Effect of Incentive Spirometry on Respiratory Parameters among Critically Ill Patients with Chest Tube Drainage

Marwa Fathallah Mostafa [1,2], Nayera Mohamed Tantaewy [1,3], & Asmaa Ibrahim Abo-Saeda [1]

[1]Assistant professor of Critical Care & Emergency Nursing, Faculty of Nursing, Mansoura University, Egypt
[2]Associate Professor of Critical Care and Emergency Nursing, Faculty of Nursing, British University in Egypt
[3]Associate Professor of' Critical Care & Emergency Nursing, Faculty of Applied Medical Science Alula, Taibahu University, KSA.

Corresponding author: **Marwa Fathallah Mostafa**

Email:Marwa.fathallah@bue.edu.eg

Abstract

Background: Chest tube drainage is a common procedure following cardiac or thoracic surgery, which can lead to respiratory disorders. Incentive spirometry (IS) is used to enhance respiratory outcomes by promoting deep breathing and lung expansion. **Aim:** evaluate the effect of incentive spirometry on respiratory parameters among critically ill patients with chest tube drainage. **Research Design:** A quasi-experimental design was used in this study. **Setting:** Cardiothoracic intensive care unit at the Cardiothoracic and Vascular Surgery Center of Mansoura University. **Subjects:** A convenience sample of 120 patients who underwent chest tube drainage was randomly assigned to either the IS group (n = 60) or the control group (n = 60). **Tool**: Data were collected using The Respiratory Distress Observation Scale. **Results:** Patients in the IS group had a significantly lower heart rate (mean ± SD: 87.85 ± 10.97 beats per minute) compared to those in the control group (mean ± SD: 107.08 ± 18.06 beats per minute, $p < 0.001$). Additionally, Patients in the IS group had a significantly lower respiratory rate (mean ± SD: 14.93 ± 2.6 breaths per minute) compared to those in the control group (mean ± SD: 23.38 ± 6.52 breaths per minute, $p < 0.001$). **Conclusion:** Patients in the IS group showed improvements in respiratory parameters compared to control group. The findings support using IS as a safe, non-invasive device to prevent respiratory complications. **Recommendations:** The IS technique should be used as an adjunct to the routine care for patients with chest tube drainage.

Keywords: Chest Tube Drainage, Critically Ill Patients, Incentive Spirometry, Respiratory Parameters.

Introduction

The respiratory system plays a pivotal role in facilitating breathing, and its dysfunction can significantly affect overall health. The thoracic cavity, which is responsible for the expansion and contraction of the lungs, can be impacted by a wide range of pathological conditions, including acute and chronic respiratory diseases **(Alwekhyan, Alshraideh, Yousef, & Hayajneh, 2022).**

Postoperative pulmonary complications can develop after cardiac or thoracic interventions. These changes can manifest as impaired gas exchange, altered lung compliance, and ventilatory dysfunction, ultimately affecting the body's ability to maintain adequate oxygenation and carbon dioxide removal. As a result, functional integrity of the respiratory system is critical for maintaining homeostasis and preventing postoperative respiratory complications **(Dote et al., 2020).**

The consequences of respiratory system dysfunction following surgical interventions can be severe, manifesting as increased hospital expenses, elevated morbidity and mortality rates, and prolonged hospital stay **(Sweity, Alkaissi, Othman & Salahat, 2021).** Cardiothoracic patients have been shown to exhibit diminished lung base ventilation, reduced total inspiratory time, and decreased inspiratory capacity, thereby increasing their susceptibility to postoperative pulmonary complications, which can have severe consequences on patient outcomes **(Chaudhary, Chaudhary, Ghewade & Mahajan, 2020).**

Thoracic and abdominal movements, which are essential for respiratory function, are influenced by forces acting on the respiratory system. Impaired muscle strength can disrupt normal respiratory dynamics, potentially leading to alterations in ventilation and gas exchange **(Vardhan & Nikhade, 2024).**

Following cardiothoracic operations, pulmonary impairment is a common consequence that can be mitigated through chest physical therapy. A chest tube may be used for a variety of reasons, such as cardiac procedures, postoperative thoracic use, pleural effusion, severe physical trauma, penetrating chest injuries, hemothorax, and bronchopleural fistula **(Lokhande, Sharath & Thakre, 2023).** Chest drains are the gold standard for drainage of the pleural, mediastinal, and pericardial spaces. They are used in several conditions, including pneumothorax, pleural effusion, and postoperative removal of air and fluid, to help the lungs operate normally. Many several types and sizes of chest tubes are available **(Wilson, Teeter, Kolarczyk, Haithcock & Long, 2019).**

Incentive spirometry (IS) is a type of pulmonary training frequently employed to prevent pulmonary complications. IS involves prolonged maximum inspiration exercises that aim to enhance lung function and promote optimal gas exchange by strengthening respiratory muscles and increasing lung capacity **(Awolola & Maharaj, 2023).**

The IS technique mainly prevents postoperative patients from developing atelectasis and alveolar collapse. Although the IS technique is frequently used to treat patients following surgery, it is unclear how well this method works, either by itself or in conjunction with general deep breathing and coughing, to minimize postoperative respiratory problems **(Kamau, 2020)**.

