- ***Basic Research***

Effect of Incentive Spirometer on Dyspnea Intensity following Cardiothoracic Surgery

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Abstract

Background: Postoperative dyspnea, commonly observed after cardiothoracic surgery, often occurs due to the procedure's chest-opening technique and the use of mechanical ventilation in the critical care unit, which can impact breathing ability. Dyspnea, characterized by difficult or labored breathing and shortness of breath, is typically associated with decreased lung compliance or increased airway resistance. An incentive spirometer is used to enhance lung expansion and improve overall circulation by promoting better breathing quality. Aim: To evaluate the effect of using incentive spirometer on post-operative dyspnea intensity following cardiothoracic surgery. Design: A quasi-experimental pre post-test design was used. Setting: This study was conducted in the cardiothoracic intensive care unit and cardiothoracic ward at the International Medical Center. A purposive sample of 50 adult patients who underwent cardiothoracic surgery was included. Tools: The study utilized a patient demographic data sheet, a clinical data sheet, BORG Visual Analogue Dyspnea Scale, and lung capacity measurement. Results: 56 % of patients experienced no dyspnea after one week of using the incentive spirometer. 70% of post-operative cardiothoracic patients experienced increase in lung capacity after using the incentive spirometer, which was found to be highly statistically significant improvement. Conclusion: The use of an incentive spirometer significantly reduced dyspnea in post-operative cardiothoracic patients, with more than half experiencing no dyspnea after one week of use. Recommendations: Incorporating the use of an incentive spirometer into patient care standards pre- and post-operative care for cardiothoracic surgery patients.

Keywords: Cardiothoracic Surgery, Dyspnea Intensity, Incentive Spirometer

Introduction

Cardiothoracic surgeries, which involve surgical interventions on the heart, lungs, oesophagus, and other organs within the thoracic cavity, are among the most complex and high-risk procedures in modern medicine. These surgeries are commonly performed to treat a variety of life-threatening conditions such as coronary artery disease, congenital heart defects, valve disorders, and lung cancers. Advances in surgeries and post-operative care have a significant effect on better patient outcomes; however the cardiothoracic procedures' complexity continues to have many challenges for surgeons and patients. Those patients require a prolonged hospital stay, critical monitoring, and a multidisciplinary care to prevent any further complications (Vinck et al., 2021).

In spite of the technological advancements in the medical field, the cardiothoracic surgeries' complications remain a challenging concern, as it may lead to increased patients' mortality and morbidity. Respiratory issues are of the most critical complications, as pneumonia acute respiratory distress syndrome (ARDS), and atelectasis, which may frequently occur because of mechanical ventilation used intra-operative and the invasive technique of the cardiothoracic operations. The other complications may be cardiac dysrhythmias as atrial fibrillation (AF), surgical sepsis, bleeding, and vascular events as embolisms (Ibrar et al., 2022).

Certainly these complications will affect the patients' recovery time, require more intervention, and raise the burden on medical resources. The effective post-operative management, such as early mobilization, physiotherapy, and critical monitoring are vital to reduce the complications' incidence and severity as well (Vinck et al., 2021).

Dyspnea is considered a common complication post cardiothoracic surgeries, affecting the process of recovery and further affect patients' quality of life. It often occurs related to direct manipulation on the respiratory muscles, and pleura and the prolonged use of mechanical ventilation. Moreover, cardiopulmonary bypass that is often used may lead to fluid precipitation causing less lung compliance, which worsen dyspnea. Patients may complain from dyspnea at rest or with effort, which needs more respiratory rehabilitation to help patients in restoring normal breathing (Dewi et al., 2021).

The post-operative dyspnea severity and duration depend on several factors as the type of surgery, other present health conditions, and post-operative care. In the severe cases, dyspnea occurs due to other events as atelectasis, pleural effusions, or pulmonary edema, which may be common following cardiothoracic surgeries (Vervoort et al., 2020).

