Original Article
DOI: https://doi.org/10.70749/ijbr.v3i3.759

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Role of Incentive Spirometry as a Part of ERAS Protocol in Prevention of Postoperative Pulmonary Complications after Major Abdominal Surgery

Muhammad Fawad[1], Muhammad Tabish Iqbal[2], Abdul Hameed[3], Jawad Hameed[2], Sohail Akram[1], Shakeel Ahmed Zia[3]

[1]Combined Military Hospital, Kohat, Pakistan
[2]Combined Military Hospital, Kharian, Pakistan
[3]Combined Military Hospital, Nowshehra, Pakistan

ARTICLE INFO

Keywords

Incentive Spirometry, ERAS, Postoperative Pulmonary Complications, Abdominal Surgery, Perioperative Care, Hospital Stay, Fluid Management.

Corresponding Author: Muhammad Fawad,
Combined Military Hospital, Kohat, Pakistan
Email: kfawad3@hotmail.com

Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.
Conflict of Interest: No conflict of interest.
Funding: No funding received by the authors.

Article History
Received: 25-12-2024
Revised: 22-02-2025
Accepted: 03-03-2025

ABSTRACT

Background: Postoperative pulmonary complications (PPCs) significantly impact morbidity and healthcare burden after major abdominal surgeries. Enhanced Recovery After Surgery (ERAS) protocols have improved surgical outcomes, but the role of incentive spirometry (IS) as an adjunct in ERAS remains underexplored. **Objective:** To evaluate the efficacy of incentive spirometry within the ERAS framework in reducing PPCs, total fluid administration, and hospital length of stay (LOS) in patients undergoing major abdominal surgery. **Methods:** This quasi-experimental study was conducted at CMH Rawalpindi from June 2022 to March 2023 (ERC #393). A total of 182 patients (n = 91 per group), aged 18–60 years (ASA I–III), scheduled for elective major abdominal surgeries were included. Patients were allocated to the ERAS plus IS group (Group-IS) or conventional care group (Group-C). PPCs, perioperative fluid administration, and LOS were assessed using clinical and radiological parameters. Data were analyzed using SPSS (version 23), with statistical significance set at $p \leq 0.05$. **Results:** PPC incidence was significantly lower in Group-IS (1.1%) than in Group-C (7.7%) ($p = 0.03$). Group-IS had significantly reduced perioperative fluid administration (1509 ± 178.23 mL vs. 2300 ± 256.23 mL, $p = 0.000$) and shorter LOS (1.44 ± 0.89 vs. 2.29 ± 0.87 days, $p = 0.000$). **Conclusion:** Incentive spirometry as part of the ERAS protocol significantly reduces PPCs, optimizes fluid management, and shortens LOS in major abdominal surgery, demonstrating clinical and economic benefits.

INTRODUCTION

Enhanced Recovery After Surgery (ERAS) is a multimodal, evidence-based approach designed to optimize perioperative care, reduce surgical stress, and promote early recovery. Initially developed for colorectal surgeries, ERAS protocols have been widely adopted across various surgical specialties, demonstrating improved patient outcomes and reduced hospital stays (1). Postoperative pulmonary complications (PPCs) remain a significant concern following major abdominal surgeries, with incidences ranging from 20% to 90% for atelectasis and approximately 40% for pulmonary edema (2). These complications contribute to prolonged hospitalization, increased healthcare costs, and elevated morbidity and mortality rates. Effective perioperative strategies are required to mitigate pulmonary risks and improve patient recovery. While ERAS protocols emphasize early mobilization and multimodal analgesia, the role of incentive spirometry (IS) as an adjunct remains underexplored.

