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Conventional versus High Frequency Chest Wall Oscillation Care in Critical Unit: A Comparative Study of Respiratory Outcomes

ABSTRACT

Background: critical care nurses have an important role in applying High-Frequency Chest Wall Oscillation (HFCWO) devices which offers a great practical advantage in improvement of airway clearance in patient with various respiratory conditions. **Objectives of study:** to evaluate the effect of using high frequency chest wall oscillation device on respiratory outcomes among critically ill patients. **Method:** This study was carried out at the respiratory intensive care units at Assiut University Hospital, Egypt by using Quazi experimental research design. A Purposive sample of 60 adult critically ill patients from August 2024 to March 2025. Patients were randomly assigned into intervention group and control group. **Tools**: Three tools were utilized in this study**; I**: Patient assessment tool. **II:** Respiratory system assessment. **III**: Patients′ Outcomes. **Results**: regarding arterial blood gases; study results revealed that intervention group showed an improvement than control group in mean PaO2 from 72.53 ±21.03 pre intervention to 85.90 ± 14.92 at 7th day and mean SaO2 from 90.13 ±6.66 pre intervention to 93.23 ±5.67 at 7th day with statistically significant differences (P = 0.033, 0.022) respectively. Also, intervention group had lower length of ICU stay than control group with statistically significant difference (P = 0.032). **Conclusion:** HFCWO device was an effective way to enhance patients' respiratory status and decrease length of ICU stay than manual chest physiotherapy. **Recommendations:** study results encourage using HFCWO device in all ICUs at Assiut university hospitals.

Keywords: manual chest physiotherapy; critically ill patients; High frequency chest wall oscillation.

INTRODUCTION

The critical care nurse has very important role in monitoring patients who using HFCWO device; the nurse should assess and monitor hemodynamic status of patient and respiratory status in terms of respiratory rate, rhythm, presence of normal or abnormal breathing sounds, presence and degree of dyspnoea, use of accessory muscles, presence and characteristics of secretions (amount, colour and viscosity) and oxygen saturation (SpO_2) during chest physiotherapy session, evaluates extent of improvement of patient status and assesses patient for occurrence of complications if present.

Patients in respiratory intensive care unit (ICU) often have increased risk for respiratory infection, sputum retention and more of them may intubated and mechanically ventilated. This may be due to pathophysiology of many respiratory diseases which may result in excess sputum production. The early clearance of mucus and secretions from the airways is important in the treatment of pulmonary diseases **(Michael et al., 2019)**.

Cough, sputum, and shortness of breath are cardinal features of chronic obstructive pulmonary disease (COPD). Mucus hyper secretion is a significant clinical challenge in these patients, often contributing to poor disease control and frequent exacerbations despite maximal pharmacological therapy **(Mari et al., 2025)**.

Airway clearance management has been a cornerstone of therapy to facilitate mucociliary clearance (MCC) and promote mobilization and removal of pulmonary secretions which is a critical component of both maintenance of respiratory health and management of acute respiratory illnesses. The process of effective airway clearance begins with the recognition of secretions in the airway and culminates in expectoration or swallowing **(Gipsman et al., 2023).**

Chest physiotherapy has several secretion management techniques like manual chest wall physiotherapy (CWPT) and Positive Expiratory Pressure (PEP) systems, modified postural drainage, position, percussion, positive expiratory pressure devices, breathing technique or intrapulmonary

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percussive ventilation. Alongside use of mechanical devices, including High-Frequency Chest Wall Oscillation (HFCWO), High-Frequency Chest Wall Compression (HFCWC) or High-Frequency Chest Compression (HFCC) systems, has gained prominence. These devices deliver high-frequency vibrations to the chest wall, enhancing secretion mobilization and elimination **(Marin et al., 2024).**

RESEARCH METHODOLOGY

Research Objectives

The primary objective is to evaluate the effect of using high frequency chest wall oscillation device on respiratory outcomes among critically ill patients.

Research Hypothesis

H1:- Patients who are using high frequency chest wall oscillation device for airway clearance will exhibit more improvement in respiratory function and arterial blood gases than who are receiving manual chest physiotherapy.