Hospitals employ the IS extensively because of its low cost. They are employed in the management and prevention of pulmonary

problems **(Pieczkoski et al., 2021).**

The IS technique aims to improve lung function by prolonging exhalation, thereby increasing the ability of the lung to expand and empty efficiently. This respiratory exercise is particularly beneficial for patients with compromised lung function, as it can help to enhance gas exchange and overall respiratory health **(Yazdani et al., 2021).**

Significance of the Study

Incentive spirometry (IS) has shown promise in preventing postoperative pulmonary complications, but its efficacy among critically ill patients with chest tube drainage remains under investigation. Nurses are pivotal in implementing incentive spirometry procedures. They are responsible for patient education, technical demonstrations, and ongoing monitoring of IS use. Using of IS has demonstrated efficacy in improving respiratory parameters, including a reduced respiratory rate, increased oxygen saturation, and enhanced lung expansion. Consequently, IS has been associated with decreased ICU length of stay, ventilator days, and mortality rates. IS was often integrated into perioperative care protocols due to its potential to prevent pulmonary complications, particularly atelectasis **(Alwekhyan et al., 2022).** While the American Association for Respiratory Care (AARC) Clinical Practice Guidelines recommend IS as a component of comprehensive pulmonary rehabilitation, the evidence supporting its specific benefits in patients with chest tube drainage remains inconclusive **(Chang et al., 2022).** So, this study aimed to evaluate the effect of incentive spirometry on respiratory parameters among critically ill patients with chest tube drainage.

Aim of the study

To evaluate the effect of incentive spirometry on respiratory parameters among critically ill patients with chest tube drainage.

Operational Definition

In the present study, respiratory parameters refer to the obtained measurement of heart rate, respiratory rate, restlessness, paradoxical breathing pattern, accessory muscles use, grunting at end-expiration, nasal flaring, and look of fear.

Research Hypothesis

Patients who receive incentive spirometry are expected to have better respiratory parameters than the control group who receive routine hospital care.

Subjects and Method

Research Design

A quasi-experimental design (study/control) was used in this study.

Setting

The study was conducted at the Cardiothoracic Intensive Care Unit in the Cardiothoracic and Vascular Surgery Center of Mansoura University.

Subjects

A purposive sample of 120 adult-conscious patients who underwent chest tube drainage and were able to understand and comply with IS instructions was included in the study. Patients with cardiac conditions, suffering from bronchial asthma or using supplemental oxygen therapy, those with neurological or psychological abnormalities, and those on a cardiac pacemaker are among the exclusion criteria.

Patients were randomly divided into two equal groups; 60 patients each. The IS group used incentive spirometry while the control group received routine hospital

Sample Size Calculation:

The sample size was calculated according to the following equation

$$n = \frac{Z^2\ P(1-p)}{d^2}$$

where Z is the statistic that represents the degree of confidence, P is the predicted frequency, n is the sample size, and d stands for precision, which relates to effect size. The study sample was estimated using a power estimate. A test with a power of 80% and a value of significance of 0.05 was considered appropriate **(Serdar et al., 2021).** The sample size was estimated to be 60 people in each group. A 10% increase in sample size was made to account for potential losses. Finally, 60 participants for each group were included.

Data Collection Tools

One tool was used to collect the data, it consisted of two parts

Part I: Patients' Socio-demographic and Profile Data: obtained from patients and medical records, it contains personal characteristics such as age, gender, level of education, marital status, and physical exercise.

Part II: Respiratory Distress Observational Scale (RDOS). This scale was adopted from **(Zhuang et al., 2019).** It included heart rate, breathing rate, behavioral indicators such as restlessness, presence of atypical breathing patterns, activation of accessory respiratory muscles, facial expressions of discomfort during expiration, and physical signs of nasal flaring, as well as fear-related emotional cues.

Scoring system for RDOS: Each item is assigned a score based on the observed severity. These scores are then summed to calculate the total RDOS score. A higher RDOS score indicates greater respiratory distress. The median RDOS score was 2, with an interquartile range of 1-3, encompassing a range of 0 to 7. According to the receiver operating characteristic (ROC) curve analysis, scores of 0-2 indicate minimal or no respiratory distress, while scores of ≥3 suggest moderate to severe respiratory distress **(Campbell & Templin, 2015).**

Validity and Reliability

A high degree of reliability was demonstrated by the interobserver coefficient of correlation for the RDOS, with a value of r=0.87, supporting the validity of the scale's measurements **(Zhuang et al., 2019).**

Pilot Study

A pilot study was conducted on 10% of the sample (12 patients) to assess the feasibility and applicability of the tool. It was excluded from the study.

Ethical Considerations

The Ethical and Research Committee at Mansoura Faculty of Nursing approved the study and assigned an approval number (0608). The researcher obtained formal approval from the hospital director to carry out the study. Before participation, the study's participants gave written agreement, and during the initial interview, they were informed about the aim, methodology, and possible advantages of the study and that their participation in the study was voluntary, they could leave the study at any time without having an impact on their care. They also received assurances about the confidentiality of their data.

