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EFFECTIVENESS OF PULMONARY EXPANSION THERAPY IN REDUCING POSTOPERATIVE PULMONARY COMPLICATIONS AMONG MAJOR ABDOMINAL SURGERY PATIENTS AT SVBP HOSPITAL, MEERUT

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ABSTRACT

Background

Postoperative pulmonary complications (PPCs) are among the most frequent and serious complications following major abdominal surgery, contributing significantly to postoperative morbidity, mortality, prolonged hospitalization, and increased healthcare expenditure. Surgical trauma, general anaesthesia, postoperative pain, diaphragmatic dysfunction, and prolonged immobilization impair pulmonary mechanics, leading to atelectasis, pneumonia, hypoxemia, bronchospasm, and respiratory failure. These complications delay recovery and adversely affect patients' quality of life. Pulmonary Expansion Therapy (PET), comprising deep breathing exercises and incentive spirometry, has emerged as an evidence-based, non-invasive intervention that promotes lung expansion, improves alveolar ventilation, facilitates airway clearance, and reduces postoperative pulmonary complications. However, limited evidence is available regarding its effectiveness among major abdominal surgery patients in Indian tertiary care settings.

Objectives

1.To develop and validate Pulmonary Expansion Therapy (PET) for the prevention of postoperative pulmonary complications among patients undergoing major abdominal surgery.
2.To evaluate the effectiveness of Pulmonary Expansion Therapy in reducing postoperative pulmonary complications among patients in the experimental group.
3.To compare postoperative pulmonary complications between the experimental and control groups.
4.To determine the association between postoperative pulmonary complications and selected demographic variables.

Methodology

A quantitative research approach with a quasi-experimental pre-test–post-test control group design was adopted. One hundred patients undergoing major abdominal surgery were selected using a purposive sampling technique and allocated equally into experimental (n=50) and control (n=50) groups. Patients in the experimental group received structured Pulmonary Expansion Therapy consisting of deep breathing exercises and incentive spirometry in addition to routine postoperative care, whereas the control group received routine postoperative care alone. Postoperative pulmonary complications were assessed using the Melbourne Group Scale (Version 2). Descriptive and inferential statistics, including paired t-test, independent t-test, Chi-square test, and Fisher's exact test, were used to analyse the data.

Results

Among the 100 participants, the experimental and control groups were comparable with respect to baseline demographic and clinical characteristics. Before the intervention, the majority of participants in both groups had moderate to severe postoperative pulmonary complications. Following Pulmonary Expansion Therapy, 52% of participants in the experimental group improved to the mild postoperative pulmonary complication category, while only 2% remained in the severe category. In contrast, the majority of participants in the control group (74%) continued to experience moderate postoperative pulmonary complications after receiving routine postoperative care. The mean postoperative pulmonary complication score in the experimental group significantly decreased from 20.20 ± 4.17 during the pre-test to 10.72 ± 5.31 during the post-test, with a mean reduction of 9.48 ± 3.24 ($t = 20.69$, $p < 0.001$). In comparison, the control group demonstrated a smaller reduction in mean score from 18.88 ± 4.63 to 16.22 ± 4.74, with a mean reduction of 2.66 ± 1.78 ($t = 10.57$, $p < 0.001$). The post-test comparison between the two groups revealed a statistically significant difference ($t = 5.46$, $p < 0.001$), confirming that Pulmonary Expansion Therapy was significantly more effective than routine postoperative care in reducing postoperative pulmonary complications. Furthermore, no statistically significant

association was observed between postoperative pulmonary complication scores and selected demographic or clinical variables ($p > 0.05$).

Conclusion

Pulmonary Expansion Therapy is an effective, safe, economical, and evidence-based nursing intervention for reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. Integration of structured PET into routine postoperative nursing care may improve pulmonary function, accelerate recovery, reduce hospital stay, and enhance overall patient outcomes.

KEYWORDS: Pulmonary Expansion Therapy, Postoperative Pulmonary Complications, Major Abdominal Surgery, Incentive Spirometry, Deep Breathing Exercises, Postoperative Care, Nursing Intervention.