The proper dyspnea management includes the incentive spirometer (IS) use, physiotherapy, and early mobilization to help promoting lung expansion and prevent other complications. Adequate pain management is considered a key, because pain limits patient ability to make deep breathing or coughing, causing further compromising. Consequently, the proper handling of dyspnea promptly is important for reducing hospital stay and better patient outcome (Oshvandi et al., 2020).

The incentive spirometer is a device that helps improving lung function by encouraging patient to take a controlled and deep breath. It is commonly used for patients who experience difficult breathing. This device encompasses a plastic chamber with a breathing tube and a visual indicator, often a ball that moves upward when the patient inhales. The goal is for the patient to inhale slowly and deeply enough to give an indicator to the specific level, this visual feedback helps guiding proper expansion of the lung (Amin et al., 2021).

The main purpose of using IS is to prevent post-operative atelectasis, pneumonia, and any other respiratory problems by maintaining active lungs with prompt controlled deep breaths. By enhancing airflow and lung volume, IS helps opening alveoli which may be collapsed because of the prolonged immobility intraoperative. The patients should be

instructed to use IS many times per day as a part of their routine care to improve oxygenation, prevent lung infection, and facilitate the return to their healthy respiration (Dewi et al., 2021).

The critical care nurses have a pivotal role in the successful process of IS application post cardiothoracic surgeries. They are the main responsible personnel for educating patients and ensuring the proper use of that device and the importance of continuing deep breathing exercises in the prevention of complications and reducing dyspnea intensity. This Education includes the correct technique demonstration (Leonardsen et al., 2021).

Continuous assessment of patients' respiratory condition is a main responsibility of critical care nurses which includes respiratory rate, oxygen saturation levels and lung sounds auscultation to ensure the intended outcome. They should also be alert for respiratory distress signs or any further complications. Additionally, nurses have a vital role in pain management, utilizing pharmacological or non-pharmacological ways to reduce patients' discomfort to enhance proper performance of breathing exercises. Nurses facilitate a better recovery by encouraging adherence to the recommended number of breaths per hour using IS, and progress monitoring (Freitas et al., 2012). Therefore, this study aimed to evaluate the effect of using incentive spirometer on post-operative dyspnea intensity following cardiothoracic surgery.

Significance of the Study

Cardiothoracic surgery is often associated with a significant increase in dyspnea (shortness of breath), particularly in the first month following the procedure. Postoperative pulmonary complications (PPCs), including dyspnea, are common and can affect recovery outcomes. Globally, the incidence of postoperative pulmonary complications after cardiac surgery ranges from 24% to 63%, depending on factors such as the type of surgery and the management of mechanical ventilation (Mathis et al., 2019).

In the Middle East, studies indicate that PPCs affect up to 8.37% of patients following open-heart surgery, with symptoms including atelectasis and pneumonia. In Egypt, these complications are similarly prevalent, with postoperative pulmonary issues posing a challenge in cardiothoracic units due to limited resources and patient-specific risk factors (Mohamed, Cheng & Wei, 2021 and Askar et al., 2022).

From the empirical observation, it was observed that, postoperative cardiothoracic patients develop many pulmonary complications which can cause dyspnea which can be managed and decreased by several methods; one of these methods is IS. It is a simple, low-cost, non-invasive device that patients can easily use to promote lung function recovery. The study hopefully will raise health care providers' awareness regarding effectiveness of IS and may encourage wider use in clinical settings as an affordable intervention to improve patient outcomes. Also, use of IS can help patients by promoting lung expansion and preventing postoperative complications like pneumonia, atelectasis, and reducing the intensity of dyspnea.

Study Aim:

The aim of the current study was to evaluate the effect of using incentive spirometer on post-operative dyspnea intensity following cardiothoracic surgery.

Research Hypothesis:

H: Post-operative cardiothoracic patients who use the incentive spirometer will experience a lower severity of dyspnea than before use.

Subjects and Methods

Study design: A quasi-experimental pre-post-test research design was implemented to meet the study's aim. This design used for the comparison between pre and post intervention dyspnea severity among patients following cardiothoracic surgeries.

