONCLUSION

The study demonstrates that the Enhanced Recovery After Surgery (ERAS) protocol offers significant advantages over traditional perioperative care in pancreatic cancer surgery:

Faster Recovery Milestones: ERAS patients achieved earlier in-bed activity, bedside activity, and ambulation, showcasing faster recovery.

Improved Gastrointestinal Function: ERAS significantly shortened the time to first flatus, defecation, and water intake, indicating quicker recovery of gastrointestinal function.

Reduction in Postoperative Complications: ERAS led to a lower rate of complications compared to traditional care, affirming its role in reducing postoperative risks.

Superior Pain Management: Patients in the ERAS group reported lower pain scores at rest and during coughing, confirming the protocol's effectiveness in controlling early postoperative pain.

Higher Patient Satisfaction: The ERAS group reported significantly higher satisfaction, emphasizing the protocol’s positive impact on the overall patient experience.

Economic Benefits: ERAS reduced the length of hospital stay and overall medical costs, highlighting its potential for improving healthcare efficiency and reducing economic burdens.

9. INNOVATION AND SHORTCOMINGS OF THE RESEARCH

9.1. Innovations

Application of ERAS in Pancreatic Cancer Surgery: This study is one of the few to apply the ERAS protocol to the complex field of pancreatic cancer surgery, offering important insights into its effectiveness.

Comprehensive Postoperative Analysis: Unlike studies that focus on limited recovery indicators, this research examined multiple factors, including blood loss, pain scores, hospital stay, and costs, providing a broad view of ERAS’s impact.

Inclusion of Economic Indicators: By analyzing the total cost of hospitalization, the study extends beyond clinical outcomes to offer a more holistic evaluation of ERAS’s benefits, which is crucial in today’s cost-conscious healthcare systems.

Patient Satisfaction Scores: The inclusion of quantified patient satisfaction scores adds an important patient-centered dimension to the study, highlighting the importance of quality care.

Detailed Comparison with Traditional Care: The research clearly contrasts ERAS with traditional perioperative methods, illustrating ERAS's superiority in reducing recovery times and complications.

9.2. Shortcomings

Small Sample Size and Historical Control Method: The study used a historical control method due to ethical concerns, and the small sample size limits the generalizability of the results.

Limited Follow-up Period: The focus was primarily on short-term outcomes, such as recovery indicators during the hospital stay, with long-term effects like quality of life and survival rates unexplored.

Challenges in Multi-Department Collaboration: ERAS requires interdisciplinary collaboration, which was not fully captured in this study, limiting the findings to nursing interventions.

Financial Exclusion Bias: Patients with financial difficulties were excluded, potentially introducing socioeconomic bias and limiting the study's applicability to all populations.

Lack of Multicenter Validation: Conducting the study at a single institution reduces external validity, suggesting the need for multicenter studies to enhance the robustness of the findings.

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