DOI: https://doi.org/10.54393/pjhs.v5i09.1881

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 9 (September 2024)

Systematic Review

OPEN ACCESS

Unveiling the Impact of Enhanced Recovery After Surgery Programs on Post-Operative Morbidity and Mortality

Asad Sami[1], Kashif Rafiq[2*], Zahoor Ahmed[1] and Muhammad Umer Farooq Khan[3]

[1]Department of General Surgery, Federal Polyclinic Hospital, Islamabad, Pakistan
[2]Department of General Surgery, Ayub Teaching Hospital, Abbottabad, Pakistan
[3]Department of General Surgery, Pakistan Institute of Medical Sciences, Islamabad, Pakistan

ARTICLE INFO

Keywords:
Enhanced Recovery After Surgery, Postoperative Mortality, Surgical Outcomes, Perioperative Care

How to Cite:
Sami, A., Rafiq, K., Ahmed, Z., & Khan, M. U. F. (2024). Unveiling the Impact of Enhanced Recovery After Surgery Programs on Post-Operative Morbidity and Mortality: Enhanced Recovery After Surgery Programs on Post-Operative Morbidity . Pakistan Journal of Health Sciences (Lahore), 5(09). https://doi.org/10.54393/pjhs.v5i09.1881

***Corresponding Author:**
Kashif Rafiq
Department of General Surgery, Ayub Teaching Hospital, Abbottabad, Pakistan
kashan2002pk@yahoo.com

Received Date: 12th August, 2024
Acceptance Date: 27th September, 2024
Published Date: 30th September, 2024

ABSTRACT

Enhanced recovery after surgery is an evidence-based and holistic perioperative care approach and a real revolution in surgical settings. Initially, this concept referred to as "fast-track surgery" has evolved to enhanced recovery after surgery and acquired remarkable attention for its potential to improve patient recovery and surgical adverse outcomes, reduce the length of hospital stay, and yield beneficial impact on post-surgical mortality and morbidity. **Objective:** To evaluate the impact of enhanced recovery after surgery programs on Post-Operative Morbidity and Mortality. **Methods:** A comprehensive overview was provided based on several studies' data on the impact of enhanced recovery after surgery programs on postoperative mortality and morbidity. Nine years of epidemiological studies published between 2014-2023 were included based on the presence of qualitative and quantitative data. **Results:** Enhanced recovery after surgery significantly reduces the overall morbidity, surgical site infections, and complications associated with different surgeries, and shortens the length of stay at the hospital without escalating the readmission and mortality rate. However, only one study reported a significant difference in mortality rate between enhanced recovery after surgery and the control group. **Conclusions:** It was concluded that enhanced recovery after surgery protocols have increasingly been recognized as pivotal tools in reducing postsurgical mortality and morbidity, highlighting their efficacy in optimizing surgical consequences. By synthesizing core insights this review emphasizes the concrete advantage of enhanced recovery after surgery programs inpatient rehabilitation mobilization, encompassing faster recovery, and reducing surgical-related adverse effects.

INTRODUCTION

Post-operative complications including surgical morbidity and mortality are a significant public health concern [1-3]. It is estimated that 300 million patients undergo surgical intervention worldwide yearly [4]. The international Surgical outcomes study globally reported that 26.8% of patients who underwent major surgery exhibited postoperative complications [5]. 30-day post-surgical mortality is considered the third most common cause of death in the United States with 7.7% of deaths worldwide [6]. Post-surgical complications after major surgery increase the length of hospital stay, cost, infections, and mortality [7, 8]. Research shows that numerous endeavors have been directed toward reducing postoperative mortality and complications, which have been achieved in a few hospitals [2]. The enhanced recovery after surgery (ERAS) is a second revolution after laparoscopy experienced by the surgical community which marked a significant improvement in postoperative care [9]. Enhanced recovery after surgery ERAS programs have become the norm in surgical settings mostly for major surgery [10]. ERAS is a multimodal series of research-based healthcare approaches in the perioperative period that alleviates the physiological and physical reactions to traumatic stress, post-surgical complications, incidence of infections, readmission rate, hospital stay times, mortality, and hospital costs [11]. It was initially applied in colorectal surgery around the mid-1990s and extensive research data showed that the ERAS protocol may lead to a

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

significant decrease in the Length of Stay (LOS) and overall morbidity of up to 50% in colorectal surgery compared with standard perioperative approaches. Subsequently, the application of the ERAS protocol has been implemented in other surgical areas including hepatectomy, gastrointestinal surgery, and orthopedic surgery [12]. ERAS programs aim to enhance patient outcomes and reduce postoperative morbidity and mortality by directing attention to intra-operative, and postoperative care management mainly [13, 14]. These phases encompass technical interventions that pertain to all surgical areas as well as measures that are specific to surgical specialities. The possible mechanism of surgical procedure involves surgical stress, pathophysiological dysfunction, anxiety, pain, hypoxia, long-term fasting, and changes in blood volume, which initiates the release of inflammatory mediators and hyperglycemia leads to the development of complications [15]. ERAS plays a role in the decrease of postoperative complications by reducing surgical assertiveness and its adverse effects [10].