Study Setting: The study was conducted at the cardiothoracic intensive care unit (CICU) and the cardiothoracic inpatient unit of the International Medical Center (IMC). The IMC is a tertiary care specialized setting. This setting was selected because of its constant patient rate of cardiothoracic surgeries.

The Cardiothoracic intensive care unit (CICU) is a well-equipped unit with advanced life-support and monitoring devices. Patients receive immediate post-operative care during the first two days or more postoperative. These two units were selected for seeking the patients' data and achieve the study aim.

And after stabilization in the CICU, patients are transferred to the inpatient units, where they continue their recovery under the care of specialized nursing and medical staff. These units focus on post-operative care, including respiratory rehabilitation, pain management, and mobilization. The inpatient units were integral to the study as they provided a controlled environment to monitor the prolonged effects of IS intervention after seven days of use.

Subjects:

A purposive sample of 50 Adult patients underwent cardiothoracic surgery were included in the study. Patients were enrolled preoperatively according to inclusion and exclusion criteria. The sample size was estimated using Epi-Info program based on the following parameters: The incidence rate of the problem at 95% confidence level, and a 5% margin of error.

Inclusion criteria: Adult conscious patients of both sexes undergoing cardiothoracic surgery. All patients undergoing on bypass surgery and sternotomy opening technique surgeries.

Exclusion criteria: Known neurological, psychiatric or mental disorders, musculoskeletal disorders, history of any lung diseases or unstable hemodynamics post-operatively.

Data collection tools

Tool I: Patient Demographic and Clinical Data Sheet: This tool was designed by researchers involving two parts; part A: Patient demographic characteristics to collect essential demographics about the patients such as age, sex, and Body Mass Index (BMI) were recorded for each patient.

Tool I: Part B: Clinical Data; Clinical information including the type of cardiothoracic surgery performed, hemoglobin levels, and past medical history (e.g., previous surgeries, underlying health conditions).These variables were selected to identify any potential factors influencing post-operative dyspnea severity.

Tool II: Part A: Lung capacity measurement sheet: The tool was adapted and modified by the researcher based on guidelines from Nettina, (2013) and Alexander et al., (1994) to assess the patient's lung capacity using an incentive spirometer. Lung capacity was measured by having the patient use the spirometer to determine the maximum volume of air they could inhale after several normal breaths.

Scoring system: The inspired air volume recorded and categorized into three levels: Less than 600 ml was given score (1), 600 ml to less than 900 ml was given score (2), and 900 ml to less than 1200 ml was given score (3). This system provided a straightforward way to quantify lung capacity and track changes during recovery period.

Tool II: Part B: BORG visual analogue dyspnea scale: This standardized scale was adopted from Nettina, (2013) used to measure the severity of dyspnea experienced by patients post-operatively. It is a linear scale ranging from 0 to 10, with (0) representing no dyspnea and (10) indicating the most severe level of dyspnea. Patients were asked to mark their perceived level of difficult breathing on this scale.

Scoring system: 0= No dyspnea, 1-3= Mild dyspnea, 4-5= Moderate dyspnea, 6-7=Severe dyspnea, and 8-10= Maximum dyspnea.

Tools validity and reliability:

Tools validity was tested by face and content validity. Face validity aimed to inspect the tools for clarity, relevance, comprehensiveness, simplicity and applicability; minor modifications were done. Testing content validity was done by 5 experts, one of them was cardiothoracic surgeon, two of them were American ICU supervisors, and the other two were experts in critical care nursing speciality.

Tools reliability: The reliability of the developed tools (tool I) and tool II (part A) were tested by using Cronbach's Alpha test. Reliability coefficient values were 0.75 & 0.89 respectively. While the part B (BORG visual analogue dyspnea scale) in tool II reliability was ranged from 0.82 to 0.93 according to Kendrick et al., (2000).

Pilot study:

A pilot study was conducted at the beginning of the study on 10% (5 patients) of the study subjects. The pilot study was done to investigate the data collection tools for its applicability and stability as well as clarity of items and time needed for each tool to be filled in. Modifications of the tool were done according to the pilot study findings. Some items were omitted, added or rephrased and then the final form was developed. Subjects whom share in the pilot study were excluded from the main study sample.

