Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

EVALUATION OF EFFECT OF INCENTIVE SPIROMETRY ON POST-OPERATIVE PULMONARY COMPLICATIONS FOLLOWING ABDOMINO-THORACIC SURGERY

Laiba Adeel[1], Iqra Asad[2], Malika Nisar[3], Saqib Ramzan[4], Amina Saeed[*5]

[*1,2,3,4,*5]*Respiratory Therapy, Department of Emerging Health Professional Technologies, Allied Health Sciences, Superior University, Lahore, Pakistan*

[1]adeellaiba91@gmail.com, [2]asadiqra695@gmail.com, [3]malikanissar957@gmail.com, [4]mrsaqib435@gmail.com, [*5]saeedbinte9@gmail.com

DOI: https://doi.org/10.5281/zenodo.20538168

Keywords

Incentive spirometry; postoperative pulmonary complications; oxygen saturation; abdomino-thoracic surgery; respiratory physiotherapy; spirometry ball performance.

Article History

Received: 03 April 2026
Accepted: 15 May 2026
Published: 04 June 2026

Corresponding Author: *
Amina Saeed
saeedbinte9@gmail.com

Abstract

Background: *Patient having abdomino-thoracic surgeries are at the high risk of developing postoperative pulmonary complications due to reduced lung expansion, pain and impaired respiratory mechanics. Although there is conflicting evidence about its efficacy, incentive spirometry is frequently advised as a lung expansion technique to prevent atelectasis and enhance respiratory function*

Objective(s): *To evaluate the effect of effect of incentive spirometry pulmonary complications in patients following abdomino-thoracic surgery*

Methodology: *A controlled experimental study will be conducted on patients with post abdomino-thoracic surgery, patients will be split into two group; an incentive spirometry group and a control group. Everyday measurements of oxygen saturation, post pulmonary complications incident and spirometry ball-rising (0-3 balls) will be assessed daily. Outcomes of both groups will be observed to see the efficacy of incentive spirometry.*

Results: *In comparison to standard postoperative care alone, the study aims to ascertain whether the addition of incentive spirometry improves oxygen saturation, lowers the incidence of PPCs and improves lung functioning*

Conclusion(s): *The findings will support evidence-based postoperative physiotherapy practices by shedding light on how well incentive spirometry works to improve respiratory outcomes and prevent PPCs in patient following abdomino-thoracic surgery*

INTRODUCTION

Sullivan KA, Churchill IF, Hylton DA and Hanna WC performed a systematic review and meta-analysis to determine the effect of IS on adult patients following cardiac, thoracic and upper abdominal surgery. Researchers studied its effect on the rate of postoperative pulmonary complications such as atelectasis and pneumonia. The available studies suggests that incentive spirometry may improve lung expansion and respiratory mechanics after surgery. The authors reported that its synchrony with other respiratory physiotherapy interventions appears to reduce pulmonary complication rates. It also improved patient participation in their deep breathing exercises during recovery phase. In summary, this study concluded that incentive spirometry has a positive supportive role in postoperative respiratory care as it reduced pneumonia ,atelectasis incidences[1].

After thoracic surgery, one of the biggest challenges patients face is pulmonary complications. The surgery itself takes a real toll on the respiratory system decrease lung volumes , breathing becomes more difficult, and the

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

diaphragm doesn't move the way it normally would. This creates a window of vulnerability in the early postoperative days, where complications like collapsed alveoli, pneumonia, and hypoxemia can develop quickly. That's why respiratory care is cornerstone of recovery. Among all the techniques, incentive spirometry stands out for its simplicity and effectiveness. It's essentially a small handheld device that encourages patients to take slow, deep breaths, helping to reopen the alveoli and keep the airways clear. There's something almost intuitive about it, the patient is an active participant in their own healing. It works best as part of a broader approach. When incentive spirometry is paired with other physiotherapy techniques, the results are meaningfully better. Together, these strategies give patients safer and quicker recovery and that makes all the difference [2] .

Cengiz et al (2025) evaluated the combined effect of deep breathing exercises and incentive spirometry on postoperative pulmonary complications. It's well known that the postoperative period carries a real risk of lung-related complications. When the body goes through surgery, the lungs don't simply bounce back overnight. Breathing becomes shallower, lung volumes decreases and the normal lung mechanics get disrupt. Left unaddressed, this can lead to serious complications that prolong hospital stays. Deep breathing exercises encourage patients to take fuller, more deep breaths. Incentive spirometry adds a visual, measurable element to respiratory effort, giving patients a tangible goal to work toward with each breath .When used together, the two approaches work more effectively. They help recruit collapsed alveoli, improve the hypoxemia and gradually restore normal breathing patterns. The result of this research supports is fewer pulmonary complications and a smoother road to recovery leading to shorter hospital stays [3].