H2:- Patients who are using high frequency chest wall oscillation device for airway clearance will exhibit less ICU stay rather than who are receiving manual chest physiotherapy.

Study design and subjects

A quasi- experimental research design was used to conduct this study. This study was conducted at the respiratory intensive care units at Assiut University Hospital, Egypt on a purposive sample of 60 adult critically ill patients of both genders who were matching the selected criteria from August 2024 to March 2025.

The sample size was computed by using the results of the study by (**Farag & Mariam, 2018**). By calculating mean Sao2 according to previous studies with power 80% and Alpha 5% the mean differences between two means was 2.3 and with standard deviation 3.8 in Control group, 2.2 in Study group. It was calculated that the minimum sample size required is 30 for each group. Patients were randomly assigned into intervention group and control group.

Randomization Procedure:

The randomization process involved creating blocks of 60 slips of paper, 3/ for the study group and 3/ for the usual care group. Each slip of paper had a number (between 1 and 3/) written on it. After folding these slips were placed into an opaque envelope. One of the folded slips from the opaque envelope was drawn to identify the patient's assigned group, and then, the researchers carried out the remaining protocol steps. Patients were also selected with some inclusion and exclusion criteria as the following;

Inclusion criteria: All oriented non mechanically ventilated critically ill patients who are newly admitted with age (18 - 65 years) and were diagnosed with acute exacerbation of chronic obstructive pulmonary disease (COPD) and were suffering from dyspnea, accumulation of secretions or difficult airway clearance/ expectoration **(Saad et al., 2023)**.

Exclusion criteria: - patients with brain death, pulmonary edema, pulmonary embolism, terminal stage of cancer, active hemorrhage with hemodynamic instability, subcutaneous emphysema, burns, open wounds, and skin infections of the thorax.

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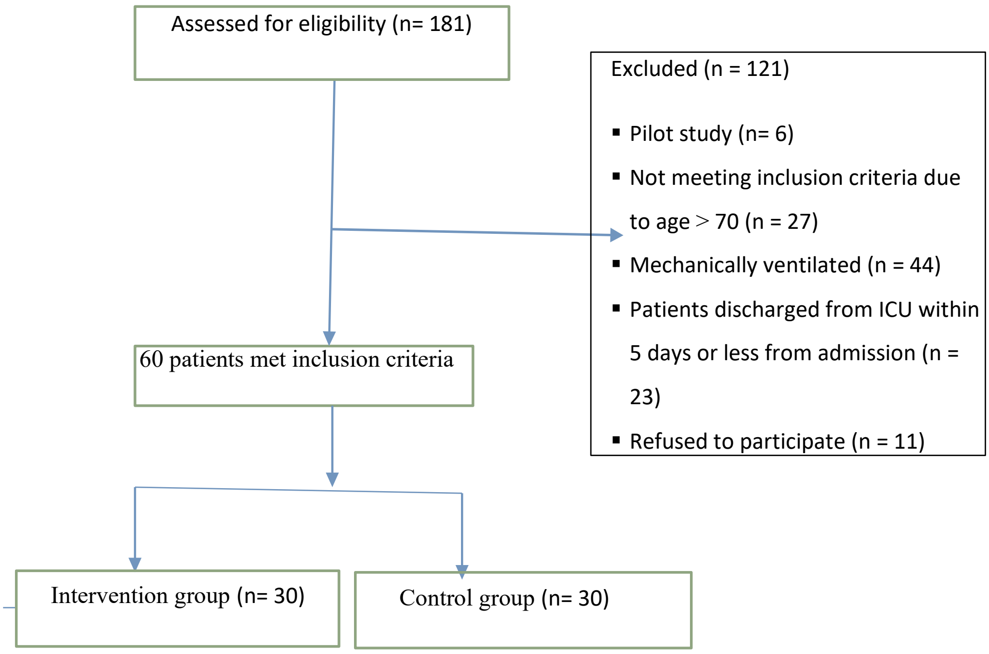

Figure (1) Flowchart of patient's selection criteria.