Ethical and legal considerations

Official permission was obtained from the Ethics Committee of the Faculty of Nursing at October 6 University and from the relevant authorities at the International Medical Center (IMC) to conduct the study. The study’s objectives, methodology, and potential impact were clearly explained to ensure transparency and foster cooperation with the hospital administration, facilitating smooth access to the CCU and inpatient units.

Ethical integrity was maintained throughout the study; informed consent was obtained from all participants after fully explaining the study's purpose, procedures, and potential benefits. Participants were made aware of their rights, including the right to withdraw from the study at any time without any impact on their standard of care. All patient data were coded anonymously, and confidentiality was strictly maintained. Data collected were used exclusively for research purposes, and any identifying information was removed from the final analysis and reports.

The well-being of patients was prioritized throughout the study. Any adverse changes in the patient’s medical condition were immediately reported to the responsible physician to

ensure timely intervention. The IS and dyspnea assessment were conducted in a manner that did not interfere with routine care.

Procedure:

The study was conducted on two phases: preparatory and implementation.

Preparatory phase: This phase started with preparing the study tools based on extensive review of literature and obtaining the official agreement to conduct the study. This phase ended by implementing pilot study.

Implementation phase: The data collection started from March 2024 to July 2024. The researchers selected the patients who met the inclusion criteria, the patients were interviewed individually to explain the purpose and nature of the study then informed consent was obtained from patients who agreed to participate in the study. Then demographic data, clinical data (tool 1 part A &B) was filled out for the patients once throughout the study period and baseline dyspnea level was assessed and documented using BORG visual analogue dyspnea scale (Tool II, Part B) before using the IS and one week after use. Patients' lung capacity was measured using the IS (Tool II, Part A), and the volume of air inhaled was recorded according to the scoring system outlined during and after using the IS.

Each patient was encouraged to use IS every two hours during the first four post-operative days. IS Protocol “Pursed-Lip Breathing Technique application”; all patients were instructed to practice pursed-lip breathing post-operatively while using IS. This breathing technique was integrated to help patients improve air flow, control breathing, and prevent airway collapse, especially when exhaling during deep breathing exercises. This technique was applied consistently for four consecutive days post-surgery to maximize respiratory recovery.

Patients were visited six times per day, starting from 10:00 AM to 8:00 PM, by the researchers to monitor and ensure adherence. The goal was to enhance lung expansion and prevent post-operative complications such as atelectasis or pneumonia. Patient's post-operative dyspnea was assessed during using IS for four days and once after one week of using IS. Patients were instructed to perform three sets of 10 deep inhalations using the IS during each session. A 30-60 second pause was allowed between each set to avoid hyperventilation or dizziness.

This regimented approach ensured that lung function was maximized, and consistent use of the spirometer was facilitated. At the last visit at 8:00 PM to assess the immediate effect of using IS throughout the day. After the initial four days period, patients were given instructions to continue using the IS independently. One week later, the researcher revisited the patients to conduct a final assessment of dyspnea severity and lung capacity to evaluate any delayed effects or sustained improvements in dyspnea severity.

Statistical Analysis:

The collected data were coded, tabulated, and entered into the computer system using SPSS version 20. Numerical variables were presented as means and standard deviations to summarize the central tendency and variability. Categorical variables were presented as frequencies and percentages. Unpaired or Paired t-tests were applied to compare means

between groups. Correlations between variables were estimated by Spearman Correlation Coefficient.

Results

Table (1) shows that more than one-third of the patients (36%) were aged between 55 and 60 years, with a mean ± SD of 56 ± 3.9 years., while less than half were classified as overweight, with a mean BMI ± SD of 27 ± 1.7.

Table (2) shows that less than one-third of the patients had a hospital stay of 9 days, with a mean ± SD of 9.61 ± 1.97 days. Regarding haemoglobin levels, more than half of the patients (52%) had haemoglobin levels ranging from 12 to 14 g/dL, with a mean ± SD of 12.65 ± 1.67 g/dL. In terms of past medical history, less than half of the patients (46%) had diabetes.