This study evaluates that after upper abdominal surgery patients are at higher risk of developing postoperative pulmonary complications because of reduced diaphragmatic movement and impaired lung function. Reduced lung volumes and changed breathing patterns following surgery are the causes of pulmonary complications which include pneumonia and atelectasis. Respiratory physiotherapy, including the use of incentive spirometers and deep diaphragmatic breathing exercises play an important role in supporting patients during their recovery journey after surgery, help them regain lung function and feel more comfortable as they heal. A recent study shows that combining these interventions may result in reduced pulmonary complications and improved respiratory parameters. Thus combining diaphragmatic exercises with incentive spirometry may be a useful technique to

improve recovery and lower postoperative pulmonary complications [4].

Postoperative pulmonary complications are the most common risk after upper abdominal surgery due to reduced lung volumes and altered pulmonary function. Patients instinctively guard against discomfort by taking smaller, shallower breaths which is completely understandable, but unfortunately it effect the lungs function and the alveoli partially collapse and effect ventilation .During that critical window respiratory physiotherapy steps in precisely at this point. Rather than leaving the lungs to recover passively, it gives patients the tools and guidance to actively rebuild their breathing capacity. Incentive spirometry is one of the most valuable of these tools simple to use, non-invasive, and remarkably effective. By encouraging slow, sustained deep breaths, it helps reopen collapsed areas of the lung and gradually brings lung function back toward normal. In this way, something as accessible as a breathing device can play a genuinely important role in keeping postoperative complications at bay and helping patients recover quickly [5].

LITERATURE REVIEW.

Ababneh QM et al (2025)compared The efficacy of deep breathing exercises (DBE) and incentive spirometry (IS) in preventing postoperative pulmonary complications . Patients having abdominal surgery were the study's main focus. The improvement of lung function was assessed for both preoperative and postoperative use of IS and DBE. The incidence of pulmonary complications decreased when IS and DBE were combined, according to the results. Following surgery, these measures encouraged lung expansion and enhanced

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

ventilation. One important factor affecting results was identified as patient compliance. In patients undergoing abdominal surgery, IS and DBE were generally found to improve postoperative respiratory recovery[9].

Chang et al (2023) demonstrated that incentive spirometry enhances the standard of postoperative care for surgical patients. Compared to patients who did not use incentive spirometry, those who did showed improved respiratory function. Regular use resulted in significant improvements in oxygenation, lung expansion, and secretion mobilization. Patients who followed the spirometry protocol had a lower incidence of postoperative pulmonary complications. To get the best results, proper technique and patient compliance were stressed. The study is in favor of routine postoperative care that includes incentive spirometry. In general, incentive spirometry lowers postoperative morbidity and improves respiratory recovery[10].

A randomized controlled trial was carried out by Sum et al. (2019) to assess the efficiency of incentive spirometry in lowering pulmonary complications in patients who have suffered traumatic rib fractures. To promote lung expansion and deep breathing, the intervention group engaged in frequent incentive spirometer exercises. In comparison to the control group, the results indicated a significant decrease in pulmonary complications, specifically respiratory distress and pneumonia. Patients who used the device showed improved respiratory recovery overall and better clearance of their airways. Additionally, the study found that the spirometry group had better clinical outcomes and shorter hospital stays. The authors came to the conclusion that incentive spirometry is an easy and efficient way to keep high-risk patients from developing respiratory problems[11].

In order to investigate the possible advantages of incentive spirometry after rib fractures, Kuimi et al. (2019) performed a propensity score analysis, expanding the study of IS beyond conventional postoperative settings. According to their research, patients who utilized incentive spirometry experienced fewer pulmonary problems than those who did not. The study found that the incentive spirometry group had better airway clearance, increased lung expansion, and better breathing mechanics. Reduced rates of respiratory distress and pneumonia, two common risks following rib fractures, were linked to these respiratory improvements. Incentive spirometry is a straightforward, low-risk intervention that can improve respiratory outcomes for trauma patients, according to the authors[12].

The advantages of incentive spirometry for lung cancer patients undergoing video-assisted thoracic surgery were examined by Liu et al. (2019). According to the study, using incentive spirometry on a regular basis encouraged deeper, longer-lasting breaths and enhanced postoperative lung function. Compared to patients who did not use the device, those who did had lower rates of pulmonary complications like hypoxemia and atelectasis. Additionally, the intervention improved overall respiratory recovery and airway clearance. The authors stressed that incentive spirometry is a non-invasive, safe, and economical method of assisting patients undergoing thoracic surgery with their postoperative respiratory care. Their results imply that incorporating incentive spirometry into routine postoperative care can lower respiratory morbidity and enhance patient outcomes[13].

