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Original Article

Effect of Mechanical Chest Vibration during Chest Physiotherapy on Ventilator Parameters and Oxygen Saturation in Mechanically Ventilated Patients

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ABSTRACT

Background: In order to enhance pulmonary perfusion and ventilation, avoid atelectasis, and facilitate the removal of secretions that have accumulated in the lungs, vibration as a chest physical therapy is required. Manual or mechanical vibrations have been demonstrated to alter respiratory perception. **The aim of the Study:** is to evaluate the effect of mechanical chest vibration during chest physiotherapy on ventilator parameters and oxygen saturation in mechanicallyventilated patients. **Design:** an experimental research design was carried out in this study. **Setting:** the general ICU at Damanhour Medical Institute served as the study's site. **Tools:** the data for this study were gathered using the outcome of chest physical therapy assessment tool. **Method:** two equal groups; one for manual vibration and the other for mechanical vibration, were randomly assigned to patients who satisfied the inclusion criteria. **Results:** both groups' means for PaO2, SaO2, and SPO2 significantly improved. Mean values of blood pressure included diastolic and systolic blood pressures were significantly increased in both groups at various intervals. **Conclusion**: there was no discernible difference in the effectiveness of chest physical therapy between the experimental and control groups. As a result, when combined with traditional chest physical therapy, mechanical vibrator chest physical therapy can encourage sputum drainage. **Recommendations:** it is recommended to use mechanical vibration more often than manual vibration.

Key words: chest physiotherapy**,** mechanical chest vibration, mechanically ventilated patients, oxygen saturation, ventilator parameters.

Introduction

Acute lung injury causes acute respiratory failure in the majority of patients admitted to the Intensive Care Unit; therefore, artificial airways are placed and ventilators are managed. Treatment with an artificial respirator and acute lung injury decrease gas exchange, function of the alveoli, as well as the artificial airway itself, inhibits the cough reflex and impedes the movement of airway cilia. Secretions become stagnant as a result. In this instance, chest physical therapy intervention is required to aid in the evacuation of secretions that have accumulated in the lungs, boost ventilation and pulmonary perfusion to avoid atelectasis **(Metersky et al., 2018; Chomton et al., 2018; Kalwaje et al., 2018).**

There are a collection of procedures known as chest physiotherapy (CPT) aim to strengthen respiratory muscles, increase lung expansion, decrease secretion from the respiratory system, and enhance respiratory efficiency **(Battaglini et al.,**

2020; James, 2016). It lessens obstruction of the airways and the associated side effects, like hyperinflation and atelectasis. Furthermore, by eliminating infected secretions, chest physical therapy can slow the rate at which proteolytic tissue damage occurs. It involves the following techniques: gravity-assisted drainage, manual lung hyperinflation, positioning, chest wall percussion, and vibration, suctioning to remove pulmonary secretions and hyper oxygenation to prevent suction-induced hypoxemia **(Yang et al., 2013; Mc Cord, 2013)**.

Patients with respiratory disorders are treated with vibration as part of their chest physiotherapy. The vibration is the application of gentle oscillatory movement and rib compression by the hands during the chest wall's expiratory movement. The primary purpose of vibration therapy is to aid in secretion clearance. Vibration has been incorporated into multimodal treatment regimens for patients with excessive secretions in a number of studies **(Belli et al., 2021; Meawad et al., 2018; Mathews, 2020)**.

Vibration involves beating the chest wall rhythmically over particular lung regions with hands that are properly shaped in order to remove mucus. This technique is based on the idea that applying an external force to the chest wall to loosen the mucus facilitates airway mobilization and clearance **(Meawad et al., 2018).**

Furthermore, vibration activates the muscles of the chest wall's afferent activity. Respiratory sensation changes could result from these modifications in the body's natural urge to breathe. It lessens dyspnea brought on by either an intrinsic or extrinsic respiratory load in addition to hypercapnia **(Mathews, 2020).**

Medical technology intended to support nurses in providing better patient care is known as nursing technology. Using a chest vibrating device to mechanically vibrate the chest is a crucial step in helping mucus to be released from the airways. To release the mucus in various regions of each lung, this procedure is repeated over the chest and back. In addition, it generates a high frequency and small amplitude, making it a suitable substitute for other conventional methods **(Morrison & Innes 2017)**.