Table (3) clarifies that lung capacity mean score after using the incentive spirometer, with a mean ± SD of 1.600 ± 0.931, was higher than during the use of the incentive spirometer, with a mean ± SD of 1.405 ± 0.549. However, the difference was not statistically significant (p = 0.12).

Table (4) shows that the majority of patients (70%) had lung capacity measurements ranging from 600 to 900 ml after one week of using the incentive spirometer, while one-third of the patients (30%) had the same lung capacity before using the incentive spirometer. The difference was statistically significant (P < 0.05).

Table (5) Clarifies that, mean dyspnea severity score after using incentive spirometer with a mean ± SD of 1.020 ± .522 was higher than that before using incentive spirometer with a mean ± SD of 1.545 ± 0 .614 and the difference was not statistically significant (P=0.81).

Table (6) shows that more than half of the patients (56%) had no dyspnea severity after one week of using the incentive spirometer, whereas only 4% had no dyspnea severity before using the incentive spirometer. The difference was highly statistically significant (P = 0.000).

Table (7) illustrates that; there is a statistically significant negative correlation between age and lung capacity (Spearman correlation = -0.502, P < 0.05). Additionally, a statistically significant positive correlation exists between age and dyspnea severity (Spearman correlation = 0.353, P < 0.05).

Table (8) shows that; there was a statistically significant positive correlation between BMI and dyspnea severity score (Spearman correlation = 0.617, P < 0.05). Additionally, there was a statistically significant negative correlation between BMI and lung capacity (Spearman correlation = -0.530, P < 0.05).

Table (9) indicates that dyspnea severity was significantly higher in females (mean ± SD = 1.875 ± 0.255) compared to males (mean ± SD = 0.987 ± 0.014). Additionally, lung capacity was significantly higher in males (mean ± SD = 1.90 ± 0.285) than in females (mean ± SD = 1.30 ± 0.391).

Table 1: Patients' demographic characteristics (n= 50).

Patients' demographics	No.	%
Age of the patients in years:		
40 › 45	8	16
45 › 50	10	20
50 › 55	14	28
55 ≥ 60	18	36
Mean ± SD	56 ± 3.9	
BMI:		
Under -weight ≤ 18.5	1	2
Normal 18.5 - 24.9	10	20
Over weight 25 - 29.9	20	40
Obese 30 – 40	19	38
Mean ± SD	27 ± 1.7	

Figure (1): Gender distribution among the study sample n=50

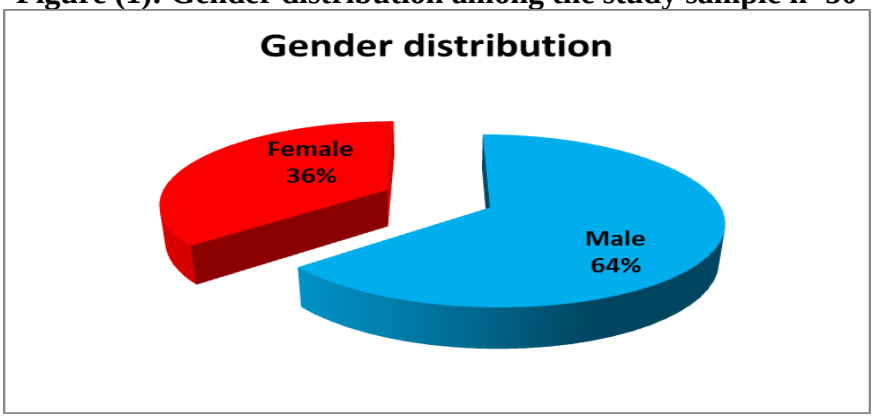

Figure (1) shows that, 64% of patients were male

Table 2: Patients' clinical data (n = 50)