The impact of structured breathing exercises, such as incentive spirometry, on postoperative recovery in patients undergoing heart surgery was examined by Bhojak et al. (2025). Using a randomized controlled design, the study compared a control group that received standard postoperative care with an intervention group that received breathing exercises. The results showed that patients who regularly engaged in breathing exercises had significantly improved pulmonary function parameters. Postoperative pulmonary complications were also less common in the intervention group. Patients who followed the breathing exercise regimen also had shorter hospital stays. The authors came to the conclusion that adding breathing exercises and incentive spirometry to routine postoperative care improves respiratory recovery and overall clinical outcomes [14]

A randomized controlled trial was carried out by Sweity et al. (2021) to assess the impact of preoperative incentive spirometry in patients

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

having coronary artery bypass graft surgery. The study looked into its potential to improve oxygenation status and prevent postoperative pulmonary complications.The incentive spirometry group had a significantly lower incidence of atelectasis than the control group, according to the findings.Additionally, patients who used incentive spirometry showed shorter mechanical ventilation times and better arterial oxygenation.Additionally, the intervention group's length of hospital stay was considerably shorter.Overall, the study confirms that preoperative incentive spirometry is a useful intervention for patients undergoing heart surgery [15].

Materials and Methods

This quasi-experimental study was conducted at Ghurki Trust Teaching Hospital over a period of four months to evaluate the effect of incentive spirometry on postoperative respiratory outcomes. The study included two groups: a study group receiving incentive spirometry along with standard postoperative care and a control group receiving only routine hospital care. A total of 100 postoperative patients were enrolled, with 50 patients in each group, and outcomes were monitored over the first four postoperative days.

The sample size was determined using a statistical calculation based on illness prevalence at a 95% confidence level with a precision of 2%, and was adjusted by 10% to account for potential non-response and missing data, with an overall study power of 85%. A non-randomized purposive sampling technique was used. Inclusion criteria comprised postoperative patients aged 17–70 years who were alert, oriented, and medically stable enough to perform breathing exercises, while patients with hemodynamic instability, severe respiratory conditions such as COPD exacerbation or acute respiratory distress, facial or chest trauma, or inability or unwillingness to use incentive spirometry were excluded.

The intervention group received incentive spirometry from the second to fourth postoperative days, performed every two hours with 5–10 repetitions per session. Patients were instructed to inhale slowly and deeply into the device, hold their breath for 2–3 seconds, and perform deep coughing exercises afterward to aid secretion clearance. The control group received standard postoperative care without incentive spirometry. Both groups were monitored using arterial blood gas analysis, vital signs every two hours, and pain assessment scores during rest, deep breathing, and coughing. Respiratory assessment also included visual inspection, auscultation, and pulse oximetry monitoring.

Ethical approval was obtained from the institutional committee of Superior University, and all participants provided written informed consent before enrollment. Confidentiality, anonymity, and participant safety were strictly maintained throughout the study. Participants were informed of their right to withdraw at any time without affecting their treatment, and no additional risks were associated with participation. Data were securely stored and accessed only by the research team.

Data analysis was performed using IBM SPSS Statistics. Independent t-tests and chi-square tests were used to compare baseline characteristics between groups, while paired t-tests assessed within-group changes over time. Between-group comparisons of respiratory outcomes such as oxygen saturation and respiratory rate were analyzed using independent t-tests. Chi-square tests were applied for categorical outcomes including postoperative pulmonary complications, and Pearson correlation analysis was used to assess relationships between incentive spirometry performance, oxygen saturation, and pain scores. A p-value of less than 0.05 was considered statistically significant.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

RESULTS

1. Baseline Characteristics

Table 1: Baseline demographics and clinical parameters (Mean ± SD or n, %)

Parameter	Study Group (n=50)	Control Group (n=50)	p-value
Smoking (never/former/current)	22/14/14	23/13/14	0.96
Lung disease (COPD/Asthma/ILD/none)	18/12/10/10	19/11/11/9	0.92
ICU days (mean)	2.5 ± 0.8	2.6 ± 0.9	0.71
Baseline SpO_2 (%)	87.5 ± 3.2	87.8 ± 3.0	0.63

Interpretation: No significant differences between groups at baseline ($p > 0.05$ for all), confirming successful randomization and group comparability.