Study tools:

Three tools were used by the researcher after reviewing of related literatures **(Lin et al., 2017)**. **Tool I: - Patient assessment sheet (Ge et al., 2023)**; it was developed by the researcher to gather patient characteristics and clinical data. It consisted of two parts: **Part I: Patient characteristics and clinical data** included age, gender, smoking history; the Smoking Index (SI) formula is calculated as the number of cigarettes smoked per day (CPD) multiplied by the number of years of smoking **(PHILIPPE et al., 2025)** in addition to clinical data as clinical presentation**. Part II**: **laboratory investigations** which included data related to the results of arterial blood gases (ABG); pH, PaO_2, $PaCO_2$, $-HCO_3$ and SpO_2). **Tool II: Respiratory system assessment (Huang et al., 2022)**; it was used by the researcher and included three parts. **Part I: Respiratory system assessment sheet** which developed by researcher and included respiratory rate, oxygen saturation by pulse oximetry (SpO_2), fraction of inspired oxygen (FiO_2), presence and amount of secretions if present which measured as 0(no secretion),1(< 6 ml), 2(6-10 ml) and 3(>10 ml) **(Karinja et al., 2015). Part II: The 5-point Likert scale for dyspnea (5PLS);** it was adopted from **(Weber et al., 2014)** which is a self-administered psychometric instrument for measuring and grading the experience of breathing discomfort. The scale includes the absence of dyspnea (a score of 1), mild shortness of breath (a score of 2), moderate shortness of breath (a score of 3), severe shortness of breath (a score of 4) and the worst possible shortness of breath (a score of 5). **Part III: Cough symptom score (CSS).** This score was designed by **(Hsu et al., 1994)** and used by **(Jakusova & Brozmanova, 2023)**. The CSS was a two-part questionnaire referring to daytime and night-time symptoms. Based on the frequency, intensity and influence of cough on daily activities and sleep, results were scored from 0 to 5, with 0 indicating no cough, 1 Cough for one short period, 2 Cough for more than two short periods, 3 Frequent coughing, which did not interfere with usual daytime activities, 4 Frequent coughing, which did interfere with usual daytime activities and 5 indicating Distressing coughs most of the day. **Tool III: Patients' Outcomes tool** which included expected patient's outcomes in terms of length of ICU stay.

Method:

The study followed three phases: preparatory, implementation, and evaluation.

1) **The preparatory phase,** official permissions were obtained from hospital authorities in chest disease intensive care unit and the faculty of nursing.

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- Content validity of tool I and tool II part one was evaluated for clarity and appropriateness by a panel of five experts of critical care and emergency. The Content Validity Index (CVI) was found to be 0.92.
- Reliability of the developed tools was calculated by using correlation coefficient and estimated by Alpha Cronbach's test. Reliability test for; tool I; r = 0.735 and tool II part one; r =0.761.
- The pilot study was conducted with 6 patients (10%) before implementation to evaluate the objectivity and clarity of tools, required no modifications and was excluded to prevent any potential bias.
- Ethical Consideration
  This study received ethical approval from the Faculty of Nursing Research Ethics Committee, Assiut University, Egypt with reference number 1120240830 on June, 2024.

2) Implementation phase:

Data collection:-

- The studied sample was fulfilling the research criteria and randomly assigned into two groups (study group and control group).
- **The control group** received the manual chest physiotherapy (vibration or percussion) for 7 days each shift.
- **Study group** received care with (HFCWO) device (Seoil Pacific Corp company): the session was adjusted on percussor mode, inhale pressure (40 cmH2o), frequency (450 CPM), I:E ratio (1:2), time set (20 minutes), two times daily for 7 days **(Duan et al., 2019)** then evaluated for extent of respiratory improvement and assessed until discharge.
- (HFCWO) is one of the innovations in airway clearance management which is made up of two pieces, an air-pulse generator and an inflatable vest that is connected to the generator by hoses. The generator sends air through the hoses, which causes the vest to inflate and deflate rapidly, as much as 20 times per second, with a slight pressure on the chest. This rapid inflation and deflation creates pressure on the chest similar to clapping. The vibrations separate mucus from the airway walls and move it up into the large airways. Typically, a patient uses the vest for five minutes and then coughs to clear the mucus. Sessions last about 20 to 30 minutes. These air pulses oscillate the chest and their vibrations causing the transient flow to increase in the respiratory tract, loosened mucus and stimulating the cough reflex **(Quissesa et al., 2021).**
- Assessment of patient files pre intervention for the following data as age, gender, clinical presentation and smoking history; smokers are classified as: Mild smoker: $SI \leq 200$, Moderate smoker: $200 < SI < 400$, Heavy smoker: $SI \geq 400$.
- During implementation period; the researcher evaluaed and recorded results of arterial blood gases (ABG); pH, PaO_2, $PaCO_2$, $-HCO_3$ and SpO_2), respiratory rate, oxygen saturation by pulse oximetry (SpO_2), fraction of inspired oxygen (fiO_2), presence and amount of secretions if present**.** Also presence or absence of dyspnea by using the 5-point Likert scale for dyspnea **(5PLS)**, daytime and night-time cough symptoms by using Cough symptom score **(CSS)** pre intervention, 4^{th} and 7^{th} day.