Clinical data	No.	%
Length of hospital stay in days		
7 days	9	18
8 days	10	20
9 days	16	32
11 days	7	14
13 days	8	16
Mean ± SD	9.61 ± 1.97	
Haemoglobin level:		
14 – 18 g \ dl	5	10
12- 14 g \ dl	26	52
10 ≤ 12 g \ dl	19	38
Mean ± SD	12.65 ± 1.67	
Past history:		
Diabetes	23	46
Renal troubles	5	10
Hepatic troubles	4	8
Non	18	36

Figure (2): Percentage distribution of the study sample according to type of operation n=50

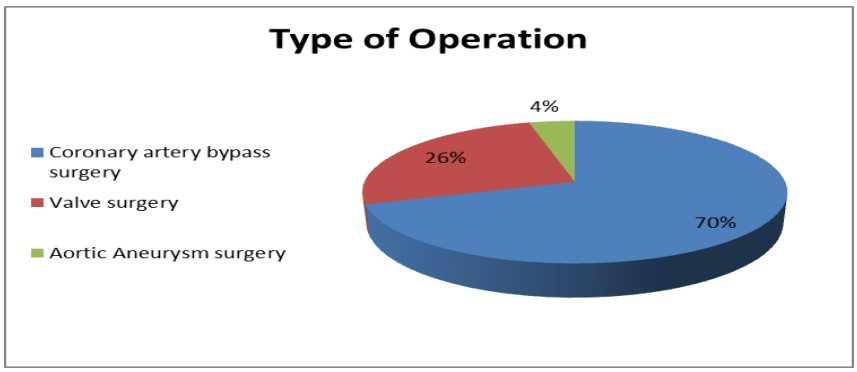

Figure (2): illustrates that, majority of studied sample (70%) underwent coronary artery bypass graft

Table 3: Comparison between lung capacity mean score measurements during and after using incentive spirometer (n = 50)

	During using spirometer	Before using spirometer	t test	P value
	Mean ± SD	Mean ±SD		
Lung capacity	1.600 ± .931	1.405 ± .549	2.6	0.012

Table 4: Comparison between lung capacity measurements before and after a week of using incentive spirometer (n = 50)

Lung capacity	Before using spirometer		After using spirometer		Chi square	P-Value
	No.	%	No.	%		
< 600 ml	35	70 %	5	1 0 %	40.5	0.000*
600 - < 900 ml	15	30 %	35	70 %		
900 - <1200 ml	0	0 %	10	20 %		

Statistically significant at P<0.05.

Table (5): Comparison between dyspnea severity mean score before and after using spirometer during four days (n = 50)

	After using spirometer	Before using spirometer	t – test	P-value
	Mean ± SD	Mean ±SD		
Dyspnea severity	1.020 ± 0.522	1.145 ± 0.614	0.23	0.81

Table (6): Comparison between level of dyspnea severity before and after one week of using incentive spirometer (n = 50)

Dyspnea severity	Before using spirometer		After one week of using spirometer		Chi square	P
	N	%	N	%		
No dyspnea	2	4 %	28	56 %	60.19	0.000*
Mild dyspnea	9	18 %	20	40 %		
Moderate dyspnea	31	62 %	2	4 %		
Sever dyspnea	8	16 %	0	0 %		

Statistically significant at P<0.05.

Table (7): Correlation between and dyspnea severity score, lung capacity and patients' age (n = 50)

	Spearman correlation	P -value
Dyspnea severity	0.353	0.04*
Lung capacity	- 0.502	0.03*

Table (8): Correlation between and dyspnea severity score, lung capacity and patients' BMI (n = 50)

	Spearman correlation	P -value
Dyspnea severity	0.617	0.02*
Lung capacity	- 0.530	0.03*

Table (9): Difference between male and female patients in relation to dyspnea severity score, lung capacity (n = 50)

	Male n=32	Female n= 18	t- test	P value
	Mean ± SD	Mean ± SD		
Dyspnea severity	0.987 ± .014	1.875 ± .255	1.32	0.02*
Lung capacity	1.90 ± .285	1.30 ± .391	0.14	0.04*

Discussion

In the present study, more than one third of patients being in the 55 to 60 age range and a mean ± SD of 56 ± 3.9 years. This result may be related to risk of cardiovascular diseases is more prevalent with older age. This aligns with the findings of Benjamin et al., (2018), who indicated that cardiac surgeries have increased among individuals over the age of 50, as older adults are at higher risk for cardiovascular diseases due to the increased prevalence of heart-related problems in this age group. Regarding gender, more than half of

the study sample was male, which was in the same line with Manap et al., (2018), who reported that cardiovascular diseases are more common in males than females.