Surgical stress induces neurohormonal responses that affect multiple organ systems, with the pulmonary system particularly vulnerable due to postoperative pain, diaphragmatic splinting, and reduced mucociliary clearance (3). Conventional perioperative management often involves prolonged fasting, excessive fluid administration, and delayed ambulation, which further exacerbate pulmonary dysfunction and delay recovery (4). Studies have shown that ERAS protocols incorporating preoperative nutritional support, goal-directed fluid therapy, and early rehabilitation significantly reduce complications and length of hospital stay (5). Despite these advancements, the integration of

IS within ERAS remains an area of limited investigation, with conflicting evidence regarding its effectiveness in reducing PPCs in major abdominal surgery patients (6). Incentive spirometry is a non-invasive pulmonary intervention that encourages deep breathing, lung expansion, and secretion clearance, reducing the risk of postoperative atelectasis and pneumonia. Research suggests that preoperative IS training can enhance postoperative lung function, with one study reporting a reduction in PPC incidence from 42.5% to 20% when IS was initiated preoperatively (7). However, clinical evidence remains inconsistent, with some studies indicating no significant benefit beyond early mobilization and multimodal analgesia (8). Given the high burden of PPCs and the need for comprehensive perioperative strategies, evaluating the efficacy of IS within ERAS protocols is essential for evidence-based surgical care.

This study aims to assess the role of IS as an adjunct to ERAS in preventing PPCs, reducing perioperative fluid administration, and shortening hospital length of stay in patients undergoing major abdominal surgery. We hypothesize that the integration of IS into ERAS protocols will significantly reduce PPC rates and improve recovery outcomes compared to conventional perioperative management.

MATERIAL AND METHODS

This quasi-experimental study was conducted at CMH Rawalpindi from June 2022 to March 2023 to evaluate the role of incentive spirometry (IS) as an adjunct within the Enhanced Recovery After Surgery (ERAS) protocol in preventing postoperative pulmonary complications (PPCs) following major abdominal surgeries. The study included adult patients aged 18–60 years scheduled for elective major abdominal procedures, with American Society of Anesthesiologists (ASA) classification I–III. Patients were recruited using a non-probability consecutive sampling technique and allocated into two groups: Group-IS, where ERAS guidelines were followed along with IS, and Group-C, which received conventional perioperative care. Patients with ASA-IV classification, pre-existing respiratory disorders that could impair spirometry use, neurological deficits affecting voluntary breathing efforts, or those undergoing emergency procedures were excluded. Ethical approval was obtained from the Institutional Review Board (ERC #393), and informed consent was secured from all participants in accordance with the Helsinki Declaration. Confidentiality was maintained by anonymizing patient identifiers and securing data storage.

The primary outcome measure was the incidence of PPCs, including atelectasis, pneumonia, and pulmonary edema, assessed clinically and via postoperative chest radiography reviewed by a consultant radiologist. Secondary outcomes included perioperative fluid administration and hospital length of stay (LOS). Preoperative patient assessments included baseline pulmonary function evaluation, ASA classification, and demographic data collection. In Group-IS, patients were trained in IS use preoperatively by a trained nurse, with a structured regimen of six daily sessions (10 breaths per session) starting two days before surgery. Perioperative care followed ERAS principles, incorporating carbohydrate loading, goal-directed fluid therapy, multimodal analgesia, and early ambulation. Intraoperative variables, including duration of surgery and anesthesia type, were documented. Postoperatively, patients in Group-IS continued IS exercises, while those in Group-C followed conventional postoperative management, which included delayed oral feeding and ambulation per standard institutional protocols. PPCs were recorded based on clinical presentation, radiographic evidence, and respiratory function deterioration. LOS was defined as the duration from surgery to hospital discharge with full recovery indicators.

Statistical analysis was performed using SPSS version 27, with continuous variables expressed as mean ± standard deviation and categorical variables as frequencies and percentages. An independent t-test was used to compare continuous variables between groups, while categorical data were analyzed using the chi-square test. A p-value ≤ 0.05 was considered statistically significant. Missing data were handled using multiple imputation techniques, and potential confounding variables, such as comorbid conditions and surgical type, were adjusted through stratified analysis. Sensitivity analysis was performed to assess the robustness of findings. By systematically integrating IS within ERAS protocols, this study aimed to provide a reproducible, evidence-based framework for optimizing perioperative respiratory care and accelerating surgical recovery.