3) Evaluation phase:

- Each patient in present study was evaluated for all assessed data for improvement of overall respiratory outcomes pre intervention, 4^{th} and 7^{th} day.
- The researcher evaluated length of ICU stay.

Statistical analysis:

Data were computerized and analyzed by computer programmed SPSS (ver.25). Quantitative data were compared using independent samples t-test for comparing two groups. Qualitative variables were compared using Chi-square test to determine Significance. The critical value of the tests "P" was considered statistically significant when p .value < 0.05. Pearson correlation analysis was used to calculate correlation coefficients.

STUDY RESULTS:

Table (1): Distribution of patient characteristics and demographic data of studied sample:

Item	Intervention	Control group	p-value	Test

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		group (n=3٠)	**(n=3٠)**		
Age groups	**18 - < 30 yrs.**	2(6.7%)	2(6.7%)	0.437	Chi square test χ^2 (2.721[a])
	30 - < 40 yrs.	2(6.7%)	6(20 %)		
	40 - < 50 yrs.	8(26.7 %)	5(16.7%)		
	50 - ≤ 65 yrs.	18 (60%)	17(56.7 %)		
Smoking status	**Non-smokers**	12 (40%)	18 (60%)	0.031*	Fisher's exact test
	Mild	6(20 %)	0(0 %)		
	Moderate	4(13.3 %)	7(2٣.3 %)		
	Heavy	8(26.7 %)	٥(16.7%)		
Gender	**Male**	18 (60%)	21(70%)	0.589	Fisher's exact test
	Female	12 (40%)	9(30%)		
length of ICU stay		8 (IQR 3)	9 (IQR 5)	0.032*	Mann-Whitney U

**Statistically significant difference p ≤ 0.05. Chi-square test, Fisher's exact test & Mann–Whitney U test.*

Table (1) shows distribution of patient characteristics and demographic data; there was a statistically significant difference between the intervention and control groups concerning smoking history as assessed by Fisher's exact test (p = 0.031), with a higher proportion of non-smokers in the control group. The intervention group demonstrated shorter length of ICU stay with a statistically significant difference by using Mann-Whitney U test (p = 0.032) compared with the control group.

Table (2): Comparison of clinical presentation between intervention and control group:

Clinical presentation	**Intervention group (n=3٠)**	**Control group (n=3٠)**	**P-value**
Cough	30(100%)	29 (96.7%)	0.313
Fever	4(13.3 %)	5(16.7 %)	0.718
Wheezing	17(56.7%)	10 (33.3%)	0.069
Chest pain	3(10 %)	1(3.3 %)	0.301

**Statistically significant difference p ≤ 0.05. Fisher's exact test.*

Table (2) compares the clinical presentation of patients in the intervention and control groups. There were no statistically significant differences between the two groups in the prevalence of cough, fever, wheezing, or chest pain (p > 0.05 for all).