INTRODUCTION

Major abdominal surgery is one of the most frequently performed surgical procedures worldwide for the management of gastrointestinal, hepatobiliary, colorectal, gynaecological, and urological disorders and continues to play a pivotal role in modern surgical practice. According to the World Health Organization (WHO), more than 313 million surgical procedures are performed globally each year, with abdominal surgeries accounting for a substantial proportion of these interventions. Despite remarkable advances in surgical techniques, anaesthetic management, perioperative monitoring, enhanced recovery protocols, and critical care services, postoperative pulmonary complications (PPCs) remain among the most common and serious adverse events following surgery. The reported incidence of PPCs ranges from 5% to 40% in the general surgical population and may increase to 40–60% among patients undergoing major upper abdominal surgery, depending on patient characteristics, type of procedure, and diagnostic criteria used. Studies have demonstrated that PPCs contribute to approximately 25% of postoperative deaths and account for nearly one-third of all postoperative complications, making them a major cause of postoperative morbidity, prolonged hospitalisation, intensive care unit admissions, increased healthcare expenditure, delayed functional recovery, reduced quality of life, and long-term disability. In India, postoperative pulmonary complications continue to impose a significant clinical burden, with reported incidences ranging from 8% to 35% among patients undergoing major abdominal surgery, particularly in tertiary care centres where elderly patients and those with multiple comorbidities constitute a large proportion of the surgical population. The occurrence of PPCs following abdominal surgery is primarily attributed to the combined effects of surgical trauma, general anaesthesia, postoperative pain, diaphragmatic dysfunction, prolonged immobilisation, impaired mucociliary clearance, ineffective cough, and reduced inspiratory effort, all of which lead to decreased lung volumes, diminished functional residual capacity, alveolar collapse, ventilation–perfusion mismatch, secretion retention, impaired gas exchange, and respiratory muscle dysfunction. Atelectasis is reported to occur in up to 90% of patients following general anaesthesia, while postoperative pneumonia develops in approximately 2–10% of abdominal surgical patients and is associated with significantly increased mortality and healthcare costs. Furthermore, several patient-related and surgical factors, including advanced age, smoking, obesity, chronic obstructive pulmonary disease, diabetes mellitus, cardiovascular disease, malnutrition, prolonged duration of surgery, upper abdominal incisions, emergency procedures, and inadequate postoperative pain control, substantially increase the risk of postoperative pulmonary complications. Early identification of these risk factors and implementation of effective preventive interventions are therefore essential for improving postoperative respiratory outcomes. Pulmonary Expansion Therapy (PET), consisting primarily of deep breathing exercises and incentive spirometry, has emerged as an effective, evidence-based, non-invasive strategy for preventing postoperative pulmonary complications by promoting sustained lung expansion, enhancing diaphragmatic excursion, improving alveolar recruitment, increasing functional residual capacity, facilitating bronchial secretion clearance, strengthening inspiratory muscles, improving oxygenation, and restoring normal pulmonary mechanics. Incentive spirometry provides visual biofeedback that encourages maximal sustained inspiration, whereas deep breathing exercises improve ventilation, reduce atelectasis, facilitate secretion clearance, and enhance pulmonary compliance, thereby accelerating postoperative recovery. Nurses play a central role in the successful implementation of Pulmonary Expansion Therapy through preoperative patient education, demonstration and supervision of breathing exercises, continuous respiratory assessment, effective pain management, encouragement of early mobilisation, monitoring of patient adherence, and timely identification of respiratory deterioration, making pulmonary rehabilitation an integral component of evidence-based postoperative nursing care. Although several international studies have demonstrated the beneficial effects of pulmonary expansion strategies in reducing postoperative pulmonary complications, the availability of well-designed quasi-experimental studies evaluating structured Pulmonary Expansion Therapy among patients undergoing major abdominal surgery in Indian tertiary care hospitals remains limited. Therefore, the present study was undertaken to evaluate the effectiveness of Pulmonary Expansion Therapy in reducing postoperative pulmonary complications among patients undergoing major abdominal surgery admitted to SVBP Hospital, Meerut. The findings of the present study are expected to strengthen the evidence base for postoperative pulmonary rehabilitation, support the incorporation of structured Pulmonary Expansion Therapy into routine postoperative nursing protocols, reduce postoperative pulmonary morbidity, shorten hospital stay, improve patient outcomes, minimise healthcare costs, and ultimately enhance the quality, safety, and effectiveness of perioperative nursing practice.

METHODOLOGY

The present study adopted a quantitative research approach with a quasi-experimental pre-test and post-test control group design to evaluate the effectiveness of Pulmonary Expansion Therapy (PET) in reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. The study was conducted in the surgical wards of

SVBP Hospital, Meerut, Uttar Pradesh, after obtaining approval from the Institutional Ethics Committee and administrative permission from the concerned hospital authorities. A total of 100 patients undergoing major abdominal surgery were selected by purposive sampling technique and were allocated into an experimental group (n = 50) and a control group (n = 50). Patients aged 18 years and above who had undergone elective or emergency major abdominal surgery, were conscious, haemodynamically stable, and willing to participate in the study were included, whereas patients requiring prolonged mechanical ventilation, diagnosed with severe chronic respiratory diseases, or having contraindications to deep breathing exercises and incentive spirometry were excluded. Baseline demographic and clinical information was collected using a structured demographic proforma, and postoperative pulmonary complications were assessed using the Melbourne Group Scale (Version 2). The experimental group received Pulmonary Expansion Therapy, comprising deep breathing exercises and incentive spirometry, in addition to routine postoperative nursing care. Deep breathing exercises were performed under supervision according to a standardized protocol, and incentive spirometry was administered using a calibrated incentive spirometer with repeated inspiratory efforts at regular intervals throughout the postoperative period. The control group received routine postoperative nursing care as per hospital protocol without the structured Pulmonary Expansion Therapy programme. Postoperative pulmonary complications were assessed before the intervention and subsequently during the postoperative observation period using the same assessment tool. The collected data were coded and analysed using IBM SPSS Statistics version 25.0. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to describe demographic and clinical characteristics, whereas inferential statistics such as the paired t-test, independent t-test, and Chi-square test were applied to determine the effectiveness of the intervention and the association between postoperative pulmonary complications and selected demographic and clinical variables. A p-value of less than 0.05 was considered statistically significant throughout the study.