RESULTS

A total of 182 patients were recruited for the study, with 91 participants assigned to each group. The American Society of Anesthesiologists (ASA) classification revealed a relatively balanced distribution between the two groups, with 42.9% of patients in Group-IS classified as ASA I compared to 45.1% in Group-C. ASA II was observed in 50.5% of Group-IS patients and 46.2% of Group-C patients, while ASA III accounted for 6.6% and 8.8% of patients in Group-IS and Group-C, respectively. The mean age of the participants was comparable between groups, with Group-IS having a mean age of 45.96 ± 9.52 years versus 47.38 ± 7.83 years in Group-C ($p = 0.271$). Gender distribution was also similar, with males comprising 63.7% and 59.3% of Group-IS and Group-C, respectively, and females accounting for 36.3% and 40.7% ($p = 0.542$).

Regarding the type of surgeries performed, herniotomy was the most common procedure, accounting for 44% of cases in Group-IS and 49.5% in Group-C. Cholecystectomy followed, with 29.7% of Group-IS and 22% of Group-C undergoing this procedure. Laparotomy was performed in 13.2% of Group-IS and 11% of Group-C, while appendectomy accounted for 7.7% and 14.3%, respectively. Less frequently performed procedures included gastrectomy (3.3% in Group-IS vs. 2.2% in Group-C) and abdominoplasty (2.2% vs. 1.1%).

Table 1
Distribution on the basis of ASA

Variables	Group-IS (n = 91)	Group-C (n = 91)	Total N=182
ASA I n (%)	39(42.9%)	41(45.1%)	80(44%)
ASA II n (%)	46(52.3%)	07 (47.7%)	88(48.4%)
ASA III n(%)	06(6.6%)	08(8.8%)	14(7.7%)

Table 2
Age and gender distribution

Variables		Group-IS (n = 91)	Group-C (n = 91)	p-value
Age in years Mean ± S.D		45.96 ± 9.52	47.38 ± 7.83	0.271
Gender n (%)	Males	58(63.7%)	54(59.3%)	0.542
	Females	33(36.3%)	37(40.7%)	

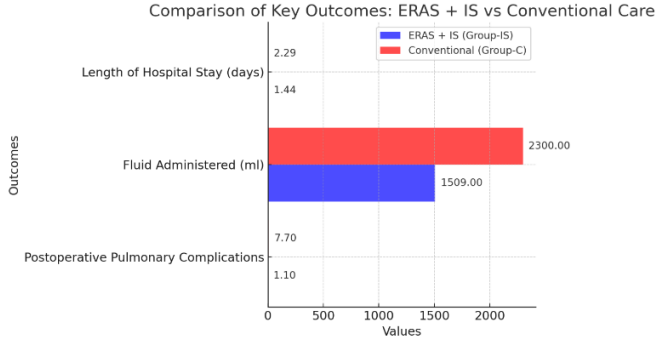
Table 3
Type of surgeries among groups

Type of surgery	Group-IS (n = 91)	Group-C (n = 91)
Herniotomy	40(44%)	45(49.5%)
Cholecystectomy	27(29.7%)	20(22%)
Laparotomy	12(13.2%)	10(11%)
Appendectomy	07(7.7%)	13(14.3%)
Gastrectomy	03(3.3%)	02(2.2%)
Abdominoplasty	02(2.2%)	01(1.1%)

Table 4
Perioperative characteristics among groups

Variables	Group-IS (n = 91)	Group-C (n = 91)	p-value
Operative time Mean ± S.D	97.70 ± 39.39 mins	95.40 ± 34.08 mins	0.673
Fluid administered. Mean ± S.D	1509 ±178.23 ml	2300 ± 256.23 ml	0.000
Post operative pulmonary complications. n(%)	01(1.1%)	07(7.7%)	0.030
Length of Hospital stay	1.44 ±0.89 days	2.29 ± 0.87 days	0.000