Data Collection Procedure

- Patients with chest tube drainage were randomly assigned to either an IS or a control group.
- Patients in the IS group received IS therapy twice daily for 30 minutes, One minute of

rest was given between sets to reduce fatigue, while those in the control group received the usual hospital care.

- The patients were monitored for respiratory parameters such as heart rate and respiratory rate. Utilizing the RDOS score, a comprehensive assessment of various physiological and behavioral indicators was conducted. Specifically, the patient's comfort and restlessness, as well as respiratory patterns characterized by paradoxical respiratory movements, auxiliary muscle usage, grunting during expiration, nasal flaring, and fearful expressions were evaluated and recorded.
- The chest tube drainage was connected to a suction device and the patients were instructed to breathe deeply and slowly to help remove secretions and promote lung expansion.
- The IS was set to deliver a flow rate of 30-40 liters per minute, which was adjusted according to the patient's inspiratory effort.
- The patients were closely monitored by a nurse during the therapy session to ensure proper technique and safety.
- The study protocol was implemented for 7 days, and data was collected and analyzed on the 8th day.
- A comparison was made between both groups (study and control groups) to examine the effect of incentive spirometry on respiratory parameters among critically ill patients with chest tube drainage.

Statistical analysis

The analysis of the collected data was conducted using SPSS version 23, a widely utilized statistical software package. The results were presented descriptively, with quantitative variables summarized as mean ± standard deviation (SD) and qualitative variables reported as frequencies and percentages (%). A significance level of 0.05 was established, with p-values below this threshold deemed statistically significant and those exceeding it considered non-significant. To examine the relationships between continuous variables, we employed the one-way analysis of variance (ANOVA) t-test, whereas categorical variables were analyzed using the chi-square test. The predictive performance of IS in diagnosing respiratory parameter improvements was evaluated using ROC curves, which enable the estimation of diagnostic accuracy. The overall effectiveness of IS was quantified by calculating the area under the ROC curve (AUC), providing a comprehensive measure of its diagnostic precision.

Results

Table (1) presents the socio-demographic data of two groups of patients. While no significant differences were observed in gender distribution ($\chi^2 = 3.52$, $p = 0.06$), a trend towards a higher proportion of males in the intervention group was noted (46.7% vs. 30%). Age, residence, and occupational status exhibited no significant differences between the two groups. However, marital status and educational level were significantly associated with group allocation. Participants in the IS group were married (88.3% vs. 63.3%, $\chi^2 = 12.25$, $p = 0.007$) and possess a bachelor's degree (71.7% vs. 55%, $\chi^2 = 11.87$, $p = 0.008$) compared to the control group. Conversely, participants in the control group were single (31.7% vs. 6.7%) and holding a master's degree (26.7% vs. 5%). No significant differences were observed in physical exercise habits between both groups.

Table (2) presents the comparative analysis between the control and incentive spirometry

(IS) group. No statistically significant differences were observed in the prevalence between the two groups except in the duration of treatment, with the IS group exhibiting a longer treatment period (mean ± SD: 5.63 ± 2.32 days) compared to the control group (mean ± SD: 3.98 ± 1.89 days; $\chi^2 = 14.56$, $p < 0.001$). Furthermore, no significant associations were found between the two groups regarding the prevalence of diabetes mellitus, hypertension, heart disease, and kidney disease.

Table (3) presents a comparative analysis of heart rate and respiratory rate between IS group and control groups. A statistically significant difference was observed in heart rate, with the intervention group exhibiting a lower mean heart rate (87.85 ± 10.97 bpm) compared to the control group (107.08 ± 18.06 bpm; t-test = 49.65, $p < 0.001$). Similarly, the intervention group demonstrated a significantly lower mean respiratory rate (14.93 ± 2.6 breaths/min) compared to the control group (23.38 ± 6.52 breaths/min; t-test = 86.8, $p < 0.001$). These findings collectively indicate that incentive spirometry was associated with a reduction in both heart rate and respiratory rate among the study participants.

Table (4) presents a comparative analysis of Respiratory Distress Observation Scale (RDOS) scores between the control and incentive spirometry (IS) groups. Statistically significant differences were observed across multiple RDOS parameters, with the control group exhibiting higher incidences of respiratory distress indicators. Specifically, the control group demonstrated significantly higher frequencies of heart rate ≥ 110 beats per minute ($\chi^2 = 49.94$, $p < 0.001$), respiratory rate ≥ 30 breaths per minute ($\chi^2 = 45.55$, $p < 0.001$), restlessness ($\chi^2 = 46.65$, $p < 0.001$), paradoxical breathing ($\chi^2 = 38.57$, $p < 0.001$), accessory muscle use ($\chi^2 = 84.26$, $p < 0.001$), and nasal flaring ($\chi^2 = 51.05$, $p < 0.001$) compared to the IS group. Furthermore, the control group exhibited a significantly higher mean total RDOS score (10.78 ± 2.21) compared to the IS group (1.75 ± 1.37), as determined by the t-test ($t = 74.59$, $p < 0.001$). Respiratory comfort was significantly compromised in the control group, with no participants reporting the absence of respiratory distress. These findings demonstrate the efficacy of IS in improving respiratory distress among the study group.