RESULTS

A total of 100 patients undergoing major abdominal surgery were included in the present study, with 50 patients in the experimental group and 50 patients in the control group. The findings are presented under the following sections.

Section I

Description of demographic and clinical characteristics of patients undergoing major abdominal surgery

The baseline demographic and clinical characteristics of the patients in the experimental and control groups are presented in Table 1.

Table 1. Distribution of patients according to their demographic and clinical characteristics in the experimental and control groups (N = 100)

Variables	Category	Experimental Group n=50 (%)	Control Group n=50 (%)
Age (years)	18–30	6 (12.0)	7 (14.0)
	31–45	19 (38.0)	17 (34.0)
	46–60	14 (28.0)	20 (40.0)
	>60	11 (22.0)	6 (12.0)
Gender	Male	27 (54.0)	24 (48.0)
	Female	23 (46.0)	26 (52.0)
Smoking history	Smoker	11 (22.0)	9 (18.0)
	Non-smoker	27 (54.0)	28 (56.0)
	Ex-smoker	12 (24.0)	13 (26.0)
Body Mass Index (kg/m²)	Underweight	4 (8.0)	5 (10.0)
	Normal	27 (54.0)	22 (44.0)
	Overweight	11 (22.0)	15 (30.0)
	Obese	8 (16.0)	8 (16.0)
Type of Anaesthesia	General	21 (42.0)	23 (46.0)
	Spinal	15 (30.0)	17 (34.0)
	Epidural	5 (10.0)	7 (14.0)
	Combined	9 (18.0)	3 (6.0)
Previous Surgical History	Yes	14 (28.0)	18 (36.0)
	No	36 (72.0)	32 (64.0)

Section II: Assessment of Postoperative Pulmonary Complications According to the Melbourne Group Scale

This section describes the distribution of postoperative pulmonary complications among patients in the experimental and control groups before and after intervention according to the original Melbourne Group Scale.

Table 2. Distribution of postoperative pulmonary complications among patients in the experimental group before and after Pulmonary Expansion Therapy according to the Melbourne Group Scale (n=50)

Postoperative Pulmonary Complication Status	Pre-test		Post-test	
	f	%	f	%

PPC Absent (MGS <4)	0	0.0	26	52.0
PPC Present (MGS ≥4)	50	100.0	24	48.0
Total	50	100.0	50	100.0

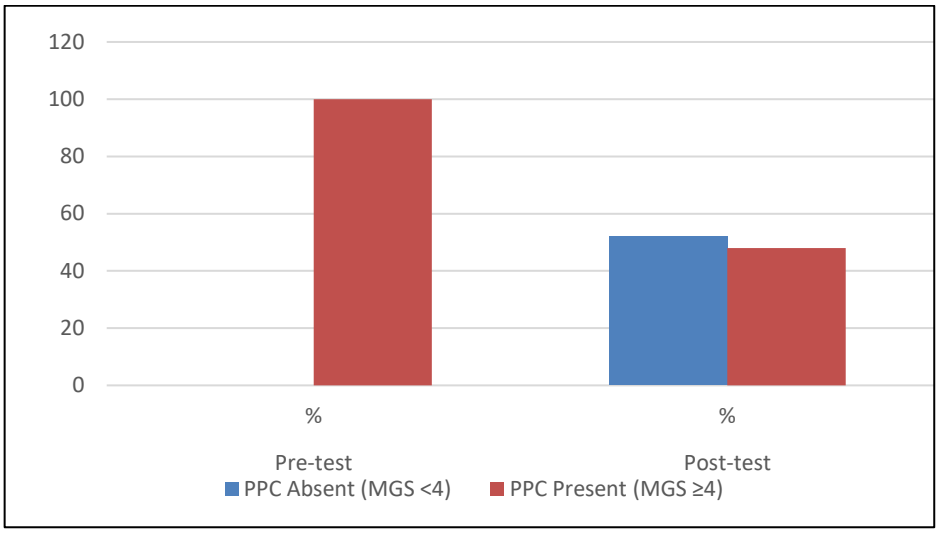

Figure2: Percentage distribution of postoperative pulmonary complications among patients in the experimental group before and after Pulmonary Expansion Therapy according to the Melbourne Group Scale

Table 3. Distribution of postoperative pulmonary complications among patients in the control group before and after routine postoperative care (n=50)

Postoperative Pulmonary Complication Status	Pre-test		Post-test	
	f	%	f	%
PPC Absent (MGS <4)	0	0.0	5	10.0
PPC Present (MGS ≥4)	50	100.0	45	90.0
Total	50	100.0	50	100.0