Graph 1: ***Baseline characteristics were comparable between groups (all $p > 0.05$), confirming successful randomization.***

2. Effect on Oxygen Saturation (SpO_2)

Table 2: Mean SpO_2 (%) over postoperative days 1–3

Day	Study Group (IS)	Control Group	Mean Difference	p-value
Day 1	88.2 ± 3.1	87.9 ± 3.4	+0.3	0.64
Day 2	93.4 ± 2.5	89.1 ± 3.0	+4.3	<0.01*
Day 3	96.8 ± 1.8	89.5 ± 2.9	+7.3	<0.001**

$p < 0.01$ moderately significant; $p < 0.001$ *highly significant*

Interpretation: By day 3, the incentive spirometry group achieved significantly higher oxygen saturation compared to controls, with a mean difference of +7.3% ($p < 0.001$).

Graph 2: ***The IS group achieved significantly higher SpO_2 by day 3 (96.8% vs 89.5%, $p < 0.001$).***

3. Postoperative Pulmonary Complications (PPCs)

Table 3: Frequency of PPCs in both groups

Complication	Study Group (n=50)	Control Group (n=50)	p-value
Atelectasis	8 (16%)	18 (36%)	0.03*
Pneumonia	4 (8%)	12 (24%)	0.04*
Hypoxemia	4 (8%)	14 (28%)	0.01*
Tachypnea	2 (4%)	8 (16%)	0.05*

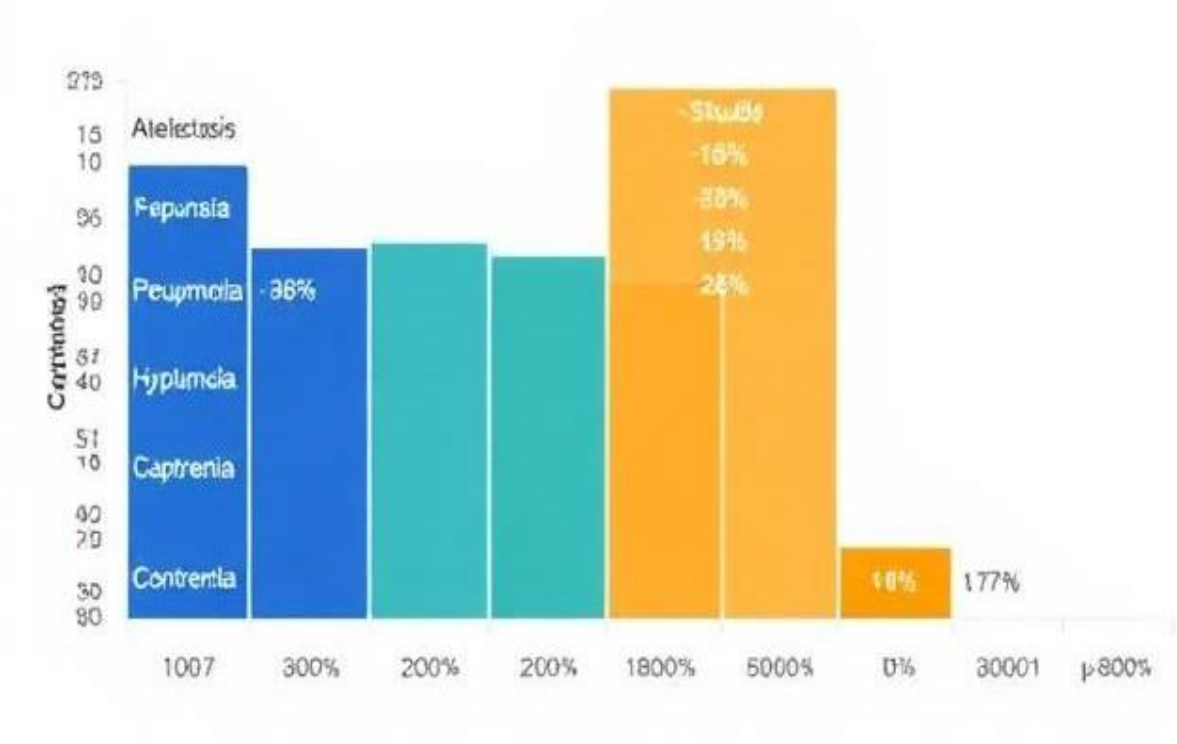
Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Complication	Study Group (n=50)	Control Group (n=50)	p-value
Pleural effusion	0 (0%)	2 (4%)	0.15
Total PPC events	**18**	**54**	**<0.001****

*Note: Some patients had >1 complication.***p < 0.05 significant; *p < 0.001 highly significant*

Interpretation: Incentive spirometry reduced total PPC events by 67% (from 54 to 18 events). The reduction in atelectasis, pneumonia, and hypoxemia was statistically significant.