Especially in intricate settings like the intensive care unit, nurses are essential in the implementation of chest physical therapy. Nonetheless, it's critical to be aware of the difficulties that come with chest physical therapy, including potential complications and patient comfort. The nurse's job is to weigh the possible advantages of chest physical therapy against any risks or discomfort, always trying to give the patient the best care possible. By doing this, nurses greatly enhance patient outcomes and quality of life, especially for those in the ICU recovering from critical illness or those with chronic lung conditions **(Ranjan, 2023)**.

Aim of the study

To evaluate how mechanical chest vibration during chest physical therapy affects the ventilator parameters and oxygen saturation in mechanically ventilated patients.

Subject and method

Design of the research

An experimental research design was used to conduct this study.

Setting

This study was carried out at general ICU at Damanhour Medical Institute. It consisted of two main halls with seven beds each and receives patients who have multiple body system alterations.

Participants

Based on the power analysis using the Epi-Info program, 90 adult mechanically ventilated patients who had started on invasive mechanical ventilation on the first day were included in the study as a convenience sample. The parameters applied were: total population 100, expected frequency 50%, acceptable error 5%, and confidence coefficient 99%. Patients who satisfied the inclusion requirements were divided into two groups—the intervention group and the control group—equitably and arbitrarily using folded paper. Moreover, 45 patients were assigned to each group.

Inclusion criteria: adult patients (aged ≥ 18 - ≤60 years) and a patient on mechanical ventilation with spontaneous modes. On the other hand, the **exclusion criteria:** patient with haemo-dynamic instability and patient with conditions such as spinal cord injuries, untreated pneumothorax, uncontrolled hypertension, pulmonary embolism, and empyema are not candidates for chest physical therapy.

Research tools for data collection

Tool: Chest physiotherapy assessment tool: the data for this study were gathered using the results of an assessment tool for chest physical therapy. The researcher created this tool after reading relevant literature. **(Meawad et al., 2018; Sethikaew et al., 2022; Nafae et al., 2018; Kriemler et al., 2016)** and it was employed to evaluate how mechanical chest vibration during chest physical therapy affected the oxygen saturation and ventilator parameters of patients on mechanical ventilation. There were five parts to it

Part I: this part includeddemographic data such as age, gender and clinical data such as level of consciousness using FOUR score and administered medication.

Part II: assessment of physiological parameters: This part was used to assess physiological parameters included heart rate, respiratory rate, Systolic blood pressure (SBP), Diastolic blood pressure (DBP), and Mean arterial blood pressure (MAP) which, was calculated by using the following formula: MAP=DBP+1/3(SBP-DBP) **(Daniel& Daliah, 2023).**

Part III: assessment of oxygenation status parameters: arterial blood gases, such as PH, Paco2, Pao2, and Sao2, as well as other oxygenation status parameters, were measured in this section. In addition, a bedside pulse oximeter was used to measure peripheral oxygen saturation (Spo2).

Part IV: assessment of ventilator parameters: this part was used to assess ventilator parameters included**:** peak inspiratory pressure (PIP), plateau pressure, inspired Vt, expired Vt and FIO_2 **(Moon & Hyeon , 2019)**

Part V: Cough stimulation and secretion assessment: this part was used to assess cough stimulation and determined if the patient coughed during physiotherapy. Also, this part assessed amount of secretion according to the following; mild amount between 30<50ml, moderate amount between 50-<75ml and severe amount between 75-≥100 ml. **(Belli et al., 2021)**

Method

The Damanhour University Faculty of

Nursing's Ethical Committee gave its approval (No. 55-a). After justification, a formal letter authorizing the study's conduct was forwarded to the hospital's administrative authorities by the Faculty of Nursing and an official approval to carry out the study was obtained from the hospital administrative authorities to collect the necessary data from the selected setting.