This systematic review aims to evaluate the impact of ERAS on postoperative mortality and morbidity in surgical settings. This involves compiling multiple studies providing data on the influence of ERAS on post-surgical complications and mortality in several types of surgeries. Investigating the ERAS program's impact on postoperative mortality and morbidity would help surgical specialities tailor patient recovery. Research in this area could identify standard procedures within ERAS protocol leading to advancement and improvement in surgical settings.

METHODS

Preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines were followed to write this systematic review. The nine years of published data (2014-2023) were collected using several databases (PubMed, Google Scholar, Sci-hub, and Science Direct) using Boolean logic "AND" and "OR", Medical Subject Headings (MeSH Terms) and keywords. Different terminologies were used to explore the literature "Enhanced recovery after surgery," combined with "Postoperative mortality", and "Postoperative morbidity". A total of 331 articles were retrieved from the included databases. Out of them, 170 studies were excluded as non-relevant after reading the titles and not written in English, 70 studies were excluded because of only the presence of qualitative data, 40 studies were excluded after considering them duplicates, and then finally out of the remaining 51 studies, 38 were excluded because they did not directly address the impact of ERAS on postsurgical outcomes. Eventually, 13 articles were considered eligible after applying inclusion/exclusion criteria and deleting the duplicates and irrelevant articles (Figure 1).

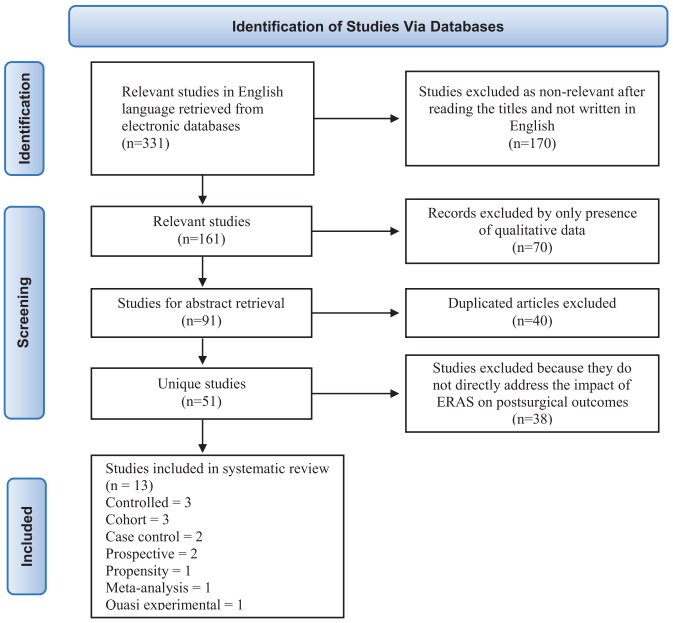

Figure 1: Depiction of the Study Selection Process

RESULTS

Enhanced recovery after surgery (ERAS) is a paradigm shift in surgical care composed of protocol designs related to the management of surgical facilities and guidelines applicable to various surgical subspecialties including Pancreatectomy, radial cystectomy, and arthroplasty bladder surgery [16]. By systematically categorizing the key components into pre-operative, intra-operative, and post-operative phases, the figure provides a clear and concise overview of the strategies employed to optimize patient outcomes. The figure plays a crucial role in enhancing the article's clarity, comprehensibility, and persuasive power. By providing a visual overview of ERAS protocols, the figure effectively conveys the key strategies that contribute to improved patient outcomes (Figure 2).

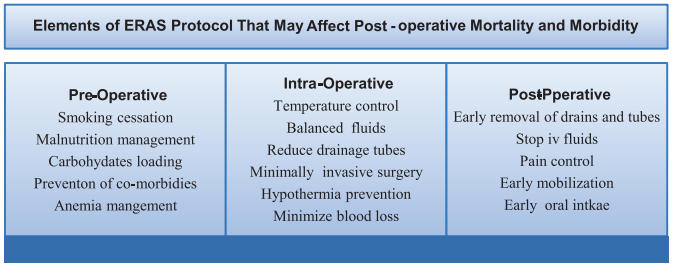

Figure 2: Elements of the ERAS Program

All of the identified studies assess the impact of ERAS on postoperative mortality/morbidity by comparing the ERAS group implemented with intervention against a control group subjected to the conventional approach [17-28]. Key endpoints of the study included feasibility, postoperative mortality/morbidity, complications, and LOS [29]. One study examined the ERAS impact on pancreatectomy [30]. Two studies included patients undergoing Pancreaticoduodenectomy (PD). Three studies evaluated

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

the ERAS impact on colorectal surgery. Three studies included radial cystectomy whereas the other two included liver resection and one study was on ERAS impact on joint arthroplasty. Each study involved a different number of participants but a total of 23805 patients were evaluated in this analysis, out of which 10462 were provided with ERAS services and 13343 were included as control (Table 1).