Figure 1: *Comparison of Key Outcomes*



Key perioperative outcomes demonstrated significant differences between the two groups. The mean operative time was slightly higher in Group-IS (97.70 ± 39.39 minutes) compared to Group-C (95.40 ± 34.08 minutes), though this difference was not statistically significant (p = 0.673). However, perioperative fluid administration was significantly lower in Group-IS (1509 ± 178.23 mL) compared to Group-C (2300 ± 256.23 mL), with a highly significant p-value of 0.000, indicating superior fluid management in the ERAS-plus-IS group. Notably, postoperative pulmonary complications occurred in only 1.1% (n = 1) of Group-IS patients compared to 7.7% (n = 7) in Group-C, with a statistically significant reduction (p = 0.030). The length of hospital stay was also significantly shorter in Group-IS, with a mean duration of 1.44 ± 0.89 days versus 2.29 ± 0.87 days in Group-C (p = 0.000). These findings suggest that incorporating incentive spirometry within the ERAS protocol not only improves pulmonary outcomes but also optimizes perioperative fluid management and accelerates postoperative recovery.

DISCUSSION

The findings of this study demonstrate that integrating incentive spirometry (IS) within the Enhanced Recovery After Surgery (ERAS) protocol significantly reduces postoperative pulmonary complications (PPCs), optimizes perioperative fluid management, and shortens hospital stays in patients undergoing major abdominal surgeries. The incidence of PPCs was markedly lower in the IS group (1.1%) compared to the conventional care group (7.7%), reinforcing the beneficial role of IS in mitigating respiratory complications. Additionally, the mean length of hospital stay was significantly reduced in the ERAS-plus-IS group (1.44 ± 0.89 days) compared to the conventional care group (2.29 ± 0.87 days), indicating that IS enhances the effectiveness of ERAS protocols in accelerating postoperative recovery. These results align with previous studies highlighting the efficacy of ERAS in reducing surgical stress and improving patient outcomes (1). However, this study further strengthens the evidence by demonstrating that IS, when employed as an adjunct, can amplify these benefits.

The reduction in PPCs observed in the IS group aligns with prior research demonstrating that respiratory prehabilitation, including IS, improves pulmonary function and reduces postoperative atelectasis and pneumonia (2). The pathophysiological basis of PPCs following abdominal surgery includes diaphragmatic splinting due to postoperative pain, reduced lung volumes, and impaired mucociliary clearance, all of which predispose patients to atelectasis and pneumonia (3). IS promotes deep inspiration, alveolar recruitment, and secretion clearance, mitigating these complications. Previous trials have reported that preoperative IS

training reduces PPC incidence from 42.5% to 20%, emphasizing the importance of early intervention (4). However, conflicting evidence exists, with some studies suggesting that IS alone may not offer significant advantages over early mobilization and multimodal analgesia (5). This study contributes to this ongoing debate by demonstrating that IS, when integrated into a structured ERAS framework, significantly enhances pulmonary recovery.

Fluid management is another critical determinant of postoperative outcomes, as excessive perioperative fluid administration has been associated with increased risk of pulmonary complications, delayed gastrointestinal recovery, and prolonged hospital stays (6). In this study, the ERAS-plus-IS group received significantly lower fluid volumes (1509 ± 178.23 mL vs. 2300 ± 256.23 mL, $p = 0.000$), highlighting the effectiveness of goal-directed fluid therapy within ERAS. Prior research has indicated that restrictive fluid strategies within ERAS protocols reduce complications and enhance recovery, particularly in abdominal surgeries (7). The present findings further validate this approach, suggesting that incorporating IS may indirectly contribute to improved fluid management by promoting early mobilization and better respiratory function, thereby reducing the need for excessive intravenous fluids.