Concerning BMI, the majority of patients was into the overweight and obese categories, with a mean of 27 ± 1.7. The researchers interpreted this as the prevalence of overweight and obesity has been increasing over the past few decades, especially in middle-aged and older adults. This is supported by Meyer et al., (2021), who provided strong evidence that the association between BMI and ischemic heart disease progressively increases throughout the BMI range.

Regarding the length of hospital stay, it was observed that less than one-third of the patients in the study stayed an average of 9 days. This result is explained by Pahwa et al., (2021), who stated that the length of hospital stay after open heart surgery may be influenced by multiple factors, including other health problems that can increase mortality and prolong hospitalization. However, this finding contradicts the report by Kao et al., (2022), who stated that most patients undergoing cardiac surgery are generally discharged within the first week post-operation. It also contradicted with Widmer, Oesch & Bachmann, (2022) who reported that the use of breathing exercises and spirometers can help reduce hospital stays after coronary artery bypass surgery.

From the researchers' point of view, prolonged hospital stay may be related to delayed wound healing which is primarily due to pre-existing comorbidities (about half of the study sample were diabetic), and the physical condition of patients, including age and obesity.

In the present study, the lung capacity mean score improved after the use of IS, increasing from 1.405 ± 0.549 before IS use to 1.600 ± 0.831 afterward. However, the overall difference between these means was not statistically significant. Despite this, a majority of patients (70%) exhibited a higher lung capacity measurement after using the IS, and this particular finding was highly statistically significant.

This result is in agreement with Branson, (2013) the study highlighted the importance of IS in lung recovery, noting that patients who consistently used IS post-cardiothoracic surgery often reported subjective improvements in breathing, even if objective lung capacity measurements didn’t always show a dramatic statistically significant change across all patients.

In addition, Freitas et al., (2012) in the Cochrane review on IS use after coronary artery bypass graft (CABG) surgery, found that while the overall improvement in lung function wasn’t always statistically significant in all studies, patients consistently showed trends of lung function improvement. The use of IS encouraged deeper breaths and improved alveolar ventilation.

Contradicting this result, Do Nascimento Junior, (2014) looked at patients undergoing upper abdominal surgery concluded that IS did not significantly improve lung function compared to spontaneous breathing exercises. Their results indicated that while some patients may feel better subjectively, the objective measurement of lung capacity did not show a statistically significant increase, challenging the idea that IS alone can drive significant physiological improvements.

In the present study, mean dyspnea severity score after using IS, with a mean ± SD of 1.020 ± 0.522, was lower than before using IS, which had a mean ± SD of 1.545 ± 0.614. However, the difference was not statistically significant. And more than half of the patients had no dyspnea severity after one week of using IS, compared to only 4% who had no dyspnea severity before using it, and this difference was highly statistically significant.

These results are supported by Zhang et al., (2022) who explained that during controlled breathing, dyspnea is relieved by reducing hyperinflation of the rib cage, improving gas exchange, increasing the strength of respiratory muscles, and optimizing the pattern of thoraco-abdominal motion. This finding is also consistent with Ubolnuar et al., (2022), who demonstrated that pursed-lip breathing reduces dyspnea by lengthening expiratory time and the full ventilator cycle. Additionally, Yang et al., (2022), stated that pursed-lip breathing is effective in improving gas exchange and reducing dyspnea.