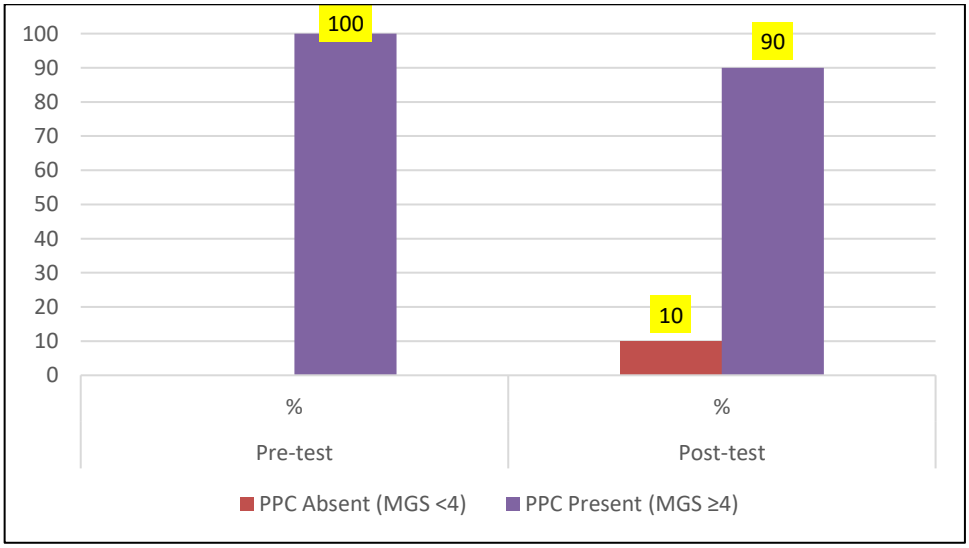

Figure 3. Percentage distribution of postoperative pulmonary complications among patients in the control group before and after routine postoperative care

Section III: Effectiveness of Pulmonary Expansion Therapy in Reducing Postoperative Pulmonary Complications
This section evaluates the effectiveness of Pulmonary Expansion Therapy by comparing the pre-test and post-test Melbourne Group Scale scores within the experimental and control groups and between the two groups following intervention.

Table 4. Comparison of pre-test and post-test Melbourne Group Scale scores among patients in the experimental group (n=50)

Assessment	Mean	SD	Mean Difference	Paired t-value	p-value
Pre-test	20.20	4.17			
Post-test	10.72	5.31	9.48 ± 3.24	20.69	<0.05

Significant at p <0.05

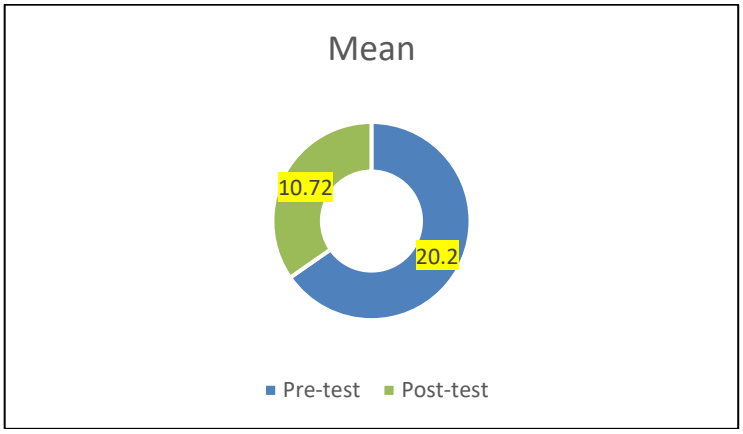

Figure4: Shows comparison of pre-test and post-test Melbourne Group Scale scores among patients in the experimental group

Table 5. Comparison of pre-test and post-test Melbourne Group Scale scores among patients in the control group (n=50)

Assessment	Mean	SD	Mean Difference	Paired t-value	p-value
Pre-test	18.88	4.63			
Post-test	16.22	4.74	2.66 ± 1.78	10.57	<0.05

Significant at p <0.05

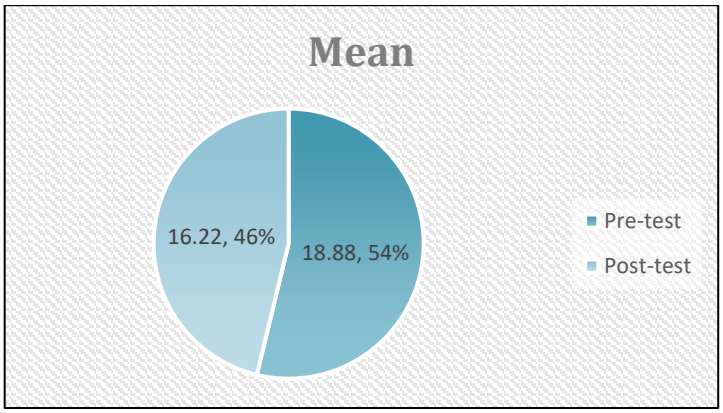

Figure 5. shows comparison of pre-test and post-test Melbourne Group Scale scores among patients in the control group