The reduction in hospital stay observed in this study is consistent with previous research indicating that ERAS protocols facilitate earlier discharge by optimizing perioperative care (8). A study evaluating ERAS in thoracic surgery reported a median hospital stay reduction from 13 to 11 days, with improved postoperative lung function (9). Similarly, an ERAS-based approach in gastrointestinal surgery reduced complications by 41% and hospital stay by 33% (10). The present study extends these findings to major abdominal surgeries, demonstrating that IS within ERAS further enhances recovery by minimizing PPCs and optimizing perioperative care. Importantly, the clinical and economic implications of these findings are substantial, as shorter hospital stays translate into reduced healthcare costs and improved resource utilization.

Despite the strengths of this study, including its structured ERAS implementation and statistically robust findings, several limitations should be acknowledged. The sample size, though adequately powered, remains relatively small, limiting the generalizability of the results to broader populations. Additionally, the quasi-experimental design, while effective in assessing intervention outcomes, lacks the rigorous randomization of a controlled trial, which may introduce selection bias. The study also focused solely on elective major abdominal surgeries, and its findings may not be directly applicable to emergency surgical cases or other surgical specialties. Future research should aim to validate these findings through larger, randomized controlled trials, incorporating diverse patient populations and extended follow-up periods to assess long-term pulmonary and functional recovery outcomes.

Given the compelling evidence supporting the integration of IS within ERAS, future investigations should explore its mechanistic effects in greater detail, including objective pulmonary function assessments such as spirometry and arterial blood gas analysis. Additionally, studies comparing IS with alternative respiratory interventions, such as positive expiratory pressure therapy or inspiratory muscle training, could provide further insight into optimizing perioperative pulmonary care. The potential benefits of preoperative IS training, rather than initiation postoperatively, also warrant further investigation, as early respiratory prehabilitation may enhance postoperative outcomes.

CONCLUSION

In conclusion, this study provides strong evidence that incentive spirometry, when incorporated within the ERAS protocol, significantly reduces postoperative pulmonary complications, improves fluid management, and shortens hospital stays in patients undergoing major abdominal surgery. These findings underscore the importance of a multimodal approach to perioperative care, integrating pulmonary rehabilitation strategies within ERAS to enhance surgical outcomes. While further research is necessary to validate and expand upon these findings, the results support the routine implementation of IS within ERAS protocols to optimize postoperative recovery and reduce surgical morbidity.

REFERENCES

1. Ashok A, Niyogi D, Ranganathan P, Tandon S, Bhaskar M, Karimundackal G, et al. The Enhanced Recovery After Surgery (ERAS) Protocol to Promote Recovery Following Esophageal Cancer Resection. Surg Today. 2020;50(4):323-34. https://doi.org/10.1007/s00595-019-01891-0
2. Noba L, Rodgers S, Chandler C, Balfour A, Hariharan D, Yip VS. Enhanced Recovery After Surgery (ERAS) Reduces Hospital Costs and Improves Clinical Outcomes in Liver Surgery: A Systematic Review and Meta-Analysis. J Gastrointest Surg. 2020;24(4):918-32. https://doi.org/10.1007/s11605-019-04407-1
3. Miralpeix E, Mancebo G, Gayete S, Corcoy M, Solé-Sedeño JM. Role and Impact of Multimodal Prehabilitation for Gynecologic Oncology Patients in an Enhanced Recovery After Surgery (ERAS)