Table (3): Comparison between the two groups in relation to results of arterial blood gases (ABGs):

Arterial blood gases (ABGs)		**Intervention group (n=3٠)**	**Control group (n=3٠)**	**P-value**
pH	**Pre intervention**	7.34 ± 0.10	7.38 ± 0.11	0.868
	4th day	7.38 ± 0.07	7.42 ± 0.07	
	7th day	7.39 ± 0.06	37.42 ± 0.04	
PaO_2 (mmHg)	**Pre intervention**	72.53 ± 21.03	72.53 ± 12.96	0.033
	4th day	83.23 ± 16.40	73.57 ± 15.33	

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	7th day	85.90 ± 14.92	72.77 ± 11.04	
$PaCO_2$ (mmHg)	**Pre intervention**	60.13 ± 19.05	57.40 ± 23.68	0.658
	4th day	58.32 ± 16.48	53.29 ± 17.71	
	7th day	60.67 ± 18.41	53.64 ± 10.81	
- HCO_3 (mEqu/L)	**Pre intervention**	33.63 ± 8.80	33.05 ± 10.27	0.611
	4th day	35.98 ± 14.51	33.97 ± 8.64	
	7th day	36.38 ± 8.63	33.52 ± 6.89	
SaO_2 (%)	**Pre intervention**	90.13 ± 6.66	91.57 ± 3.13	0.022*
	4th day	94.30 ± 3.54	92.30 ± 3.87	
	7th day	93.23 ± 5.67	95.70 ± 2.67	

**Statistically significant difference $p \leq 0.05$.* Repeated measures of ANOVA.

Table (3) summarizes values of arterial blood gases for the intervention and control groups on days of assessment. Intervention group had an improvement in PaO_2 and SaO_2 with statistically significant differences (P = 0.033, 0.022) respectively.

Table (4): Comparison among the both groups as regarding to respiratory assessment data:

Group		**Intervention group(n=3٠)**	**Control group (n=3٠)**	**P-value**
Pre intervention	Respiratory rate (breaths/min)	25 (IQR 3.3)	26.50 (IQR 6)	0.152
	SpO_2 (%)	90.50 (IQR 4)	91 (IQR 5.50)	0.727
	FiO_2 (%)	40 (IQR 15)	40 (IQR 10)	0.041
4th day	Respiratory rate (breaths/min)	21 (IQR 2.5)	21 (IQR 4.25)	0.715
	SpO_2 (%)	94 (IQR 3.25)	93 (IQR 4.25)	0.352
	FiO_2 (%)	31 (IQR 9)	35 (IQR 9)	0.529
7th day	Respiratory rate (breaths/min)	23 (IQR 4.25)	24 (IQR 5.50)	0.004*
	SpO_2 (%)	93 (IQR 1.25)	92 (IQR 4.25)	0.055
	FiO_2 (%)	28 (IQR 7)	28 (IQR 4)	0.969

**Statistically significant difference $p \leq 0.05$.* Mann–Whitney U test.

Table (4) illustrates a comparison between the intervention and control groups in terms of respiratory assessment data. The intervention group showed a lower respiratory rate with a statistically significant difference (p = 0.004) compared to the control group at 7th day.

Table (5): Comparison between the two groups in relation to amount of secretions across days of assessment:

Characteristics of secretions	**Intervention group(n=3٠)**	**Control group (n=3٠)**	**P-value**

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Pre intervention	< 6 ml	7(23.3%)	11(36.7%)	0.104
	6– 10 ml	19(63.30%)	19(63.30%)	
	>10 ml	4(13.3%)	0(0.0%)	
At 4th day	No secretion	1(3.3%)	4(13.3%)	0.042*
	< 6 ml	18(60.0%)	12(40.00%)	
	6– 10 ml	6(20.0%)	13(43.3%)	
	>10 ml	5(16.7%)	1(3.3%)	
At 7th day	No secretion	18(60%)	11(36.67%)	0.017*
	< 6 ml	5(16.7%)	15(50%)	
	6– 10 ml	7(23.3%)	3(10%)	
	>10 ml	0(0.0%)	1(3.33%)	

**Statistically significant difference $p \leq 0.05$.* Fisher's exact test.

Table (5) shows a comparison between the intervention and control groups regarding the amount of secretions. There were statistically significant differences in amount of secretions at 4th and 7th day (p = 0.042, 0.017) respectively. More than half of the patients in the intervention group (60%) had no secretions compared to (36.67%) in the control group at 7th day.