Table 1: Summary of Extracted Data on the Impact of ERAS on Postoperative Mortality and Morbidity

S. No.	ERAS Group	Control	Surgery	Key Outcomes	Study Type	References
				Safe effective		
1	97	75	Pancreatectomy	Reduced LOS without Increasing Mortality and Morbidity	Controlled	[17]
2	2008	2139	Pancreaticoduo denectomy	Decrease Overall Morbidity Incidence of SSI Reduced LOS without Compromising Mortality	Controlled	[18]
3	97	87	Pancreaticoduo denectomy	Reduced LOS without Compromising Mortality	Case-Control	[19]
4	140	167	Lobectomy in lung cancer	Decrease LOS and Complication Rate	Propensity Score-Matched	[20]
5	100	100	Radial Cystectomy	Reduced LOS and Infectious Complications Reduced Time to Recovery and Cost	Cohort	[21]
6	110	NR	Radial Cystectomy	Shortens LOS without Compromising the Readmission Rate 82% had a Bowel Movement on day 2 /Reduced Complications	Prospective	[22]
7	79	121	Cystectomy	Reduction in LOS No increase in Complications and Readmissions	Quasi-Experimental	[23]
8	282	224	Colorectal Resections	Reduction in Morbidity and LOS/ Lesser Complications	Prospective	[24]
9	319	360	Colorectal	Reduction in LOS and Morbidity	Cohort	[25]
10	61	122	Colorectal	Reduction in LOS and Morbidity	Cohort	[26]
11	134	100	Liver Resection	Safe / Effective No Adverse Outcomes	Case-Control	[27]
12	91	93	Liver Resection	Safe / effective Reduced Postoperative Complications	Prospective Cohort	[28]
13	6944	9755	Joint Arthroplasty	Significantly Reduce Mortality Rate, LOS, and Complications	Meta-Analysis	[30]

LOS, Length of stay; PD Pancreaticoduodenectomy; SSI, Surgical site infections; NR, not reported Intra-operative management

To examine the influence of ERAS intra-operative protocol, brief data from two studies were included. According to the study, there was a decrease in intra-operative blood loss, red blood cell transfusion, and plasma transfusion in the ERAS group compared to the control group. Whereas the use of According to prophylaxis carbohydrate loading and hemodynamic monitoring increased in the ERAS group [31] (Table 2).

Table 2: Enhanced Recovery After Surgery Pathway Intraoperative Management Outcomes

S. No.	ERAS Pathway	Control Group	ERAS Group	Surgery	References
1	Perioperative Oral Carbohydrate Drink	No	Novel	Cystectomy	[21]
	Thrombosis Prophylaxis	Common	Increased		
	Hemodynamic Monitor Use	Lower	Higher		
	Postoperative use of Nasogastric Tube	Higher	Lower		
	Blood Loss	Higher	Lower		
	Red Blood Cell Transfusion	Increased	Decreased		
	Fresh Frozen Plasma Transfusion	Increased	Decreased		
	Crystalloid Use	Increased	Decreased		
2	Operation Time	Longer	Shorter	laparoscopic surgery / colorectal cancer	[18]
	Blood Loss	Higher	Lower		
	Length of Surgical Site	Longer	Shorter		
	Oral Fluid Intake Time	Longer	Shorter		
	Postoperative LOS	Longer	Shorter		

Data on postoperative outcomes were extracted from thirteen studies. Heterogeneity was observed in the data. Despite a thorough review of the study results showed a significant reduction in the length of stay (LOS), readmission rate, morbidity, and associated complications (details discussed later). In four studies compliance rate of

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

the ERAS protocol was observed to be high. However, no significant difference was found in the mortality rate between the two groups. Out of 13 studies, only one conducted by Deng et al,. reported a significant reduction in mortality between the control and ERAS groups [30]. The reason for this can be explained by the fact that the reported incidence of mortalities in the studies was too low to identify any significance or it might be due to the small sample size which leads to the wrong conclusion that there is no difference [32] (Table 3).

Table 3: Postoperative Outcomes

LOS days		Morbidity %		Mortality%		Mortality Significance Level	Readmission Rate %		Compliance Rate%		References
ERAS	Control	ERAS	Control	ERAS	Control	ERAS / Controls	ERAS	Control	ERAS	Control	[17]
10	13	Decr	No diff	Decr	No diff	Not Significant	Incr	Incr	74	34	
Shorter	Longer	48.1	62.3	1.5	3.50	Not Significant	11	12.9	NR		[18]
14	20	NR	NR	4.7	6.20	Not Significant	12.8	14.4	NR		[19]
5	7	29.3	36.5	NR	NR	NR	3.6	5.4	81		[20]
7	10	NR	NR	2	2	Unchanged	20	38	95		[21]
4	NR	NR	NR	NR	NR	Unchanged	21	NR	NR		[22]
5	8	NR	NR	NR	NR	NR	NR	NR	NR		[23]
5	6	Lesser	NR	Lesser	NR	Not Significant	NR	NR	NR		[24]
11	13	NR	NR	4.7	2.5	Not Significant	4.3	6.3	88		[25]
6	9	14.8	33.6	0	1.6	Not Significant	1.6	3.3	NR		[26]
4	6	NR	NR	0	0	No difference	3	2	NR		[27]
6	6	NR	NR	1	1	No difference	12	9	NR		[28]
Shorter	Longer	Lesser	NR	Decr	NR	Significant	NR	NR	NR		[30]