Figure (1) shows the diagnostic accuracy of incentive spirometry (IS) in predicting respiratory distress, as measured by the Respiratory Distress Observation Scale (RDOS), was assessed using receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) values for heart rate, respiratory rate, restlessness, paradoxical breathing pattern, accessory muscle use, grunting at end-expiration, nasal flaring, and look of fear were 0.183, 0.169, 0.217, 0.267, 0.164, 0.175, and 0.243, respectively. These findings indicate limited diagnostic accuracy of IS in differentiating patients with and without respiratory distress based on these individual RDOS components. However, the overall model incorporating all RDOS parameters demonstrated significant discrimination ($p < 0.0001$), suggesting that IS, when used in conjunction with other clinical assessments, may contribute to identifying patients at risk for respiratory distress.

Table (1): Socio-demographic data among the studied groups

Variable	Parameter	Control group N=60	IS group N=60	χ^2	p-value
Sex	Male	18 (30%)	28 (46.7%)	3.52	0.06
	Female	42 (70%)	32 (53.3%)		
Age	Mean ± SD	58.83±10.81	51.23 ± 11.94	4.9	0.08
	Min-max	28-87	20-72		
	<40	4 (6.7%)	8 (13.3%)		
	40-60	29 (48.3%)	36 (60%)		
	≥60	27 (45%)	16 (26.7%)		
Residence	Rural	10 (16.7%)	11 (18.3%)	0.058	0.81
	Urban	50 (83.3%)	49 (81.7%)		
Marital status	Single	19 (31.7%)	4 (6.7%)	12.25	0.007
	Married	38 (63.3%)	53 (88.3%)		
	Divorced	2 (3.3%)	2 (3.3%)		
	Widowed	1 (1.7%)	1 (1.7%)		
Educational level	Diploma	10 (16.7%)	14 (23.3%)	11.87	0.008
	Bachelor	33 (55%)	43 (71.7%)		
	Master's degree	16 (26.7%)	3 (5%)		
	PhD	1 (1.7%)	0 (0%)		
Occupational status	Non-employed	19 (31.7%)	16 (26.7%)	0.36	0.54
	Employed	41 (68.3%)	44 (73.3%)		
Physical exercise	Yes	6 (10%)	9 (15%)	0.68	0.4

Data is presented as numbers (frequencies), means ± SDs, SD: standard deviation, chi-square test for determining significance among categorical variables, p-value: the value of significance. P is considered significant if it is <0.05.

Table (2): Clinical characteristics among the studied groups

Variable	Parameter	Control group N=60	IS group N=60	χ^2	p-value
Pneumonia	Yes	32 (53.3%)	29 (48.3%)	0.3	0.58
Pneumothorax	Yes	29 (48.3%)	21 (35%)	2.19	0.13
Duration of disease (days)	Mean ± SD	3.33 ± 1.96	4.08 ± 1.52	0	1
	Min-max	1-10	1-8		
	≤5 days	54 (90%)	54 (90%)		
	>5 days	6 (10%)	6 (10%)		
Duration of treatment (days)	Mean ± SD	3.98 ± 1.89	5.63 ± 2.32	14.56	<0.001
	Min-max	1-10	2-15		
	≤5 days	52 (86.7%)	33 (55%)		
	>5 days	8 (13.3%)	27 (45%)		
Diabetes mellitus (DM)		22 (36.7%)	20 (33.3%)	0.14	0.7
Hypertension		25 (58.3%)	29 (48.3%)	0.53	0.46
Heart disease		7 (11.7%)	11 (18.3%)	1.04	0.3
Kidney disease		7 (11.7%)	12 (20%)	1.56	0.21

Data is presented as numbers (frequencies), means ± SDs, SD: standard deviation, chi-square test for determining significance among categorical variables, p-value: the value of significance. P is considered significant if it is <0.05.

Table (3): Vital signs among the studied groups

Variable	Parameter	Control group N=60	IS group N=60	t-test	p-value
Heart rate per min (beats /min = bpm)	Mean ± SD	107.08 ± 18.06	87.85 ± 10.97	49.65	<0.001
	Min-max	50-140	60-115		
Respiratory rate per minute (auscultated) (breaths /min)	Mean ± SD	23.38 ± 6.52	14.93 ± 2.6	86.8	<0.001
	Min-max	13-36	11-20		

Data is presented as means ± SDs, SD: standard deviation, t- test for determining significance among continuous variables, p-value: the value of significance. P is considered significant if it is <0.05.