Table (6): Comparison between the two groups in relation to the 5-point Likert scale for dyspnea:

The 5-point Likert scale for dyspnea		**Intervention group(n=3٠)**	**Control group (n=3٠)**	**P-value**
Pre intervention	Moderate shortness of breath	11(36.7%)	6(20%)	0.217
	Severe shortness of breath	16(53.3%)	23(76.7%)	
	The worst possible shortness of breath	3(10.0%)	1(3.3%)	
At 4th day	Absence of dyspnea	4(13.3%)	0(0.0%)	0.018*
	Mild shortness of breath	21(70.0%)	17(56.7%)	
	Moderate shortness of breath	5(16.7%)	13(43.33%)	
At 7th day	Absence of dyspnea	24(80.0%)	15(50.0%)	0.011*
	Mild shortness of breath	1(3.3%)	10(33.33%)	
	Moderate shortness of breath	2(6.7%)	3(10.0%)	
	Severe shortness of breath	2(6.7%)	2(6.7%)	
	The worst possible shortness of breath	1(3.3%)	0(0.0%)	

**Statistically significant difference $p \leq 0.05$.* Fisher's exact test.

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Table (6) shows a comparison between the intervention and control groups regarding the 5-point Likert scale for dyspnea; there were statistically significant differences between the intervention group and control group regarding the severity of dyspnea in the 4th and 7th day (p = 0.018, 0.011).

Table (7): Comparison between the two groups in relation to Cough symptom score in the days of assessment (day time):

Cough symptom score (day time)		**Intervention group(n=3٠)**	**Control group (n=3٠)**	**P-value**
Pre intervention	Cough for more than 2 short periods	1(3.3%)	0(0.0%)	1.000
	Frequent coughing, did not interfere with usual daytime activities	19(63.30%)	20(66.70%)	
	Frequent coughing, did interfere with usual daytime activities	7(23.3%)	6(20.0%)	
	Distressing coughs most of the day	3(10.0%)	4(13.3%)	
At 4th day	No cough during the day	1(3.3%)	0(0.0%)	0.012*
	Cough for one short period	7(23.3%)	0(0.0%)	
	Cough for more than two short periods	17(56.7%)	21(70.0%)	
	Frequent coughing, which did not interfere with usual daytime activities	5(16.7%)	9 (30.0%)	
At 7th day	No cough during the day	15(50.0%)	9(30.0%)	0.006*
	Cough for one short period	14(46.7%)	12(40.00%)	
	Cough for more than two short periods	0(0.0%)	8(26.7%)	
	Frequent coughing, which did not interfere with usual daytime activities	0(0.0%)	1(3.3%)	
	Distressing coughs most of the day	1(3.3%)	0(0.0%)	

**Statistically significant difference $p \leq 0.05$.* Fisher's exact test.

Table (7) shows comparison between the two groups in relation to cough symptom score (daytime): These findings demonstrated that patients in the intervention group experienced a significantly greater improvement in daytime cough symptoms compared to the control group at 4th and 7th day (p = 0.012, 0.006) respectively.

Table (8): Comparison between the two groups in relation to Cough symptom score in the days of assessment (night time):

Cough symptom score (night time)	**Intervention group(n=3٠)**	**Control group (n=3٠)**	**P-value**

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Pre intervention	Wake once or early due to cough	1(3.3%)	0(0.0%)	0.213
	Frequent waking due to coughs	22(73.3%)	17(56.7%)	
	Frequent coughs most of the night	4(13.3%)	10(33.33%)	
	Distressing coughs preventing any sleep	3(10.0%)	3(10.0%)	
At 4th day	No cough during the night	1(3.3%)	0(0.0%)	0.091
	Cough on waking only	6(20.0%)	3(10.0%)	
	Wake once or early due to cough	19(63.3%)	17(56.7%)	
	Frequent waking due to coughs	3(10.0%)	10(33.3%)	
	Frequent coughs most of the night	1(3.3%)	0(0.0%)	
At 7th day	No cough during the night	13(43.33%)	7(23.3%)	0.107
	Cough on waking only	11(36.7%)	14(46.7%)	
	Wake once or early due to cough	5(16.7%)	5(16.7%)	
	Frequent waking due to coughs	0(0.0%)	4(13.3%)	
	Distressing coughs preventing any sleep	1(3.3%)	0(0.0%)	

**Statistically significant difference $p \leq 0.05$.* Fisher's exact test.

Table (8) shows comparison between the two groups in relation to cough symptom score (at night time): intervention group showed an improvement in cough symptom (at night time) but with no statistically significant difference ($p > 0.05$).