Table 6. Comparison of post-test Melbourne Group Scale scores between the experimental and control groups (N=100)

Group	Mean	SD	Mean Difference	Independent t-value	p-value
Experimental (n=50)	10.72	5.31			

Control (n=50)	16.22	4.74	5.50	5.46	<0.05

Significant at <0.05

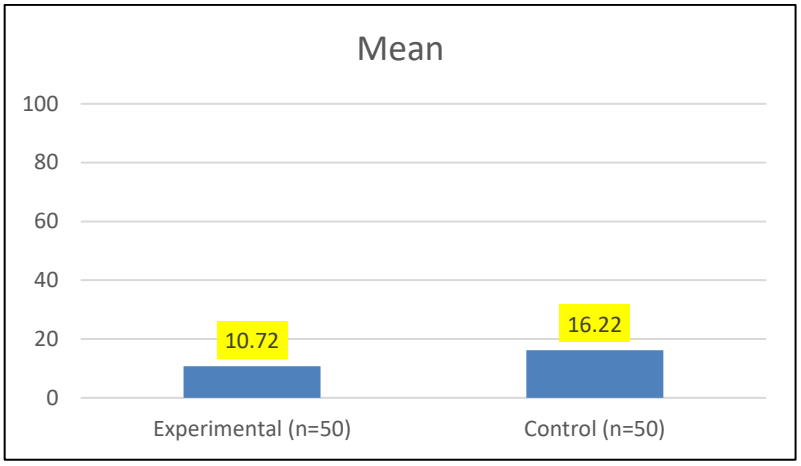

Figure 6 shows comparison of post-test Melbourne Group Scale scores between the experimental and control groups

Table 7. Comparison of postoperative pulmonary complication status between the experimental and control groups after intervention according to the Melbourne Group Scale (N=100)

Postoperative Pulmonary Complication Status	Experimental Group (n=50)		Control Group (n=50)		χ^2	p-value
	f	%	f	%		
PPC Absent (MGS <4)	26	52.0	5	10.0		
PPC Present (MGS ≥4)	24	48.0	45	90.0	17.63	<0.05
Total	50	100.0	50	100.0		

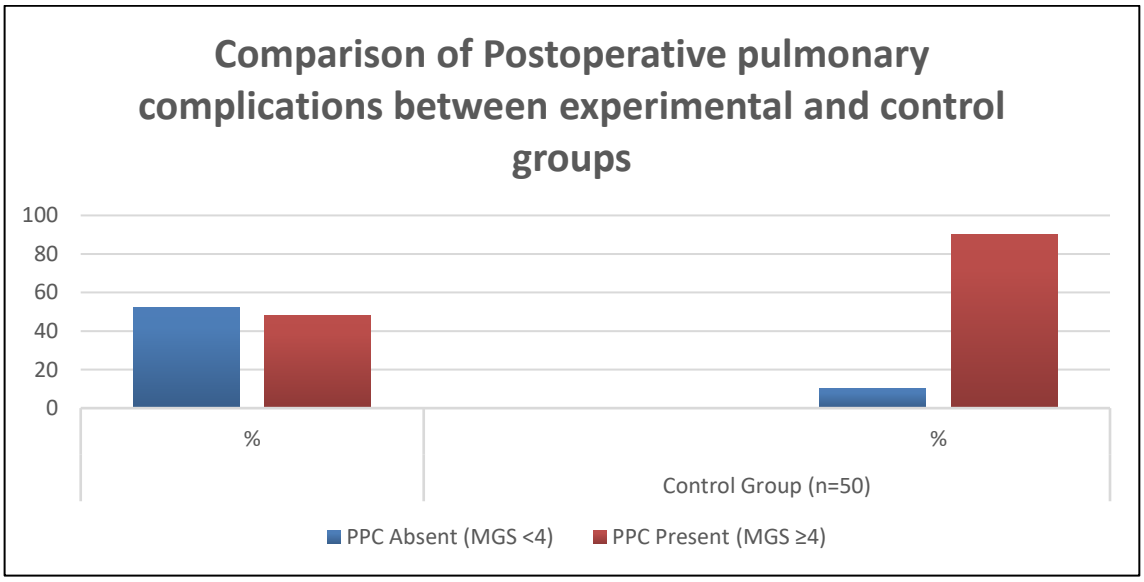

Figure 7. shows comparison of postoperative pulmonary complication status between the experimental and control groups after intervention according to the Melbourne Group Scale

Section IV: Association of Postoperative Pulmonary Complications with Selected Demographic and Clinical Variables

Table 8. Association of postoperative pulmonary complications with selected demographic and clinical variables among patients in the experimental and control groups. (N=100)