LOS, Length of Stay; decr, decrease; incr, increase; NR, Not Reported

DISCUSSION

The present systematic review provides strong evidence for the efficacy of ERAS protocols in significantly reducing postoperative morbidity and length of stay. The consistent findings across diverse surgical specialities underscore the versatility and strength of the ERAS approach. The observed reductions in surgical site infections, complications, and readmission rates highlight the substantial benefits for patient outcomes. While the majority of studies demonstrated the effectiveness of ERAS in improving postoperative outcomes, the inconsistent findings regarding mortality are noteworthy. This inconsistency may be attributed to several factors, including variations in study populations, sample sizes, and the specific ERAS protocols implemented. Further research with larger sample sizes and standardized methodologies is warranted to elucidate the impact of ERAS on mortality rates. The integration of intraoperative management strategies within ERAS protocols appears to be a critical component in optimizing patient outcomes. The observed reductions in intraoperative blood loss and transfusion requirements suggest potential cost-effectiveness and improved patient safety. To determine the impact of the ERAS program on postoperative morbidity and mortality in an initial effort, a prospective controlled study was undertaken by Perinel *et al.,* [17] in Lyon France compared two teaching hospitals, intervention and control with the duration of 3 years, to evaluate the ERAS program intervention on postoperative outcomes after pancreatectomy (surgical removal of the pancreas). The study compared two groups one that implemented an ERAS program (n=97) and the other that followed traditional care (n=75). According to the findings, the ERAS program exhibited a high compliance rate of 95% and was associated with significantly reduced length of days at the hospital (LOS) based on hazard ratio (1.61; 95% CI), and postoperative morbidity, Furthermore, overall mortality and readmission rates were decreased in the ERAS group but the difference was not significant ($p<0.005$). These findings are similar to the retrospective cohort study carried out by Balzano *et al.,* at a tertiary referral university hospital with a duration of 3 years, which compared ERAS and control groups after PD for the outcomes LOS, readmission rate, and morbidity reported a significant decrease in (LOS 13 vs 15 days $p<0.001$) in the ERAS group [33]. A meta-analysis encompassing 22 studies published between 1990 to 2019 (multiple countries) was carried out by Wang *et al.,* in China [18]. Among them, 3 studies were randomized controlled trials and 19 were non-randomized, including a combined total number of 4147 patients to examine the impact of ERAS on postoperative outcomes after pancreaticoduodenectomy (PD) for the surgical outcomes, LOS morbidity, infection, readmission rate. The results of the study demonstrated that ERAS had significantly decreased overall morbidity (Relative risk; RR: 0.80, 95% CI, $p<0.001$) and incisional infections (RR: 0.75, 95% CI). A reduction in the duration at