Figure (1): Comparison of patient's outcomes between the intervention and control groups:

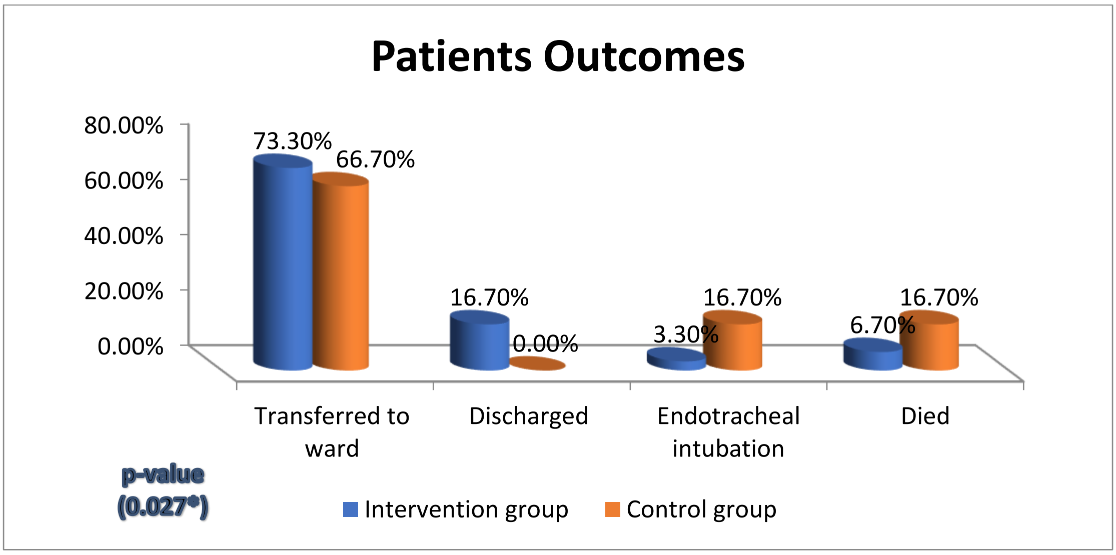

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Figure (1) shows comparison between the both groups in relation to patients outcomes; there was a statistically significant difference between the two groups (p = 0.027). It was observed that most of the studied patients in both groups transferred to chest unit (73.3% vs. 66.7%).

DISCUSSION

HFCWO therapy has exhibited safety, tolerability and enhanced compliance among patients with excessive secretions and has emerged as a valuable additional therapy to improve lung function **(Marin et al., 2024)**. So, this study aims to evaluate the effect of using HFCWO device versus manual chest physiotherapy on critical ill patients outcomes, suggested that if there was a significant change in patients' outcomes after implementation of either HFCWO or manual chest physiotherapy.

In light of the patient's demographic data, there were no statistically significant differences between the intervention and control groups regarding age groups or gender (p > 0.05) and the highest percentage of patients whose age ranged from 50 ≤ 65 years and more than one half of patients of both group (60% vs. 70%) were males. These findings were supported by **(Samir et al., 2024)** who showed that "About one half (48.9%) of study group and two thirds (62.2%) of control group were in the age group of 51- 60 years and more than half (55.6%) of control group and about two thirds (62.2%) of study group were males".

In my opinion; COPD more commonly occurs in male gender and smoker patients which mainly complicated with increased age.

Regarding to smoking history; higher proportion of non-smokers in the control group compared to the intervention group (60% vs. 40%). A significant difference was observed between both groups concerning smoking status (p = 0.031). These findings were not consistent with **(Farag & Mariam, 2018)** who mentioned that "in the current study, the three studied groups are age matched with male predominance with no significant differences between them regarding smoking pack/years (*P* = 0.32)".