Table (4): Respiratory Distress Observation Scale (RDOS) score among the studied groups

Variable	Parameter	Control group N=60	IS group N=60	χ^2	p-value
Heart rate per min (beats /min = bpm)	<90	6 (10%)	32 (53.3%)	49.94	<0.001
	90-110	20 (33.3%)	27 (45%)		
	≥ 110	34 (56.7%)	1 (1.7%)		
Respiratory rate per minute (auscultated) (breaths /min)	<19	14 (23.3%)	50 (83.3%)	45.55	<0.001
	19-29	33 (55%)	10 (16.7%)		
	≥ 30	13 (21.7%)	0 (0%)		
Restlessness: non-purposeful movements	No	13 (21.7%)	48 (80%)	46.65	<0.001
	Yes - Occasional, slight movements	25 (41.7%)	12 (20%)		

	Yes - Frequent movements	22 (36.7%)	0 (0%)		
Paradoxical breathing pattern: abdomen moves in on inspiration	No	14 (23.3%)	48 (80%)	38.57	<0.001
	Yes	46 (76.7%)	12 (20%)		
Accessory muscle use: rise in clavicle during inspiration	No	6 (10%)	56 (93.3%)	84.26	<0.001
	Yes - Slight rise	29 (48.3%)	4 (6.7%)		
	Yes - Pronounced rise	25 (41.7%)	0 (0%)		
Grunting at end-expiration: guttural sounds	No	14 (23.3%)	50 (83.3%)	43.39	<0.001
	Yes	46 (76.7%)	10 (16.7%)		
Nasal flaring: involuntary movement of nares	No	13 (21.7%)	52 (86.7%)	51.05	<0.001
	Yes	47 (78.3%)	8 (13.3%)		
Look of fear:	No	23 (38.3%)	59 (98.3)	49.91	<0.001
	Yes	37 (61.7%)	1 (1.7%)		
Total score	Mean ± SD	10.78 ± 2.21	1.75 ± 1.37	74.59	<0.001
	Min-max	4-14	0-6		
	Respiratory comfort	0 (0%)	46 (76.7%)		
	Respiratory distress and need for palliation	60 (100%)	14 (23.3%)		

Data is presented as numbers (frequencies), means ± SDs, SD: standard deviation, chi square test for determining significance among categorial variables, p-value: the value of significance. P is considered significant if it is <0.05.

The ROC curve analysis of IS on RDOS score

The results of the ROC curve analysis of IS on RDOS score were presented in figure 1.