The study tool was developed by the researcher after reviewing the relevant literature **(Meawad et al., 2018; Sethikaew et al., 2022; Nafae et al., 2018; Kriemler et al., 2016).** To evaluate the study tool's content validity, five critical experts was inquired to review it. The appropriate modifications were made as a result. To determine the study's viability and the tools' applicability, a pilot study was conducted. Nine patients had it done, but those individuals were left out of the study. The appropriate adjustments were made as a result. Upon admission, the researcher evaluated whether each newly admitted patient meeting the inclusion and exclusion criteria for mechanical ventilation. Patients who were met the inclusion criteria were assigned randomly by using simple method (folded paper) into two equal groups, manual vibration and mechanical vibration groups.

For both groups, before starting chest physiotherapy the age, sex and clinical data such as level of consciousness were assessed before starting chest physiotherapy by using (part **I)**. In addition, oxygen status parameters were measured by obtaining arterial blood sample and peripheral oxygen saturation by using pulse oximeter (part II).

Chest physiotherapy was started for both groups with the postural drainage positions. The patient was placed on the right side if the left side was affected and vice versa.

The control group was subjected to chest manual vibration followed postural drainage which was done by the nurse in charge by placing one hand over the other, then press the top and bottom hand into each other to vibrate. Manual vibration was applied to group while the subject breathed 10 times. The subject was placed on the right side to avoid bony protruding areas and a sheet was placed on the left lobe of the lung on the back to prevent skin damage. Vibration was applied while the subject breathed 10 times. After that, the subject was placed on the left position, and the vibration method was re-performed in the same way.

A chest vibrating device was used to mechanically vibrate the chests of the intervention group members. The researcher used a chest vibrating device to apply the chest vibration. (Presens vibrator chest type Rs 2100, frequency 70 Hz, 200-240 v) which involved placing the patient's back and chest on a mechanical chest wall vibration pad. The subject breathed ten times while the group was subjected to mechanical vibration. Then, the subject was placed on the right side to avoid bony protruding areas and a sheet was placed on the left lobe of the lung on the back to prevent skin damage. Vibration was applied while the subject breathed 10 times. After that the subject was placed on the left position and the vibration method was performed in the same way.

For both groups: chest physiotherapy was done twice per day at morning and evening shift. Along with the all steps of chest physiotherapy the patient's vital signs was assessed every 5, 10, & 15 minutes by using part II. Following mechanical or manual vibration in accordance with the patient's assessment, which included chest auscultation and visual inspection of the ventilator's graphics, tracheal suctioning was performed after mechanical hyper oxygenation by 100% for a maximum of 15 seconds. Cough stimulation and frequency of cough was determined. In addition, amount of secretion was determined at the end of each session. In addition, oxygen status parameters were reassessed by obtaining arterial blood sample and peripheral oxygen saturation by using pulse oximeter (part III).

Also, patients were reassessed for mechanical ventilator's data; peak inspiratory pressure (PIP), plateau pressure, inspired Vt, expired Vt, FIO_2 and RR by using part IV. Using appropriate statistical analysis, a comparison of the study's results between the two groups was conducted .In order to ascertain whether mechanical vibration during chest physiotherapy interventions improved ventilator parameters and oxygen saturation in patients on mechanical ventilation, the collected data was analyzed using the appropriate statistical test.

Ethical considerations:

The nurses provided written, informed consent to be observed. The family of the patients gave their written, informed consent to participate in the study. Patient confidentiality was upheld.

Statistical Analysis

The statistical package for social studies (SPSS) Version 25.0 was utilized to arrange, tabulate, and perform statistical analysis on the gathered data. Number and percent were used to describe quantitative data. The mean ± standard deviation was used to describe the quantitative data. Ultimately, the data were analyzed and interpreted. P-values were regarded as statistically significant if they were 0.05 or less.

Results of the research

Table (1) it can be seen that, the age of nearly one - third of the patients in the control group was in the range of 18-30 years and, that of one - third of the patients in intervention group was in the range of 41-50 years old. By sex nearly one - third of the intervention group and slightly more one - third in control group were males. In addition, two - thirds of patients of the intervention group and slightly more than two - third of patients in the control group were diagnosed with respiratory diseases. Moreover, more than half of the patients in both groups were given bronchodilators as prophylactic. Based on level of consciousness, it can be noticed that the mean was 8.7 in the intervention group and 8.6 in the control group. There was no significant difference between the two groups.