Variable	Experimental Group χ^2	p-value	Control Group χ^2	p-value
Age	2.917	0.405	4.868	0.182
Gender	0.297	0.586	0.842	0.359
Occupation	2.021	0.732	1.956	0.744
Smoking History	0.776	0.678	0.691	0.708
Body Weight	6.266	0.180	4.271	0.370
Body Mass Index	2.075	0.557	1.882	0.597
Type of Anaesthesia	4.518	0.211	2.143	0.543
Previous Surgical History	0.206	0.650	0.138	0.710

NS = Not Significant at $p<0.05$

SUMMARY

The baseline demographic and clinical characteristics of the participants are presented. The findings revealed that the experimental and control groups were comparable with respect to age, gender, educational status, occupation, smoking history, body weight, body mass index, type of anaesthesia, and previous surgical history, indicating homogeneity of the study participants before implementation of the intervention. The distribution of postoperative pulmonary complications according to the original Melbourne Group Scale is presented in Tables 2 and 3. During the pre-test assessment, all patients in both the experimental and control groups had postoperative pulmonary complications. Following administration of Pulmonary Expansion Therapy, 26 (52.0%) patients in the experimental group became free from postoperative pulmonary complications, whereas 24 (48.0%) patients continued to have postoperative pulmonary complications. In contrast, following routine postoperative care, only 5 (10.0%) patients in the control group became free from postoperative pulmonary complications, while the majority, 45 (90.0%), continued to have postoperative pulmonary complications. These findings indicate a greater reduction in postoperative pulmonary complications among patients who received Pulmonary Expansion Therapy than among those who received routine postoperative care. The effectiveness of Pulmonary Expansion Therapy was further evaluated by comparing the pre-test and post-test Melbourne Group Scale scores, as shown in Tables 4, 5, and 6. In the experimental group, the mean postoperative pulmonary complication score significantly decreased from 20.20 ± 4.17 during the pre-test assessment to 10.72 ± 5.31 during the post-test assessment, with a mean reduction of 9.48 ± 3.24. The paired t-test demonstrated that this reduction was highly statistically significant ($t = 20.69$, $p < 0.001$). Although the control group also demonstrated a statistically significant reduction in mean postoperative pulmonary complication scores from 18.88 ± 4.63 to 16.22 ± 4.74, with a mean reduction of 2.66 ± 1.78 ($t = 10.57$, $p < 0.001$), the magnitude of improvement was considerably smaller than that observed in the experimental group. Furthermore, comparison of post-test Melbourne Group Scale scores between the experimental and control groups revealed a highly statistically significant difference, with the experimental group demonstrating significantly lower postoperative pulmonary complication scores than the control group (independent $t = 5.46$, $p < 0.001$). Similarly, comparison of postoperative pulmonary complication status after intervention (Table 7) showed that 26 (52.0%) patients in the experimental group were free from postoperative pulmonary complications compared with only 5 (10.0%) patients in the control group, while postoperative pulmonary complications persisted in 24 (48.0%) and 45 (90.0%) patients, respectively. The difference between the two groups was highly statistically significant ($\chi^2 = 17.63$, $p < 0.001$), confirming the superior effectiveness of Pulmonary Expansion Therapy in reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. The association between postoperative pulmonary complications and selected demographic and clinical variables (Table 8) was analysed using the Chi-square test. No statistically significant association was observed between postoperative pulmonary complications and age, gender, occupation, smoking history, body weight, body mass index, type of anaesthesia, or previous surgical history ($p > 0.05$), indicating that the reduction in postoperative pulmonary complications was primarily attributable to the intervention rather than differences in baseline participant characteristics.

DISCUSSION

The present study was conducted to evaluate the effectiveness of Pulmonary Expansion Therapy (PET) in reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. Pulmonary Expansion Therapy, comprising deep breathing exercises and incentive spirometry, was administered to the experimental group in addition to routine postoperative care, whereas the control group received routine postoperative care alone. The findings of the present study demonstrated that Pulmonary Expansion Therapy significantly reduced postoperative pulmonary complications and improved postoperative pulmonary recovery among patients undergoing major abdominal surgery. The discussion of the findings is presented in relation to the objectives of the study and compared with the findings of previous national and international studies.

The findings of the present study revealed that the demographic and clinical characteristics of the participants in both the experimental and control groups were comparable before the intervention. The majority of the participants belonged to the age group of 31–45 years, followed by 46–60 years. More than half of the participants were males, while nearly half were females. Most of the participants were non-smokers, had a normal body mass index, underwent general anaesthesia during surgery, and had no previous surgical history. The homogeneity of the baseline characteristics between the two groups ensured comparability and indicated that the observed changes in postoperative pulmonary complication scores were attributable to the intervention rather than differences in participant characteristics. Similar findings were reported by Shirodkar et al. (2022), who observed comparable baseline demographic characteristics between the experimental and control groups before administration of pulmonary rehabilitation interventions. Likewise, Agostini et al. (2017) also

reported that patients undergoing major abdominal surgery had comparable baseline characteristics before receiving postoperative respiratory physiotherapy, thereby permitting valid comparison of postoperative outcomes.