Graph 3: ***IS reduced total PPC events by 67% (p < 0.001), with significant reductions in atelectasis, pneumonia, and hypoxemia.***

4. IS Performance and Pain Correlation (Study Group Only)

Table 4: Daily IS performance, pain at rest, and SpO_2

Day	Mean IS balls (0–3)	Pain at rest (0–10)	SpO_2 (%)
Day 1	0.9 ± 0.8	3.2 ± 1.5	88.2
Day 2	2.1 ± 0.7	1.9 ± 1.1	93.4
Day 3	2.8 ± 0.4	0.8 ± 0.9	96.8

Correlation:

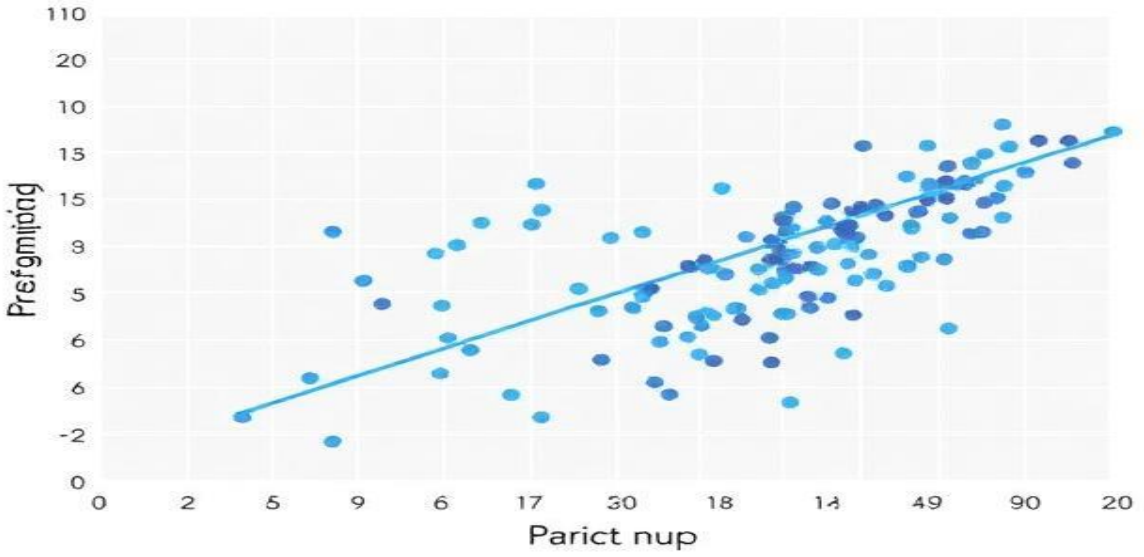
- IS balls vs. SpO_2: r = +0.85 (p < 0.001) – strong positive

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Pain vs. IS balls: r = -0.72 (p < 0.01) – moderate negative

[Figure 4A: Correlation Between IS Perfomance and Oxygen Sprogen Descationes Salarmilty o55.991S)

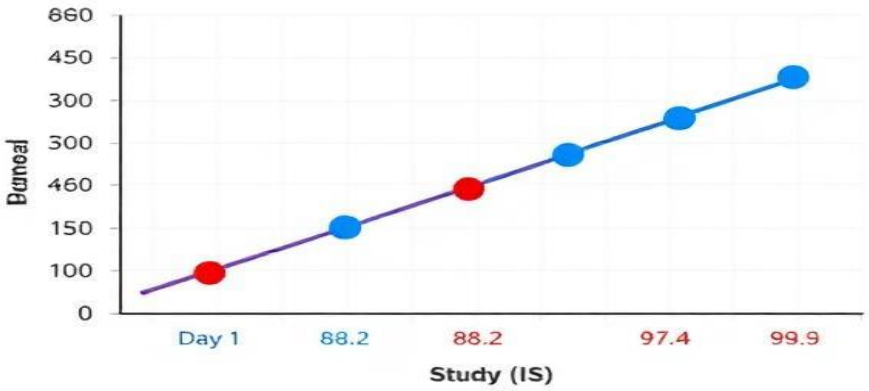


LEI Pt LATS: Correationsies of Therpli ce cored and tnd oxogen Saltuation ut d, Oxygen eccrrltation, orflguss contligh of year rightal ard more. p. 2 = S 072

Graph 4: IS performance strongly correlated with SpO_2 (r = +0.85, p < 0.001) and inversely with pain (r = −0.72, p < 0.01).