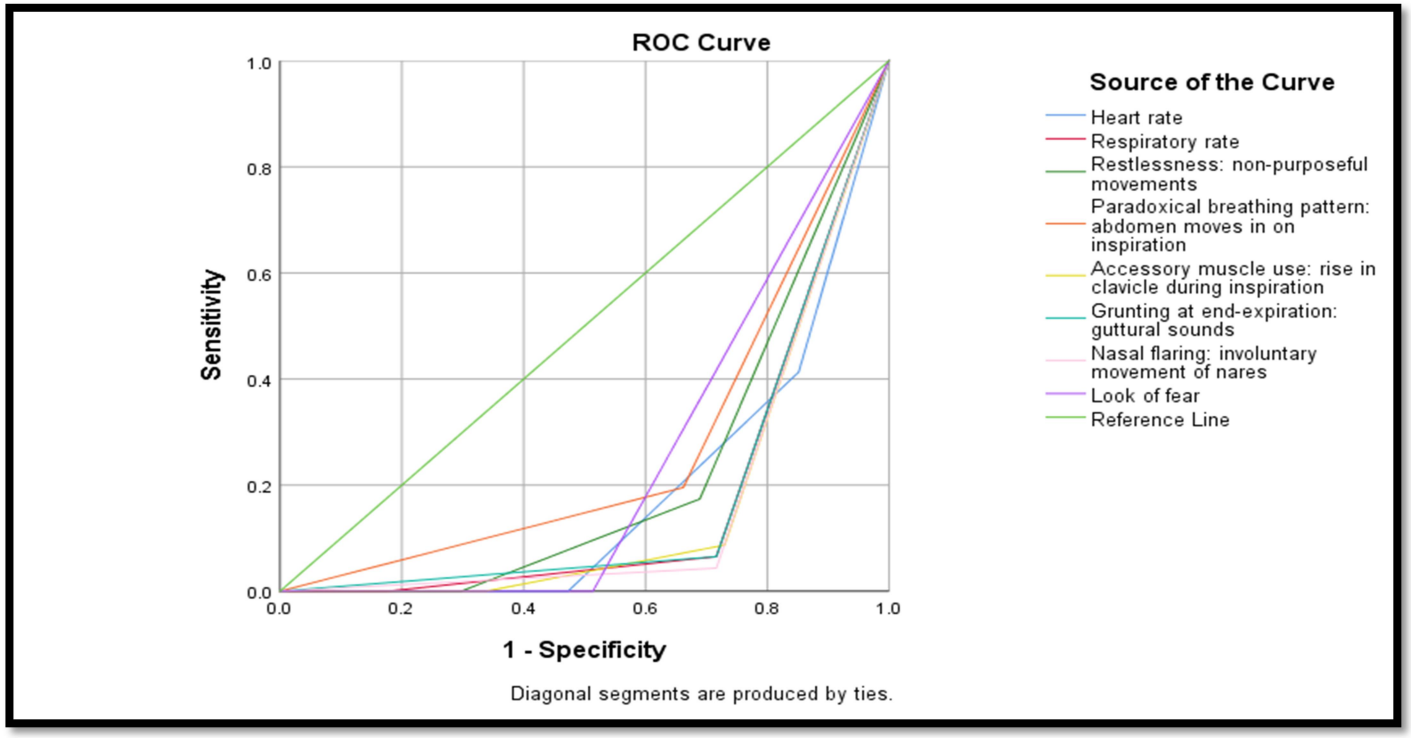

Figure (1): The ROC curve analysis of IS on RDOS score

Discussion

Peak inspiratory flow was assessed using incentive spirometry, a technique involving the measurement of inhaled air volume via a piston-driven device **(Alwekhyan et al., 2021).** This instrument provides visual feedback to encourage maximal inhalation, thereby facilitating optimal respiratory function **(Dote et al., 2020).** Owing to its affordability, ease of use, and lack of reported adverse effects, incentive spirometry is a widely employed tool in respiratory rehabilitation to enhance patient engagement and inspiratory capacity **(Sweity et al., 2021).** The current study was conducted to evaluate how IS affects respiratory parameters in patients undergoing chest tube drainage.

A comprehensive analysis of the patient demographics in the current study reveals that most participants were female, with a preponderance of individuals falling within the age range of 40-60 years. This finding is partially corroborated by **Sharma and Kaur (2020),** who reported that half of their patients fell within the age group of 46-60 years. In contrast, a notable disparity is observed in the gender distribution, as most patients were male, diverging from the predominantly female composition of the current study's patient population**.**

In the current study, the incidence of pneumonia, and hemo-pneumothorax were comparable between the two groups indicating that this difference was not statistically significant. It indicates that most patients with chest trauma are generally presented with this diagnosis. A study by **Dote et al. (2020)** confirmed the current findings and showed that individuals with chest trauma would occasionally arrive with respiratory failure because the thorax or lung parenchyma might have been damaged.

A significant majority of patients had a prior history of chronic illness, which may have influenced their treatment outcomes or response to therapy.

The main results of the current study showed that the IS group had improved respiratory parameters compared to the control group. This was consistent with **Reychler et al., (2016)** and the results of **Toor et al., (2021)** who showed that when prescribed daily breathing exercises with an incentive spirometer, study participants experienced an increase in their maximal inspiratory volume. The same result was found in an experimental study by **Muthukumaran et al., (2020)** who assessed the effectiveness of incentive spirometry exercise on pulmonary parameters of patients with lower respiratory tract disorder.

A randomized controlled trial by **Heydari et al., (2015)** comparing inspiratory resistive muscle training with incentive spirometry in the rehabilitation of COPD patients revealed that the IS improves respiratory function tests compared to inspiratory resistive muscle training. Also**, Sharma and Kaur (2020)** reported that few patients experienced respiratory distress during the post-test, compared to all patients during the pre-test. Their findings were judged to be highly statistically significant. A study conducted by **Messika et al., (2019)** investigated the effects of IS on cardiovascular and psychological outcomes using RODS. revealed a statistically significant reduction in blood pressure and peritraumatic distress assessment following the implementation of IS, which is consistent with the current study's observation. Similarly, in a study done by **Ammous et al., (2023)** who assessed the effect of inspiratory muscle training on chronic obstructive pulmonary

disease, as a stand-alone intervention and when combined with pulmonary rehabilitation, this study concluded that inspiratory muscle training may improve respiratory muscle strength and endurance in COPD patients but its effectiveness remains unclear when combined with pulmonary rehabilitation.

On the other hand, **do Nascimento Junior et al., (2014) and Odor et al., (2020)** failed to demonstrate a significant improvement in patient outcomes following the use of IS in the perioperative setting. Another study concluded that the IS did not improve overall lung function recovery or reduce postoperative pulmonary complications

in patients following thoracotomy and lung resection **(Agostini et al., 2013).**

This disparity highlights the complexity of the relationship between IS and patient outcomes and underscores the need for further research to elucidate the mechanisms by which IS may exert its effects.

The current investigation revealed a statistically significant difference in respiratory patterns between both groups. The control group exhibited a higher frequency of paradoxical breathing patterns, accessory muscle use, and nasal flaring compared to those who received IS. Furthermore, ROC curve analysis demonstrated that IS was significantly more accurate in identifying patients with respiratory distress based on the RDOS score ($p < 0.0001$). Notably, these findings are consistent with **Alwekhyan et al. (2021),** who found that IS guided by nurses led to favorable outcomes in patients assessed by RDOS score. Previous research by **Gbiri et al., (2016)** has established a correlation between the rate of postoperative respiratory complications and the implementation of patient monitoring and supervision strategies to ensure compliance with IS use. Their study found that a decreased rate of postoperative respiratory complications was associated with the monitoring and supervision of patients to guarantee adherence to IS protocols. This suggests that the effective management of IS, facilitated by close patient monitoring and supervision, is a crucial factor in reducing the incidence of postoperative respiratory complications. Similarly, a previous study by **Mueenudheen et al., (2022)** investigated the effects of IS on pulmonary function and gas exchange in patients undergoing straightforward coronary artery bypass graft surgery. The results demonstrated that IS use during the initial three postoperative days significantly improved pulmonary function, as measured by various respiratory indices, and also resulted in favorable changes in partial pressure of oxygen and partial pressure of carbon dioxide.