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

the hospital was noted in the ERAS group (WMD: -5.07, 95% CI) without compromising the mortality (RR: 0.70, 95% CI) and readmission rate (RR: 1.03, 95% CI). However, no substantial variance in mortality rate (p<0.005) was found between ERAS and the control group. These results were similar to the meta-analysis undertaken by Coolsen *et al.*, in the university hospital Maastricht in the Netherlands, which included 8 studies of multiple countries (data published between 1996 to 2012) in which two were retrospective, three were case-control, and one was prospective [34]. The study included a total no 1558 patients to evaluate the influence of ERAS on post-surgical outcomes (LOS, morbidity, complications, and readmission rate) after PD. Results indicated that implementation of ERAS significantly reduced the length of hospital stay by 2-6 days, complications and cost and increase in mortality and readmission rate were not found. An additional systematic review composed of six randomized control studies (RCTs) and 8 clinical controlled trials (CCTs) was conducted by Lei *et al.*, China [35]. The study aimed to assess the efficacy of ERAS including (control group n=1199 and ERAS group n=1366) composed of a total no of 2565 patients who underwent PD. Findings reported a decrease in postoperative complications (morbidity) (OR=0.73, 95% CI) and mortality rate (OR=0.63 95% CI: p<0.005) in the ERAS group compared with the control group. Another study executed by Coolsen *et al.*, took place in Maastricht University Medical Center between January 1995 and January 2012 in the Netherlands and included the ERAS group (n=97) and no ERAS group (n=87) underwent PD [19]. Findings suggested that implementation of the ERAS program aided in decreasing the duration of stay at the hospital from 20 days in the control group to 14 days in the ERAS group p<0.0001 and postoperative complications from 16 to 9 days without influencing other outcomes, whereas mortality and readmission rates were unchanged. A propensity score-matched study was conducted by Forster *et al.*, which evaluated the impact of ERAS protocol on postoperative outcomes in patients undergoing thoracoscopic lobectomy including 167 pre-ERAS/ 140 ERAS between January 2014 and October 2019 [20]. The outcomes of the measures were LOS, postoperative complications, and readmission rate. Findings reported a high compliance rate of 81% with a significant reduction in the length of days at the hospital (7 to 5 days, p=0004). Based on the propensity score, there was a 13% reduction in surgical complications. Readmission rates (5.4% vs 3.6% p=0.75) were the same between the two groups. As radial cystectomy is associated with postoperative morbidity, Dunkman *et al.*, carried out a cohort study to assess the impact of the ERAS program in an academic medical center in North Carolina with a duration of 3 years [21]. In this study cohort of 100 patients undergoing radial cystectomy with ERAS was compared with a cohort of radial cystectomy with traditional care. Results of the study indicated a significant reduction in postoperative complications, days to pass first stool (Control/ERAS: 5.83/3.88; p<0.001), days to first solid food (9.68 vs 3.2; p<0.001), and a reduction in infectious complications. Decreased hospital stay (ERAS/Control: median LOS 7 days IQR=6-11 vs 10 days IQR=8-18) and 26.6% reduction in costs were observed in the ERAS group, whereas the mortality rate was unchanged. The findings of implementing the ERAS program with radial cystectomy were in contrast with a prospective randomized controlled study carried out by Jensen *et al.*, in a hospital in Denmark among patients who underwent radial cystectomy with a duration of three years [36]. The study included an intervention group (n=50) and a standard group (n=57) that reported similar LOS and severity of complications in both groups. However, postsurgical mobilization was improved in the intervention group. A research study composed of data from 11 articles (multiple countries), conducted by Cerantola *et al.*, to systematically assess the impact of ERAS applied to cystectomy patients, demonstrated a reduction in morbidity, quick bowel recovery, and shortened LOS [37]. The results are similar to the prospective study carried out by Daneshmand *et al.*, in the department of urology in California encompassing a total of 110 patients who underwent radial cystectomy with ERAS implementation between May 2012 to July 2023, reported 82% bowel movement on day 2 after surgery, LOS 4 days, 64% complication rate, without an increase in readmission rate [22]. Dhruva *et al.*, undertook a prospective study to examine the impact of ERAS on laparoscopic colorectal surgery among pre-ERP/post-ERP groups (total: 580) between 2008 and 2012 in Charles Hospital in the United Kingdom [24]. The findings indicated a reduction in hospital stays (pre-ERP; 6 days: post-ERP; 5 days) and other complications. A decrease in morbidity and mortality rate was observed in the ERP group but did not reach a statistical significance level. Additionally, another study carried out by Ripollés *et al.*, in a teaching hospital in Spain between 2010 through 2015, examines the impact of the ERAS program encompassing perioperative measures on postoperative complications associated with colorectal surgery [25]. In this study pre-ERAS (360) and post-ERAS (319) groups were compared. Results of the study showed a decrease in the length of stay at the hospital in the post-ERAS (11 days) group as compared to the pre-ERAS (13 days), whereas the pre-ERAS group (15.5%; p<0.001) experienced more severe complications as compared to post-ERAS (5.3%; p<0.001). No significant difference was found between mortality rates (pre-ERAS/post-ERAS;

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

4.7%/2.5%: p=0.154). Deng *et al.*, conducted out meta-analysis through 2 May 2018 encompassing 25 studies that included 16699 patients in the Tahie Hospital orthopedics department in China, to compare the impact of ERAS after Joint arthroplasty [30]. Results of the study showed a significant reduction in mortality rate (RR: 0.48, 95% CI), incidence of complications (RR: 0.74, 95% CI), and a 26% reduction in overall morbidity whereas no impact was shown on the readmission rate. It is noteworthy that in this systematic review majority of studies did not find a significant difference in mortality rate between the ERAS and control group except for the one study conducted with a large sample size. The lack of this significant difference might be due to several factors small sample size, variations in protocol, and limitations in the studies included. There is a need for multidisciplinary auditing of ERAS Programs to further evaluate its impact [38]. The implementation of Enhanced Recovery After Surgery (ERAS) protocols in Pakistan is still in its emerging stages, although demonstrating promising outcomes. A study conducted at Shifa International Hospital, Islamabad, revealed a significant reduction in the length of hospital stay and surgical site infections (SSIs) among patients undergoing colorectal surgeries when managed under ERAS compared to conventional care [39]. These findings align with the global evidence supporting the efficacy of ERAS in optimizing postoperative care. However, the successful and widespread adoption of ERAS in Pakistan faces several challenges, as highlighted by a qualitative study conducted in Lahore [40]. These challenges include inadequate resource allocation, limited patient education, and a lack of standardized protocols. Additionally, the study emphasized the importance of interdisciplinary collaboration and strong leadership for successful ERAS implementation. While these challenges are not unique to Pakistan, their impact on the adoption of ERAS in a resource-constrained setting is particularly pronounced. To fully realize the benefits of ERAS in Pakistan, concerted efforts are required to address these challenges through policy changes, educational initiatives, and capacity building. Moreover, further research is needed to evaluate the cost-effectiveness of ERAS in the local context and to identify strategies for sustainable implementation.