•

5. Figure



The incenity spiromeetry gnow theferge ands signiful improvaes in oxygen inrecation saturation from a day day. BS thesis., Study graw deal frim day 1

The incentive spirometry group (●) showed progressive and significant improvement in oxygen saturation from day 1 to day 3, reaching 96.8% on day 3. The control group (○) remained stable at approximately 89%. The difference on day 3 was highly significant (p < 0.001). Error bars represent ±1 standard deviation.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Interpretation:

The incentive spirometry group demonstrated significantly higher oxygen saturation by postoperative day 3 (96.8% vs. 89.5%, $p < 0.001$) and a marked reduction in overall postoperative pulmonary complications (18 events vs. 54 events in controls, $p < 0.001$) compared to the control group receiving standard care alone. Atelectasis (16% vs. 36%, $p = 0.03$), pneumonia (8% vs. 24%, $p = 0.04$), and hypoxemia (8% vs. 28%, $p = 0.01$) were significantly lower in the IS group. Incentive spirometry performance improved from 0.9 to 2.8 balls over three days, which strongly correlated with improved oxygenation ($r = +0.85$, $p < 0.001$) and reduced pain at rest ($r = -0.72$, $p < 0.01$). Control patients had persistently lower SpO_2 and higher complication rates throughout the study period.

DISCUSSION

The study demonstrated that using incentive spirometry were effective in reducing shortness of breath severity among patients after sternotomy. Postoperative sternotomy patients commonly experience difficulty in breathing due to pain, reduced chest inflation and reduced lung function. Regular use of incentive spirometry helped improve lung inflation and improved inspiratory effort. A measurable improvement in respiratory comfort and reduction in dyspnea were observed among patients using the incentive spirometry. The findings also suggest that incentive spirometry contributes to improved ventilation and oxygenation in the postoperative recovery period. Patient participation and education to the incentive spirometry played an important role in achieving positive outcomes. Therefore, incentive spirometry can be considered an effective supportive intervention for improving respiratory recovery after sternotomy [39].

The study reports that breathing exercises improved patients recovery. From a physiological point if view oxygen saturation (SpO_2) values were significantly higher in patients who used incentive spirometry especially when exercises were used both preoperatively and postoperatively. This improvement may be linked to better alveolar reopening and enhanced ventilation, which help prevent postoperative complications such as atelectasis This suggests that while incentive spirometry is effective in improving oxygenation and subjective outcomes like pain and anxiety. Overall, the findings support the use of incentive spirometry into routine cardiac surgical care, particularly as part of a comprehensive respiratory care protocol. The study also showed the importance of early initiation both before and after surgery for maximizing patient. Further large-scale studies are recommended to strengthen evidence on long-term pulmonary outcomes and to compare IS with other respiratory physiotherapy techniques [40]

The study "Effect of Incentive Spirometer on Breathing Holding Time After Coronary Artery Bypass Graft (CABG)" highlights the significant role of incentive spirometry (IS) in improving breath-holding time, which is considered an important sign of lung inflation and respiratory effort in postoperative cardiac patients. The findings show that patients who used incentive spirometer exercises showed improvement in breath-holding time indicating better alveolar inflation and improved respiratory muscle performance after CABG surgery. By motivating deep, slow inhalation, IS strengthens inspiratory muscles, which directly contributes to improved control pause (breath-holding capacity). The study further shows that better breath-holding time reflects improved oxygenation and reduced risk of postoperative pulmonary complications, which are commonly seen after cardiac surgeries. However, the study also suggests that while IS is effective in improving functional respiratory outcomes patient use proper technique, and frequency of use [41]

CONCLUSION(S)

Incentive spirometry is highly effective in improving oxygen saturation and reducing postoperative pulmonary complications in patients undergoing abdomino-thoracic surgery. The intervention enhances lung expansion, correlates with reduced pain, and significantly lowers the incidence of atelectasis, pneumonia, and hypoxemia. These findings support the routine integration of incentive spirometry into postoperative physiotherapy protocols to prevent PPCs and optimize respiratory recovery in this high-risk surgical population.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

RECOMMENDATION(S)

1. Incentive spirometry should be routinely used into postoperative care protocols for abdominothoracic surgery patients.
2. Patients should receive proper preoperative and postoperative guidance regarding the correct use of incentive spirometry.
3. Healthcare professionals should closely monitor patient participation and technique to ensure effective results.
4. Incentive spirometry should be combined with other respiratory physiotherapy and intervention such as deep breathing exercises and early mobilization.
5. Further studies with larger sample sizes and longer follow-up periods are recommended for strong evidence.

LIMITATION(S)

1. The comparatively small sample size is one of the study's primary drawbacks, as it may limit statistical power and lessen the findings.
2. The brief follow-up period, which was limited to the early postoperative phase, is another drawback
3. Data collection was performed in a single hospital setting; therefore, the results may not represent all postoperative patients.
4. Psychological factors such as anxiety, fear, or fatigue may have influenced patient participation in respiratory exercises.