Conclusion

According to this research, patients with chest tube drainage had significant improvements in their respiratory parameters by using IS. patients had significantly lower respiratory rates, heart rates, and RDOS scores compared to those who did not receive the IS therapy.

Recommendations

The findings of the study recommend using IS as an adjunct to the routine care for patients with chest tube drainage. further research is warranted to investigate the efficacy of IS in various patient populations and to elucidate its long-term effects on respiratory outcomes, thereby providing a comprehensive understanding of its therapeutic potential and potential limitations. Additionally, future studies should examine the optimal duration and frequency of IS therapy to achieve maximum benefits.

References

Agostini, P., Naidu, B., Cieslik, H., Steyn, R., Rajesh, P. B., Bishay, E., Kalkat, M. S., & Singh, S. (2013). Effectiveness of incentive spirometry in patients following thoracotomy and lung resection including those at high risk for developing pulmonary complications. *Thorax*, *68*(6), 580–585. https://doi.org/10.1136/thoraxjnl-2012-202785

Alwekhyan, S. A., Alshraideh, J. A., Yousef, K. M., & Hayajneh, F. (2022). Nurse-guided incentive spirometry use and postoperative pulmonary complications among cardiac surgery patients: A randomized controlled trial. *International Journal of Nursing Practice*, *28*(2). https://doi.org/10.1111/ijn.13023

Ammous, O., Feki, W., Lotfi, T., Khamis, A. M., Gosselink, R., Rebai, A., & Kammoun, S. (2023). Inspiratory muscle training, with or without concomitant pulmonary rehabilitation, for chronic obstructive pulmonary disease (COPD). *The Cochrane Library*, *2023*(1). https://doi.org/10.1002/14651858.cd013778.pub2

Awolola, E. O., & Maharaj, S. S. (2023). Inspiratory versus expiratory incentive spirometry: A randomised control trial study protocol. *The South African Journal of Physiotherapy*, *79*(1). https://doi.org/10.4102/sajp.v79i1.1841

Campbell, M. L., & Templin, T. N. (2015). Intensity cut-points for the Respiratory Distress Observation Scale. *Palliative Medicine*, *29*(5), 436–442. https://doi.org/10.1177/0269216314564238

Chang, P.-C., Chen, K.-H., Jhou, H.-J., Lee, C.-H., Chou, S.-H., Chen, P.-H., & Chang, T.-W. (2022). Promising effects of digital chest tube drainage system for pulmonary resection: A systematic review and network meta-analysis. *Journal of Personalized Medicine*, *12*(4), 512. https://doi.org/10.3390/jpm12040512

Chaudhary, S., Chaudhary, N. I., Ghewade, B., & Mahajan, G. (2020). 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*, *12*(17), 51–58. https://doi.org/10.31782/ijcrr.2020.121710

do Nascimento Junior, P., Módolo, N. S. P., Andrade, S., Guimarães, M. M. F., Braz, L. G., & El Dib, R. (2014a). Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. *The Cochrane Library*, *2014*(2). https://doi.org/10.1002/14651858.cd006058.pub3

Dote, H., Homma, Y., Sakuraya, M., Funakoshi, H., Tanaka, S., & Atsumi, T. (2020). Incentive spirometry to prevent pulmonary complications after chest trauma: a retrospective observational study. *Acute Medicine & Surgery*, *7*(1). https://doi.org/10.1002/ams2.619

Gbiri, C., Ajepe, T., & Akinbo, S. (2016). Efficacy of chest-physiotherapy and incentive-spirometry in improving cardiovascular and pulmonary functional performances in individuals post-thoraco-abdominal surgery: A randomised comtrolled study. *International Journal of Therapies and Rehabilitation Research*, *5*(2), 1.

https://doi.org/10.5455/ijtrr.000000118

Heydari, A., Farzad, M., & Ahmadi hosseini, S.-H. (2015). Comparing inspiratory resistive muscle training with incentive spirometry on rehabilitation of COPD patients. *Rehabilitation Nursing: The Official Journal of the Association of Rehabilitation Nurses*, *40*(4), 243–248. https://doi.org/10.1002/rnj.136

Kamau, M. (2020). Immediate effects and outcomes of respiratory physical therapy on critically ill patients in Kenyatta National Hospital intensive care unit. *Master's thesis, University of Nairobi.* Available from: http://erepository.uonbi.ac.ke/handle/11295/153866 [15.4.2024]