CONCLUSIONS

It was concluded that the present systematic review of the literature shows that implementation of ERAS programs significantly reduces the overall morbidity, incidence of infections, and complications, and shortens the LOS without intensifying the risks of re-hospitalization and mortality. However, more large-scale research is required to provide valuable insight into the impact of ERAS on postoperative mortality and morbidity.

Authors Contribution

Conceptualization: AS
Methodology: KR
Formal analysis: MUFK
Writing review and editing: ZA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Shimada H, Fukagawa T, Haga Y, Oba K. Does Postoperative Morbidity Worsen the Oncological Outcome After Radical Surgery for Gastrointestinal Cancers? A Systematic Review of the Literature. Annals of Gastroenterological Surgery. 2017 Apr; 1(1): 11-23. doi: 10.1002/ags3.12002.

[2] Dencker EE, Bonde A, Troelsen A, Varadarajan KM, Sillesen M. Postoperative Complications: An Observational Study of Trends in the United States from 2012 to 2018. BioMed Central Surgery. 2021 Nov; 21(1): 393. doi: 10.1186/s12893-021-01392-z.

[3] Dharap SB, Barbaniya P, Navgale S. Incidence and Risk Factors of Postoperative Complications in General Surgery Patients. Cureus. 2022 Nov: 14(11). doi: 10.7759/cureus.30975.

[4] Gillespie BM, Harbeck E, Rattray M, Liang R, Walker R, Latimer S *et al.* Worldwide Incidence of Surgical Site Infections in General Surgical Patients: A Systematic Review and Meta-Analysis of 488,594 Patients. International Journal of Surgery. 2021 Nov; 95: 106136. doi: 10.1016/j.ijsu.2021.106136.

[5] Ripollés-Melchor J, Ramírez-Rodríguez JM, Casans-Francés R, Aldecoa C, Abad-Motos A, Logroño-Egea M et al. Association Between Use of Enhanced Recovery After Surgery Protocol and Postoperative Complications in Colorectal Surgery: The Postoperative Outcomes Within Enhanced Recovery After Surgery Protocol (POWER) Study. Journal of the American Medical Association Surgery. 2019 Aug; 154(8): 725-36. doi: 10.1001/jamasurg.2019.0995.

[6] Nepogodiev D, Martin J, Biccard B, Makupe A, Bhangu A, Ademuyiwa A et al. Global Burden of Postoperative Death. The Lancet. 2019 Feb; 393(10170): 401. doi: 10.1016/S0140-6736(18)33139-8.

[7] Javed H, Olanrewaju OA, Owusu FA, Saleem A, Pavani P, Tariq H *et al.* Challenges and Solutions in Postoperative Complications: A Narrative Review in

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

General Surgery. Cureus. 2023 Dec; 15(12). doi: 10.7759/cureus.50942.

[8] Govaert JA, Fiocco M, Van Dijk WA, Scheffer AC, De Graaf EJ, Tollenaar RA *et al.* Costs of Complications After Colorectal Cancer Surgery in the Netherlands: Building The Business Case for Hospitals. European Journal of Surgical Oncology. 2015 Aug; 41(8): 1059-67. doi: 10.1016/j.ejso.2015.03.236.

[9] Slim K. Fast-Track Surgery: The Next Revolution in Surgical Care Following Laparoscopy. Colorectal Disease. 2011 May; 13(5): 478-80. doi: 10.1111/j.1463-1318.2011.02589.x.

[10] Slim K and Theissen A. Enhanced Recovery After Elective Surgery. A Revolution That Reduces Post-Operative Morbidity and Mortality. Journal of Visceral Surgery. 2020 Dec; 157(6): 487-91. doi: 10.1016/j.jviscsurg.2020.07.005.

[11] Ljungqvist O, de Boer HD, Balfour A, Fawcett WJ, Lobo DN, Nelson G *et al.* Opportunities and Challenges for the Next Phase of Enhanced Recovery After Surgery: A Review. Journal of the American Medical Association Surgery. 2021 Aug; 156(8): 775-84. doi: 10.1001/jamasurg.2021.0586.

[12] Thiele RH, Rea KM, Turrentine FE, Friel CM, Hassinger TE, Goudreau BJ *et al.* Standardization of Care: Impact of an Enhanced Recovery Protocol on Length of Stay, Complications, And Direct Costs After Colorectal Surgery. Journal of the American College of Surgeons. 2015 Apr; 220(4): 430-43. doi: 10.1016/j.jamcollsurg.2014.12.042.