REFERENCES

Sullivan, K.A., et al., *Use of incentive spirometry in adults following cardiac, thoracic, and upper abdominal surgery to prevent post-operative pulmonary complications: a systematic review and meta-analysis.* Respiration, 2021. 100(11): p. 1114-1127.

Kotta, P.A. and J.M. Ali, *Incentive spirometry for prevention of postoperative pulmonary complications after thoracic surgery.* Respiratory Care, 2021. **66**(2): p. 327-333.

Öner Cengiz, H., Z. Uluşan Özkan, and E. Gani, *The effect of preoperative deep breathing exercise with incentive spirometer initiated in the preoperative period on respiratory parameters and complications in patients underwent open heart surgery: a randomized controlled trial.* BMC anesthesiology, 2025. **25**(1): p. 36.

Christo Ajai, S.S., C. Karishma, and S. Jeffery, *Combined Effect of Incentive Spirometry and Diaphragmatic Exercise on Respiratory Outcomes Post Upper Abdominal Surgery: A Literature Review.* INTI JOURNAL, 2025. **2025**(06): p. 1-8.

Nandi, B., et al., *Effectiveness of incentive spirometry in improving peak expiratory flow rate in post abdominal surgery: An experimental study.* Journal Medical Thesis, 2015. **3**(1): p. 15-18.

Narayanan, L.T. and S. Hamid, *Incentive spirometry inspiratory capacity changes and predictors after open heart surgery: a 5-day prospective study.* Med J Malaysia, 2020. **75**(3): p. 226-234.

Alwekhyan, S.A., et al., *Nurse-guided incentive spirometry use and postoperative pulmonary complications among cardiac surgery patients: A randomized controlled trial.* International Journal of Nursing Practice, 2022. **28**(2): p. e13023.

Kloni, M., et al., *Incentive Spirometer in COVID-19: A Systematic Review.* Journal of Clinical Medicine, 2026. **15**(4): p. 1425.

Ababneh, Q.M., et al., *Effectiveness of Incentive Spirometry Versus Deep Breathing Exercises in Preventing Postoperative Pulmonary Complications After Abdominal Surgery: A Comprehensive Review.* Cureus, 2025. **17**(3).

Chang, P.-C., et al., *Incentive spirometry is an effective strategy to improve the quality of postoperative care in patients.* Asian Journal of Surgery, 2023. **46**(9): p. 3397-3404.

Sum, S.-K., et al., *Using an incentive spirometer reduces pulmonary complications in patients with traumatic rib fractures: a randomized controlled trial.* Trials, 2019. **20**(1): p. 797.

Kuimi, B.L.B., et al., *Potential benefits of incentive spirometry following a rib fracture: a propensity score analysis.* Canadian Journal of Emergency Medicine, 2019. **21**(4): p. 464-467.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Liu, C.-J., et al., *Is incentive spirometry beneficial for patients with lung cancer receiving video-assisted thoracic surgery?* BMC pulmonary medicine, 2019. **19**(1): p. 121.

Bhojak, N. and R. Mathew, *Effect Of Breathing Exercises On Postoperative Recovery After Cardiac Surgery.* Vascular and Endovascular Review, 2025. **8**(9s): p. 254-261.

Sweity, E.M., et al., *Preoperative incentive spirometry for preventing postoperative pulmonary complications in patients undergoing coronary artery bypass graft surgery: a prospective, randomized controlled trial.* Journal of cardiothoracic surgery, 2021. **16**(1): p. 241.

Khan, A.A., *Effect of Incentive Spirometry on Post Operative Pulmonary Complications after Bariatric Surgery: A Cross Sectional Study in Hospital Setting.* Journal of Biological and Allied Health Sciences, 2025. **5**(1): p. 21-28.

Batra, A., C.V. Kalyani, and K. Kusum, *Effect of incentive spirometry on recovery of post-operative patients: Pre experimental study.* Int J Nurs Educ, 2020. **12**(3): p. 1-5.

Kaur, A. and C.V. Kalyani, *Effect of incentive spirometry on recovery of post-operative patients: pre experimental study.* Journal Of Nursing Practice, 2020. **3**(2): p. 220-225.

Franklin, E. and F. Anjum, *Incentive spirometer and inspiratory muscle training*, in *StatPearls [Internet]*. 2023, StatPearls Publishing.

Tantaewy, N.M., *Effect of Incentive Spirometry on Respiratory Parameters among Critically Ill Patients with Chest Tube Drainage.* 2024.

Eltorai, A.E., et al., *Incentive spirometry adherence: a national survey of provider perspectives.* Respiratory care, 2018. **63**(5): p. 532-537.