Lokhande, U. R., Sharath, H. V., & Thakre, V. M. (2023). Effect of chest physiotherapy technique on bilateral bronchial pneumonia secondary to acute respiratory distress syndrome: A case report. *Cureus*. https://doi.org/10.7759/cureus.50437

Messika, J., Martin, Y., Maquigneau, N., Puechberty, C., Henry-Lagarrigue, M., Stoclin, A., Panneckouke, N., Villard, S., Dechanet, A., Lafourcade, A., Dreyfuss, D., Hajage, D., & Ricard, J.-D. (2019). A musical intervention for respiratory comfort during noninvasive ventilation in the ICU. *The European Respiratory Journal: Official Journal of the European Society for Clinical Respiratory Physiology*, *53*(1), 1801873. https://doi.org/10.1183/13993003.01873-2018

Mueenudheen, T. P., Moiz, J. A., & Gupta, V. P. (2012). A comparative study on the effects of incentive spirometry and deep breathing exercise on pulmonary functions after uncomplicated coronary artery bypass grafting surgery. *Indian Journal of Physiotherapy and Occupational Therapy*, *6*(2), 63–67. https://www.i-scholar.in/index.php/ijpot/article/view/47187

Muthukumaran, D., Danasu, & Kosalai. (2020). An Experimental Study to assess the effectiveness of Incentive Spirometry exercise on Pulmonary parameters of patients with Lower Respiratory Tract disorders in SVMCH and RC, Puducherry. *Asian Journal of Nursing Education and Research*, *10*(1), 5. https://doi.org/10.5958/2349-2996.2020.00002.6

Odor, P. M., Bampoe, S., Gilhooly, D., Creagh-Brown, B., & Moonesinghe, S. R. (2020). Perioperative interventions for prevention of postoperative pulmonary complications: systematic review and meta-analysis. *BMJ (Clinical Research Ed.)*, m540. https://doi.org/10.1136/bmj.m540

Pieczkoski, S. M., de Oliveira, A. L., Haeffner, M. P., Azambuja, A. de C. M., & Sbruzzi, G. (2021). Positive expiratory pressure in postoperative cardiac patients in intensive care: A randomized controlled trial. *Clinical Rehabilitation*, *35*(5), 681–691. https://doi.org/10.1177/0269215520972701

Reychler, G., Delacroix, S., Dresse, D., Pieters, T., & Liistro, G. (2016). Randomized controlled trial of the effect of inspiratory muscle training and incentive spirometry on respiratory muscle strength, chest wall expansion, and lung function in elderly adults. *Journal of the American Geriatrics Society*, *64*(5), 1128–1130. https://doi.org/10.1111/jgs.14097

Serdar, C. C., Cihan, M., Yücel, D., & Serdar, M. A. (2021). Sample size, power and effect size revisited: simplified and

practical approaches in pre-clinical, clinical and laboratory studies. *Biochemia Medica*, *31*(1), 27–53. https://doi.org/10.11613/bm.2021.010502

Sharma, K., & Kaur A. (2020). Effectiveness of Incentive Spirometry on Respiratory Parameters among Patients with Chest Tube drainage. *International Journal of Nursing.* Available from: https://medicopublication.com/index.php/ijonc/article/view/8602/8032 [15.4.2024]

Sweity, E. M., Alkaissi, A. A., Othman, W., & Salahat, A. (2021). 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*, *16*(1). https://doi.org/10.1186/s13019-021-01628-2

Toor, H., Kashyap, S., Yau, A., Simoni, M., Farr, S., Savla, P., Kounang, R., & Miulli, D. E. (2021). Efficacy of incentive spirometer in increasing maximum inspiratory volume in an out-patient setting. *Cureus*. https://doi.org/10.7759/cureus.18483

Vardhan, V., & Nikhade, D. N. (2024). Efficacy of POWERbreathe Medic Plus device on maximal inspiratory pressure, functional capacity and quality of life in coronary artery bypass graft patients: A randomized controlled trial protocol. *F1000Research*, *13*, 472. https://doi.org/10.12688/f1000research.144783.1

Wilson, H. K., Teeter, E. G., Kolarczyk, L. M., Haithcock, B., & Long, J. (2019). Troubleshooting chest drains. In *Principles and Practice of Anesthesia for Thoracic Surgery* (pp. 969–979). Springer International Publishing.

Yazdani, M., Malekzadeh, J., Sedaghat, A., Mazlom, S. R., & Pasandideh khajebeyk, A. (2021). The effects of manual lung hyperinflation on pulmonary function after weaning from mechanical ventilation among patients with abdominal surgeries: Randomized clinical trial. *Journal of Caring Sciences*, *10*(4), 216–222. https://doi.org/10.34172/jcs.2021.034

Zhuang, Q., Yang, G. M., Neo, S. H.-S., & Cheung, Y. B. (2019). Validity, reliability, and diagnostic accuracy of the respiratory distress observation scale for assessment of dyspnea in adult palliative care patients. *Journal of Pain and Symptom Management*, *57*(2), 304–310. https://doi.org/10.1016/j.jpainsymman.2018.10.506