[13] Batchelor TJ, Rasburn NJ, Abdelnour-Berchtold E, Brunelli A, Cerfolio RJ, Gonzalez M *et al.* Guidelines for Enhanced Recovery After Lung Surgery: Recommendations of the Enhanced Recovery After Surgery Society and the European Society of Thoracic Surgeons. European Journal of Cardio-Thoracic Surgery. 2019 Jan; 55(1): 91-115. doi: 10.1093/ejcts/ezy301.

[14] Joliat GR, Kobayashi K, Hasegawa K, Thomson JE, Padbury R, Scott M *et al.* Guidelines for Perioperative Care for Liver Surgery: Enhanced Recovery After Surgery (ERAS) Society Recommendations 2022. World Journal of Surgery. 2023 Jan; 47(1): 11-34. doi: 10.1007/s00268-022-06732-5.

[15] Karunarathna I. The Impact of Hyperglycemia on Perioperative Outcomes in Patients with Diabetes Mellitus. Uva Clinical Lab. Retrieved from The Impact of Hyperglycemia on Perioperative Outcomes in Patients with Diabetes Mellitus. 2024 May.

[16] Smith Jr TW, Wang X, Singer MA, Godellas CV, Vaince FT. Enhanced Recovery After Surgery: A Clinical Review of Implementation Across Multiple Surgical Subspecialties. The American Journal of Surgery. 2020 Mar; 219(3): 530-4. doi: 10.1016/j.amjsurg.2019.11.009.

[17] Perinel J, Duclos A, Payet C, Bouffard Y, Lifante JC, Adham M. Impact of Enhanced Recovery Program After Surgery in Patients Undergoing Pancreatectomy on Postoperative Outcomes: A Controlled Before and After Study. Digestive Surgery. 2020 Feb; 37(1): 47-55. doi: 10.1159/000496510.

[18] Wang XY, Cai JP, Huang CS, Huang XT, Yin XY. Impact of Enhanced Recovery After Surgery Protocol on Pancreaticoduodenectomy: A Meta-Analysis of Non-Randomized and Randomized Controlled Trials. Hepato-Pancreato-Biliary. 2020 Oct; 22(10): 1373-83. doi: 10.1016/j.hpb.2020.07.001.

[19] Coolsen MM, Van Dam RM, Chigharoe A, Olde Damink SW, Dejong CH. Improving Outcome After Pancreaticoduodenectomy: Experiences with Implementing an Enhanced Recovery After Surgery (ERAS) Program. Digestive Surgery. 2014 Jul; 31(3): 177-84. doi: 10.1159/000363583.

[20] Forster C, Doucet V, Perentes JY, Abdelnour-Berchtold E, Zellweger M, Faouzi M *et al.* Impact of an Enhanced Recovery After Surgery Pathway On Thoracoscopic Lobectomy Outcomes in Non-Small Cell Lung Cancer Patients: A Propensity Score-Matched Study. Translational Lung Cancer Research. 2021 Jan; 10(1): 93. doi: 10.21037/tlcr-20-891.

[21] Dunkman WJ, Manning MW, Whittle J, Hunting J, Rampersaud EN, Inman BA *et al.* Impact of an Enhanced Recovery Pathway on Length of Stay and Complications in Elective Radical Cystectomy: A Before and After Cohort Study. Perioperative Medicine. 2019 Dec; 8: 1-0. doi: 10.1186/s13741-019-0120-4.

[22] Daneshmand S, Ahmadi H, Schuckman AK, Mitra AP, Cai J, Miranda G et al. Enhanced Recovery Protocol After Radical Cystectomy for Bladder Cancer. The Journal of Urology. 2014 Jul; 192(1): 50-6. doi: 10.1016/j.juro.2014.01.097.

[23] Baack Kukreja JE, Kiernan M, Schempp B, Siebert A, Hontar A, Nelson B *et al.* Quality Improvement in Cystectomy Care with Enhanced Recovery (QUICCER) Study. British Journal of Urology International. 2017 Jan; 119(1): 38-49. doi: 10.1111/bju.13521.

[24] Dhruva Rao PK, Howells S, Haray PN. Does an Enhanced Recovery Programme Add Value to Laparoscopic Colorectal Resections? International Journal of Colorectal Disease. 2015 Nov; 30: 1473-7. doi: 10.1007/s00384-015-2320-9.

[25] Ripollés-Melchor J, Varela ML, Camargo SC, Fernández PJ, Barrio ÁC, Martínez-Hurtado E et al. Enhanced Recovery After Surgery Protocol Versus Conventional Perioperative Care in Colorectal

DOI: https://doi.org/10.54393/pjhs.v5i09.1881

Surgery. A Single Center Cohort Study. Revista Brasileira De Anestesiologia. 2018 Jul; 68: 358-68. doi: 10.1016/j.bjane.2018.01.007.

[26] Teeuwen PH, Bleichrodt RP, Strik C, Groenewoud JJ, Brinkert W, Van Laarhoven CJ *et al.* Enhanced Recovery After Surgery (ERAS) Versus Conventional Postoperative Care in Colorectal Surgery. Journal of Gastrointestinal Surgery. 2010 Jan; 14(1): 88-95. doi: 10.1007/s11605-009-1037-x.