Beltrame, T., D. Hobbs, and J. Nguyen, *Respiratory rehabilitation through an assistive electronic trumpet*. 2019, Flinders University, College of Science and Engineering.

Fawad, M., et al., *Role of Incentive Spirometry as a Part of ERAS Protocol in Prevention of Postoperative Pulmonary Complications after Major Abdominal Surgery.* Indus Journal of Bioscience Research, 2025. **3**(3): p. 21-25.

Manapunsopee, S., et al., *Effectiveness of incentive spirometry on inspiratory muscle strength after coronary artery bypass graft surgery.* Heart, Lung and Circulation, 2020. **29**(8): p. 1180-1186.

Fazal, A.I.A., et al., *Effectiveness of Incentive spirometry to reduce pulmonary complications and improve respiratory parameter after coronary artery bypass graft surgery: a narrative review.* J Clin Respir Dis and Care, 2023. **9**: p. 02.

Chaudhary, S., et al., *The immediate effects of breathing exercises with Acapella and incentive spirometer on preventing early pulmonary complications following cabg.-A comparitive study.* International Journal of Current Research and Review, 2020. **12**(17): p. 51-58.

Gökçe, E., et al., *Outcomes of Incentive Spirometry for Patients Undergoing Coronary Artery Bypass Surgery: A Randomised Controlled Trial.* International Journal of Nursing Practice, 2025. **31**(2): p. e70011.

Shaphe, M.A., et al., *Efficacy of incentive spirometer and diaphragmatic breathing exercise on the alteration of arterial blood gas measures in patients after coronary artery bypass grafting: A randomized comparative trial.* Medicine, 2025. **104**(44): p. e45538.

Fatima, A. and S. Kazmi, *Comparison of effects of incentive spirometry and deep breathing exercises on pulmonary functions after coronary artery bypass grafting.* Khyber Medical University Journal, 2021. **13**(3): p. 131-5.

Sorour, D.M., et al., *Effect of deep breathing exercises versus incentive spirometry on pulmonary complications among geriatric patients undergoing upper abdominal surgery.* International Journal of Novel Research in Healthcare and Nursing, 2019. **6**(3): p. 537-555.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Maity, B., A. Choudhury, and C. Banerjee, *THE EFFICACY OF INCENTIVE SPIROMETRY IN RESTORING BASELINE LUNG CAPACITY AFTER UPPER ABDOMINAL AND MIDLINE LAPAROTOMY: A RANDOMISED CASE CONTROL STUDY.* Int J Acad Med Pharm, 2023. **5**(3): p. 1961-6.

Susila, C. and G. Dhanalakshmi, *Incentive spirometry on respiratory status among post operative patients subjected to major abdominal surgery.* The Journal of Nursing Trendz, 2021. **9**(3): p. 22-26.

Tyson, A.F., et al., *The effect of incentive spirometry on postoperative pulmonary function following laparotomy: a randomized clinical trial.* JAMA surgery, 2015. **150**(3): p. 229-236.

de Souza Mendes, L.P., et al., *Incentive spirometer: Aspects of the clinical practice of physical therapists from Minas Gerais working with patients with respiratory dysfunction.* Brazilian Journal of Physical Therapy, 2021. **25**(5): p. 632-640.

Miskovic, A. and A. Lumb, *Postoperative pulmonary complications.* BJA: British Journal of Anaesthesia, 2017. **118**(3): p. 317-334.

Haisley, K., et al., *Schwartz's Principles of Surgery.* 2019.

Kvarnström, K., et al., *Factors contributing to medication adherence in patients with a chronic condition: a scoping review of qualitative research.* Pharmaceutics, 2021. **13**(7): p. 1100.

Hafen, B. and S. Sharma, *Oxygen saturation. 2021 Aug 12.* StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, 2022.

El Bishbeshy MM. The Effect of Breathing Exercise by Using Incentive Spirometry on Dyspnea Severity after Sternotomy. Helwan International Journal for Nursing Research and Practice. 2025 Jun 1;4(10):1-5.

Çiftçi H, Korkut S, Karaca S. The Effect of Breathing Exercise With Incentive Spirometer on Pain, Anxiety, Comfort, and Physiological Parameters Before and After Cardiac Surgery: A Randomized Controlled Experimental Study. Journal of PeriAnesthesia Nursing. 2025 Jun 9.

Effect of Incentive Spirometer on Breathing Holding Time After Coronary ArterBypass Graft.Waheeb Bakur Hennawi, Amr Ahmad Fallatah, Ahmad Mohammed Alzahrani, Abdullah Othman Nasseeb, EJ Maddawi, MA Alghamdi, HA Alsayedali