This study results revealed a significant correlations between dyspnea severity and patient factors, including age, BMI, and gender. A positive correlation was found between age and dyspnea severity. These findings aligned with Ubolnuar et al., (2022), who documented age-related respiratory changes that impact lung capacity and function. They noted that, with age, there is an increase in residual lung volume and a decrease in vital capacity, gas exchange, and diffusion capacity, accompanied by a loss of chest wall mobility, restricting tidal air flow. Consequently, older adults experience a decreased oxygen diffusion capacity, leading to lower arterial oxygen levels.

A statistically significant positive correlation was also observed between BMI and dyspnea severity, consistent with Yang et al., (2022), who explained that; dyspnea is common in obese patients. This relationship is partly due to increased ventilation demand and reduced lung volumes, with a restrictive ventilation effect caused by increased chest wall and abdominal mass, which raises the work of breathing. Dyspnea is often one of the first symptoms in this physiological change, influenced by the patient's weight and reduced physical conditioning.

Additionally, a significant negative correlation was noted between BMI and lung capacity. This result was supported by Meyer et al., (2021), who highlighted that BMI is correlated with postoperative pulmonary complications, showing linear relationships between BMI and both vital capacity and total lung capacity.

Gender differences in lung capacity were also significant, with males exhibiting higher lung capacity than females. This finding is consistent with Yang et al., (2022), who attributed these differences to females having smaller airway calibers than males, resulting in decreased lung elasticity over time and affecting lung expansion and contraction.

Conclusion

Based on the study results, there was a highly statistically significant improvement in dyspnea severity, which supports the research hypothesis; as more than half of patients had no dyspnea after one week of using the incentive spirometer compared to only 4% before. A highly statistically significant improvement in lung capacity was observed after one week of using the incentive spirometer among near three quarters of patients.

Recommendations:

The study recommended that:

- Incorporating the use of an incentive spirometer into patient care standards pre- and post-operative care for cardiothoracic surgery patients. This could help enhance respiratory recovery and reduce post-operative complications such as dyspnea and atelectasis.
- Further researches are needed to explore the various factors such as pre-existing lung conditions, surgery type, and baseline lung function to identify which patients are most likely to benefit from IS therapy.
- Healthcare institutions should consider developing guidelines for IS use tailored to different types of surgeries.

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الملخص العربي

تأثير استخدام جهاز تحفيز التنفس على شدة ضيق التنفس بعد جراحة القلب والصدر

مقدمة: يعد ضيق التنفس من الأعراض الشائعة بعد جراحة القلب والصدر، وغالبًا ما يحدث ذلك بسبب تقنية فتح الصدر المستخدمة خلال تلك الجراحة، وكذلك استخدام جهاز التنفس الصناعي في وحدة العناية المركزة، مما قد يؤثر على القدرة على التنفس. يتميز ضيق التنفس بصعوبة التنفس أو التنفس المجهد، ويرتبط عادةً بانخفاض مرونة الرئتين أو زيادة مقاومة الممرات الهوائية. يمكن استخدام جهاز تحفيز التنفس لتعزيز تمدد الرئتين وتحسين الدورة الدموية بشكل عام من خلال تحسين جودة التنفس.

الهدف: هدفت الدراسة الي اختبار تأثيراستخدام جهاز تحفيز التنفس على شدة ضيق التنفس بعد جراحة القلب والصدر.
التصميم: تم استخدام تصميم شبه تجريبي اختبارقبلى وبعدى.

النتائج: 56٪ من مرضى جراحة القلب والصدر لم يعانوا من ضيق في التنفس بعد أسبوع واحد كما ان 70٪ منهم شهدوا زيادة في سعة الرئة بعد استخدام جهاز تحفيز التنفس، ووُجد أن هذا التحسن له دلالة إحصائية عالية.

الخلاصه والتوصيات: كان لاستخدام جهاز تحفيز التنفس تأثير كبير في تقليل ضيق التنفس لدى مرضى جراحة القلب والصدر بعد العملية، حيث لم يعاني أكثر من نصف المرضى من ضيق التنفس بعد أسبوع من الاستخدام. واوصت الدراسه بإدراج استخدام جهاز التحفيز التنفسي ضمن معايير رعاية المرضى قبل وبعد عمليات جراحة القلب والصدر.