According to this study; intervention group had an improvement in PaO_2 and SaO_2 with statistically significant differences (P = 0.033, 0.022) respectively. These findings were in line with **(Cheng et al., 2022)** who showed that "after treatment, significantly increased PaO2 and significantly decreased PaCO2 were observed for both groups. Moreover, after treatment, group A had significantly higher PaO2 and lower PaCO2 than group B. The differences were statistically significant (P < 0:05)". Also **(Farag & Mariam, 2018)** mentioned that post treatment assessment for both HFCWO and Flutter groups demonstrated that oxygenations parameters (PaO2, SaO2 %) were significantly improved (p < 0.05).

But these findings were not in line with **(Longhini et al., 2020)** who showed that "no differences of ABGs were recorded among studied groups".

In this study; the intervention group showed a lower respiratory rate with a statistically significant difference (p = 0.004) compared to the control group at 7th day. This may indicate an improvement in breathing status in the intervention group. These findings in line with **(Reda et al., 2024)** who showed that "Furthermore, a significant difference in RR was observed in this trial between an intervention group (who received both a cough assist device and standard chest physiotherapy) and the control group (*P* = 0.004)".

This study results documented that there were statistically significant differences in amount of secretions at 4th and 7th day (p = 0.042, 0.017) respectively. More than half of the patients in the intervention group (60%) had no secretions compared to (36.67%) in the control group at 7th day. These findings were in line with **(Quissesa et al., 2021)** who showed that "initiation of HFCWO treatment was associated with a positive experience of airway clearance".

Also; these findings supported by **(Samir et al., 2024)** who showed that "As regard to expectorated sputum volume, mean expectorated sputum volume increased in study group compared to control group with statistical significant difference, which described by patient's inability to expectorate sputum efficiently". But these findings were not consistent with **(Lin et al., 2017)** who stated that "the sputum volume did not differ significantly between the two groups (p=0.085)".

Regarding severity of dyspnoea, these results revealed that dyspnoea severity improved in intervention group than control group with statistically significant differences (p = 0.018, 0.011) at the 4th and 7th day. These findings were agreed with **(Farag & Mariam, 2018)** who stated that the level of perceived dyspnea decreased significantly in the intervention group.

Additionally **(Samir et al., 2024)** reported that "Regarding severity of dyspnea, our results revealed that; dyspnea severity improved in study group than control group at post intervention and follow-up test but without any significant statistical difference between studied groups (p = 0.1, 0.2, 0.3)

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Respectively. But these results were in conflict with the findings of **(Huang et al., 2022)** who found that there was a non-significant improvement in severity of dyspnoea in COPD patients following the HFCWO.

These study findings demonstrated that patients in the intervention group experienced a significantly greater improvement in daytime cough symptoms compared to the control group at 4th and 7th day with statistically significant difference ($p = 0.012, 0.006$) respectively. However there was no statistically significant difference in night time cough symptoms among both groups. These findings were supported by **(Farag & Mariam, 2018)** who stated that the HFCWO group and Flutter group had significantly improvement of dyspnea score, less cough and mucus production than before. These findings point out that cough, expectoration and dyspnea were the most common troubling symptoms among patients with AECOPD and adjunctive treatment with either HFCWO or Flutter devices help expectoration and airway clearance. From the researcher point of view about no significant improvement in night time cough symptoms among may be due to compromised respiration, pulmonary congestion and immobility at night.

Finally; this study showed that the intervention group demonstrated shorter length of ICU stay with a statistically significant difference ($p = 0.032$) compared with the control group. These findings were consistent with **(Cheng et al., 2022)** who showed that "the length of stay of patients in group A was significantly shorter than those of group B (P < 0:05)". But these findings were not consistent with **(Lee et al., 2011)** who stated that there was no difference in the length of hospital and ICU stay between two the therapy groups

LIMITATIONS:

The major limitation of this study was the sample size. It was limited with special inclusion criteria as oriented patients and not intubated or mechanically ventilated.

CONCLUSION: Based on study results, HFCWO device was an effective way to enhance patient outcomes than manual chest physiotherapy as regarding to respiratory function measures as respiratory rate, SaO_2, PaO_2, decreased amount of secretions and length of ICU stay.

RECOMMENDATIONS: Replicate the study in a large probability sample and several hospitals to generalize the results and ongoing training for critical care nurses about using HFCWO.

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CONFLICT OF INTEREST

The authors declared that they have no competing interests.

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