The present study further revealed that before administration of Pulmonary Expansion Therapy, the majority of participants in both the experimental and control groups had moderate to severe postoperative pulmonary complications. Following the intervention, a marked improvement in pulmonary status was observed among patients in the experimental group. More than half of the participants improved to the mild postoperative pulmonary complication category, while only one participant remained in the severe category. In contrast, patients in the control group demonstrated comparatively less improvement following routine postoperative care, with the majority continuing to have moderate postoperative pulmonary complications during the post-test assessment. These findings suggest that Pulmonary Expansion Therapy effectively promotes lung expansion, improves inspiratory capacity, enhances alveolar ventilation, facilitates secretion clearance, and prevents postoperative atelectasis, thereby reducing the incidence and severity of postoperative pulmonary complications. These findings are consistent with the study conducted by Guimarães and Faresin (2009), who concluded that deep breathing exercises significantly improved postoperative pulmonary function and reduced pulmonary complications following upper abdominal surgery. Similar findings were also reported by Kundra et al. (2010), who demonstrated that postoperative respiratory physiotherapy improved pulmonary expansion, enhanced oxygenation, and reduced pulmonary morbidity among patients undergoing abdominal surgical procedures.

The effectiveness of Pulmonary Expansion Therapy was further confirmed by comparison of the pre-test and post-test postoperative pulmonary complication scores. In the experimental group, the mean postoperative pulmonary complication score decreased significantly from 20.20 ± 4.17 during the pre-test assessment to 10.72 ± 5.31 during the post-test assessment, with a mean reduction of 9.48 ± 3.24. Statistical analysis showed that the reduction was highly significant ($t = 20.69$, $p < 0.001$). Although the control group also demonstrated improvement following routine postoperative care, the reduction in postoperative pulmonary complication scores was considerably smaller, with a mean reduction of only 2.66 ± 1.78. Furthermore, comparison of post-test scores between the two groups revealed a statistically highly significant difference ($t = 5.46$, $p < 0.001$), indicating that Pulmonary Expansion Therapy was significantly more effective than routine postoperative care alone in reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. The findings of the present study are supported by Agostini et al. (2017), who reported that postoperative respiratory physiotherapy significantly reduced pulmonary complications and promoted early postoperative recovery. Similar findings were reported by Miskovic and Lumb (2017), who concluded that pulmonary expansion techniques are among the most effective evidence-based interventions for preventing postoperative pulmonary complications in patients undergoing major surgical procedures. Likewise, Yadav et al. (2024) observed that structured pulmonary rehabilitation programmes significantly reduced postoperative pulmonary complications and facilitated faster postoperative recovery among patients undergoing major abdominal surgery.

The present study also examined the association between postoperative pulmonary complication scores and selected demographic and clinical variables. The findings revealed that there was no statistically significant association between postoperative pulmonary complication scores and age, gender, occupation, smoking history, body weight, body mass index, type of anaesthesia, or previous surgical history in either the experimental or control group ($p > 0.05$). These findings indicate that the reduction in postoperative pulmonary complications observed in the experimental group was primarily attributable to Pulmonary Expansion Therapy rather than differences in demographic or clinical characteristics of the participants. Similar findings were reported by Kumar et al. (2016), who found no statistically significant association between postoperative pulmonary complications and selected demographic variables among patients receiving structured respiratory exercise programmes. Likewise, Shirodkar et al. (2022) concluded that pulmonary rehabilitation significantly reduced postoperative pulmonary complications irrespective of demographic characteristics, thereby emphasizing the importance of early postoperative respiratory interventions for all patients undergoing major abdominal surgery.

Overall, the findings of the present study clearly demonstrate that Pulmonary Expansion Therapy is an effective, safe, economical, and evidence-based nursing intervention for reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. The intervention significantly improved pulmonary function, reduced the severity of postoperative pulmonary complications, and promoted better postoperative recovery when compared with routine postoperative care alone. These findings are consistent with previous national and international studies and further strengthen the evidence supporting the incorporation of Pulmonary Expansion Therapy into routine postoperative nursing care to enhance patient outcomes, reduce pulmonary morbidity, and improve the quality of postoperative recovery.

Nursing Implications

The findings of the present study have significant implications for nursing practice, nursing education, nursing administration, and nursing research. Pulmonary Expansion Therapy is a simple, safe, non-invasive, cost-effective, and evidence-based nursing intervention that can be incorporated into routine postoperative care for patients undergoing major abdominal surgery.

Nursing Practice

The findings of the study emphasize the important role of nurses in the prevention and management of postoperative pulmonary complications through timely implementation of Pulmonary Expansion Therapy. Nurses should incorporate deep breathing exercises and incentive spirometry into routine postoperative nursing care, particularly among patients undergoing major abdominal surgeries who are at increased risk of respiratory complications. Nurses should assess patients' respiratory status, identify risk factors, demonstrate correct techniques of pulmonary exercises, and encourage regular performance of exercises during the postoperative period. Continuous monitoring of respiratory parameters,

secretion clearance, oxygenation status, and early identification of pulmonary complications should be considered essential nursing responsibilities. Implementation of PET may improve lung expansion, reduce pulmonary complications, promote early mobilization, and enhance overall postoperative recovery.