[27] Savikko J, Ilmakunnas M, Mäkisalo H, Nordin A, Isoniemi H. Enhanced Recovery Protocol After Liver Resection. Journal of British Surgery. 2015 Nov; 102(12): 1526-32. doi: 10.1002/bjs.9912.

[28] Dasari BV, Rahman R, Khan S, Bennett D, Hodson J, Isaac J *et al.* Safety and Feasibility of an Enhanced Recovery Pathway After A Liver Resection: Prospective Cohort Study. Hepato-Pancreato-Biliary. 2015 Aug; 17(8): 700-6. doi: 10.1111/hpb.12447.

[29] Di Rollo D, Mohammed A, Rawlinson A, Douglas-Moore J, Beatty J. Enhanced Recovery Protocols in Urological Surgery: A Systematic Review. The Canadian Journal of Urology. 2015 Jun; 22(3): 7817-23.

[30] Deng QF, Gu HY, Peng WY, Zhang Q, Huang ZD, Zhang C *et al.* Impact of Enhanced Recovery After Surgery on Postoperative Recovery After Joint Arthroplasty: Results from A Systematic Review and Meta-Analysis. Postgraduate Medical Journal. 2018 Dec; 94(1118): 678-93. doi: 10.1136/postgradmedj-2018-136166.

[31] Wang C, Feng H, Zhu X, Song Z, Li Y, Shi Y *et al.* Comparative Effectiveness of Enhanced Recovery After Surgery Program Combined With Single-Incision Laparoscopic Surgery in Colorectal Cancer Surgery: A Retrospective Analysis. Frontiers in Oncology. 2022 Jan; 11: 768299. doi: 10.3389/fonc.2021.768299.

[32] Noba L, Rodgers S, Chandler C, Balfour A, Hariharan D, Yip VS. Enhanced Recovery After Surgery (ERAS) Reduces Hospital Costs and Improve Clinical Outcomes in Liver Surgery: A Systematic Review and Meta-Analysis. Journal of Gastrointestinal Surgery. 2020 Apr; 24(4): 918-32. doi: 10.1007/s11605-019-04499-0.

[33] Balzano G, Zerbi A, Braga M, Rocchetti S, Beneduce AA, Di Carlo V. Fast-Track Recovery Programme After Pancreatico-Duodenectomy Reduces Delayed Gastric Emptying. Journal of British Surgery. 2008 Nov; 95(11): 1387-93. doi: 10.1002/bjs.6324.

[34] Coolsen ME, Van Dam RM, Van Der Wilt AA, Slim K, Lassen K, Dejong CH. Systematic Review and Meta-Analysis of Enhanced Recovery After Pancreatic Surgery with Particular Emphasis on Pancreaticoduodenectomies. World Journal of Surgery. 2013 Aug; 37: 1909-18. doi: 10.1007/s00268-013-2044-3.

[35] Lei Q, Wang X, Tan S, Wan X, Zheng H, Li N. Application of Enhanced Recovery After Surgery Program in Perioperative Management of Pancreaticoduodenectomy: A Systematic Review. Zhonghua wei Chang wai ke za zhi= Chinese Journal of Gastrointestinal Surgery. 2015 Feb; 18(2): 143-9.

[36] Jensen BT, Petersen AK, Jensen JB, Laustsen S, Borre M. Efficacy of a Multiprofessional Rehabilitation Programme in Radical Cystectomy Pathways: A Prospective Randomized Controlled Trial. Scandinavian Journal of Urology. 2015 Mar; 49(2): 133-41. doi: 10.3109/21681805.2014.967810.

[37] Cerantola Y, Valerio M, Persson B, Jichlinski P, Ljungqvist O, Hubner M *et al.* Guidelines for Perioperative Care After Radical Cystectomy for Bladder Cancer: Enhanced Recovery After Surgery (ERAS®) Society Recommendations. Clinical Nutrition. 2013 Dec; 32(6): 879-87. doi: 10.1016/j.clnu.2013.09.014.

[38] Pickens RC, Cochran AR, Lyman WB, King L, Iannitti DA, Martinie JB et al. Impact of Multidisciplinary Audit of Enhanced Recovery After Surgery (ERAS)® Programs at A Single Institution. World Journal of Surgery. 2021 Jan; 45: 23-32. doi: 10.1007/s00268-020-05765-y.

[39] Soomro FH, Razzaq A, Qaisar R, Ansar M, Kazmi T. Enhanced Recovery After Surgery: Are Benefits Demonstrated in International Studies Replicable in Pakistan? Cureus. 2021 Nov: 13(11). doi: 10.7759/cureus.19624.

[40] Ahmad H, Arnaert A, Shedio W, Tanoli O, Deckelbaum D, Pasha T. Enhanced Recovery After Surgery in Pakistan: An Initial Assessment and Future Directions. 2023 Sep. doi: 10.21203/rs.3.rs-3325387/v1.