Program. Int J Gynecol Cancer. 2019;29(8):1235-43. https://doi.org/10.1136/ijgc-2019-000669
4. Hughes MJ, Hackney RJ, Lamb PJ, Wigmore SJ, Deans DA, Skipworth RJ. Prehabilitation Before Major Abdominal Surgery: A Systematic Review and Meta-Analysis. World J Surg. 2019;43(7):1661-8. https://doi.org/10.1007/s00268-019-04950-y
5. Tyson AF, Kendig CE, Mabedi C, Cairns BA, Charles AG. The Effect of Incentive Spirometry on Postoperative Pulmonary Function Following Laparotomy: A Randomized Clinical Trial. JAMA Surg. 2015;150(3):229-36. https://doi.org/10.1001/jamasurg.2014.1848
6. Kahokehr A, Sammour T, Zargar-Shoshtari K, Thompson L, Hill AG. Implementation of ERAS and How to Overcome the Barriers. Int J Surg. 2009;7(1):16-9. https://doi.org/10.1016/j.ijsu.2008.11.007
7. Lassen K, Soop M, Nygren J, Cox PB, Hendry PO, Spies C, et al. Consensus Review of Optimal Perioperative Care in Colorectal Surgery: Enhanced Recovery After Surgery (ERAS) Group Recommendations. Arch Surg. 2009;144(10):961-9. https://doi.org/10.1001/archsurg.2009.170
8. Petersen RH, Huang L, Kehlet H. Guidelines for Enhanced Recovery After Lung Surgery: Need for Re-Analysis. Eur J Cardiothorac Surg. 2021;59(2):291-2. https://doi.org/10.1093/ejcts/ezaa282
9. Awad S, Carter S, Purkayastha S, Hakky S, Moorthy K, Cousins J, et al. Enhanced Recovery After Bariatric Surgery (ERABS): Clinical Outcomes from a Tertiary Referral Bariatric Centre. Obes Surg. 2014;24(5):753-8. https://doi.org/10.1007/s11695-013-1148-x
10. Sweity EM, Alkaissi AA, Othman W, Salahat A. Preoperative Incentive Spirometry for Preventing Postoperative Pulmonary Complications in Patients Undergoing Coronary Artery Bypass Graft Surgery: A Prospective, Randomized Controlled Trial. J Cardiothorac Surg. 2021;16(1):1-9. https://doi.org/10.1186/s13019-021-01412-4
11. Melloul E, Lassen K, Roulin D, Grass F, Perinel J, Adham M, et al. Guidelines for Perioperative Care for Pancreatoduodenectomy: Enhanced Recovery After Surgery (ERAS) Recommendations 2019. World J Surg. 2020;44(7):2056-84. https://doi.org/10.1007/s00268-020-05462-w
12. Swaminathan N, Kundra P, Ravi R, Kate V. ERAS Protocol with Respiratory Prehabilitation Versus Conventional Perioperative Protocol in Elective Gastrectomy – A Randomized Controlled Trial. Int J Surg. 2020;81:149-57. https://doi.org/10.1016/j.ijsu.2020.07.011
13. Leonardi B, Sagnelli C, Fiorelli A, Leone F, Mirra R, Pica DG, et al. Application of ERAS Protocol After VATS Surgery for Chronic Empyema in Immunocompromised Patients. Healthcare (Basel). 2022;10(4):635. https://doi.org/10.3390/healthcare10040635
14. Rasmussen ML, Leeds SG, Whitfield EP, Aladegbami B, Ogola GO, Ward MA. Enhanced Recovery After Surgery (ERAS) Decreases Complications and Reduces Length of Stay in Foregut Surgery Patients. Surg Endosc. 2022;36(6):4630-8. https://doi.org/10.1007/s00464-022-09127-4
15. Shin HD, Rodriguez AM, Abraham JT, Cargile JC, Brown CN, Altman AM, et al. Does ERAS Benefit Higher BMI Patients? A Single Institutional Review. J Plast Reconstr Aesthet Surg. 2021;74(3):475-9. https://doi.org/10.1016/j.bjps.2020.09.058
16. Williams JB, McConnell G, Allender JE, Woltz P, Kane K, Smith PK, et al. One-Year Results from the First US-Based Enhanced Recovery After Cardiac Surgery (ERAS Cardiac) Program. J Thorac Cardiovasc Surg. 2019;157(5):1881-8. https://doi.org/10.1016/j.jtcvs.2018.12.021
17. Tippireddy S, Ghatol D. Anesthetic Management for Enhanced Recovery After Major Surgery (ERAS). In: StatPearls [Internet]. StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK573065/
18. Pathak U, Hollier LH Jr. Review of "Impact of a Novel Preoperative Patient-Centered Surgical Wellness Program" by Kelley KE in Ann Surg 268: 650-656, 2018. J Craniofac Surg. 2019;30(7):2294. https://doi.org/10.1097/SCS.0000000000005753