Nursing Education

The study findings highlight the need to strengthen knowledge and skills related to postoperative pulmonary care among nursing students and practicing nurses. Nursing educators should incorporate evidence-based pulmonary rehabilitation interventions, including deep breathing exercises and incentive spirometry, into undergraduate and postgraduate nursing curricula. Clinical teaching should emphasize the principles, indications, contraindications, techniques, and patient education aspects related to Pulmonary Expansion Therapy. Simulation-based training and skill demonstrations may be utilized to improve competency among nursing students. Educating future nurses regarding preventive respiratory care will enhance their ability to provide effective postoperative management and reduce patient morbidity.

Nursing Administration

Nursing administrators can utilize the findings of this study to develop and implement institutional protocols and standard operating procedures for Pulmonary Expansion Therapy in surgical wards. Regular training programs and continuing nursing education sessions should be organized to update nurses regarding evidence-based postoperative respiratory interventions. Nursing managers should ensure availability of incentive spirometers and other required resources for effective implementation of PET. Incorporation of pulmonary expansion protocols into postoperative care pathways may improve quality indicators, reduce postoperative complications, decrease length of hospital stay, and enhance patient satisfaction. Administrative support is essential for ensuring consistent application of this intervention in clinical settings.

Nursing Research

The findings of the present study provide evidence for further research related to pulmonary rehabilitation interventions in surgical patients. Nursing researchers may conduct randomized controlled trials with larger sample sizes to establish stronger evidence regarding the effectiveness of Pulmonary Expansion Therapy. Future studies may compare PET with other respiratory interventions such as inspiratory muscle training, positive expiratory pressure therapy, or early mobilization programs. Multicentric studies involving different surgical populations and healthcare settings may be undertaken to improve generalizability of findings. Researchers may also explore the cost-effectiveness, patient compliance, quality of life outcomes, and long-term effects of Pulmonary Expansion Therapy.

RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are proposed:

1. Similar studies may be conducted with a larger sample size to improve the generalizability and reliability of findings.
2. Randomized controlled trials may be conducted to establish stronger evidence regarding the effectiveness of Pulmonary Expansion Therapy in preventing postoperative pulmonary complications.
3. Comparative studies may be undertaken to evaluate the effectiveness of Pulmonary Expansion Therapy with other pulmonary rehabilitation techniques such as inspiratory muscle training and positive expiratory pressure therapy.
4. Similar studies may be conducted among patients undergoing thoracic surgery, cardiac surgery, bariatric surgery, laparoscopic surgery, and other high-risk surgical procedures.
5. Long-term follow-up studies may be conducted to assess the sustained effects of Pulmonary Expansion Therapy on pulmonary function, functional recovery, and quality of life.
6. Multicentre research studies involving various hospitals and healthcare settings may be conducted to improve external validity and applicability of findings.
7. Future studies may evaluate the cost-effectiveness of Pulmonary Expansion Therapy and its impact on hospital stay duration, healthcare utilization, and postoperative recovery outcomes.
8. Studies may be conducted to assess patient adherence, satisfaction, and barriers related to performing pulmonary expansion exercises during the postoperative period.

Limitations Of The Study

The present study had certain limitations. The study was conducted in a single tertiary care hospital; therefore, the findings may not be generalized to all healthcare settings. The sample size was limited to 100 participants, which may restrict the external validity of the findings. The follow-up period was restricted to the postoperative hospital stay, and long-term effects of Pulmonary Expansion Therapy on pulmonary function and recovery were not assessed. Patients with severe postoperative complications requiring intensive care management or mechanical ventilation were excluded, limiting applicability among critically ill populations. Additionally, continuous monitoring of patient adherence to pulmonary exercises outside supervised sessions was not feasible.

CONCLUSION

The present study concluded that Pulmonary Expansion Therapy (PET), comprising deep breathing exercises and incentive spirometry, is an effective nursing intervention for reducing postoperative pulmonary complications among patients undergoing major abdominal surgery. The findings revealed a significant reduction in postoperative pulmonary complication scores among patients who received Pulmonary Expansion Therapy compared with those who received routine postoperative care alone. The intervention enhanced lung expansion, improved pulmonary ventilation, facilitated

effective secretion clearance, and promoted early postoperative recovery by minimizing the severity of pulmonary complications. Furthermore, no statistically significant association was found between postoperative pulmonary complication scores and selected demographic and clinical variables, suggesting that the observed improvement in pulmonary outcomes was primarily influenced by the implementation of Pulmonary Expansion Therapy. Therefore, Pulmonary Expansion Therapy can be recommended as an essential component of evidence-based postoperative nursing care to improve respiratory outcomes, prevent postoperative pulmonary complications, and enhance recovery among patients undergoing major abdominal surgery.

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