Table (2) in relation to the effect of mechanical and manual vibration on oxygenation status parameters. It can be noticed that, PaO2 was increased in both groups with a significant difference ($p= 0.019$, 0.024) respectively. Moreover, this increase was higher in the manual vibration group with a significant difference ($p= 0.037$). Also, SaO_2 was increased in both groups with a significant difference ($p= 0.023$, 0.011) respectively. Moreover, this increase was higher in the manual vibration group with a significant difference ($p= 0.002$). In addition, Peripheral oxygen saturation (Spo2) was increased in both groups with a significant difference ($p= <0.001$, 0.002) respectively and this increase was higher in the manual vibration group (control group) with a significant difference (p= 0.004).

Table (3) regarding the effect of mechanical and manual vibration on ventilator parameters, it can be observed that, the most of these parameters were changed in both groups, but there was no significant difference.

Table (4) reveals the effects of physiotherapy interventions on physiological parameters. It can be noticed that pulse, systolic blood pressure and diastolic blood pressure were increased at different intervals in the mechanical vibration group with a significant difference (p= <0.001, <0.001 &<0.001) respectively. Moreover, they were increased in manual vibration group with a significant difference p= (<0.001, 0.019 &<0.001) respectively.

Table (5) shows a comparison between the effects of physiotherapy interventions on physiological parameters. It can be observed that the mean of pulse in the mechanical vibration group (89.55) was higher than the mean in manual vibration group (86.5) with a significant difference p= (<0.001). The same finding was found in relation to the mean of arterial pressure as, the mean in the mechanical vibration group (92.2) was higher than the mean in the manual vibration group (65.8) with a significant difference p= (<0.001). While the mean of diastolic blood pressure in manual vibration was higher than the mean in mechanical vibration p= (<0.001).

Table (6) illustrates the effects of physiotherapy interventions on cough stimulation and the amount of secretion. It can be noticed that two-thirds of the patients in manual vibration had a moderate amount of secretion compared with nearly two-thirds of the patients in mechanical vibration who had a mild amount of secretion with a significant difference between both groups p=(<0.001).

Table 1 Distribution of the studied groups according to age, gender and clinical characteristics.

Patients' characteristics	Mechanical vibration		Manual vibration		Test of Sig.	p
	No.	%	No.	%		
Gender						
Male	29	64.4	32	71.1	χ^2= 0.458	0.499
Female	16	35.6	13	28.9		
Age (years)						
18-30	12	26.7	13	28.9	χ^2= 1.840	0.606
31 – 40	8	17.7	12	26.7		
41 – 50	15	33.3	10	22.2		
51-60	10	22.2	10	22.2		
Mean ± SD.	45.4 ± 9.1		42.5 ± 8.9		t= 1.528	0.130
Diagnosis≠					χ^2	
Respiratory disorders	30	66.7	33	73.3	0.475	0.490
Neurological disorders	10	22.2	8	17.8	0.278	0.598
Renal disorders	9	20.0	5	11.1	1.353	0.245
Endocrine disorders	4	8.9	9	20.0	2.248	0.134
Gastrointestinal disorders	5	11.1	4	8.9	0.123	0.725
Medication*						
Bronchodilators	25	55.6	28	62.2	χ^2= 0.418	0.811
Prophylactic Antibiotics	12	26.7	10	22.2		
ACEI	8	17.8	7	15.6		
Level of consciousness						
Mean ± SD.	8.70 ± 1.34		8.60 ± 1.40		t= 0.346	0.730

≠More than one diagnosis

Table 2 Comparison between the intervention and control groups as regards oxygenationstatus parameters.

Oxygenation status parameters	Mechanical Vibration			Manual vibration			t_3 (p)	t_4 (p)
	baseline	after	t_1 (p)	baseline	after	t_2 (p)		
I-Arterial blood gases: PH								
Min. – Max.	7 – 7.6	7.1 – 7.6	0.750 (0.455)	7.2 – 7.6	7.1 – 7.5	1.861 (0.66)	0.930 (0.354)	1.627 (0.107)
Mean ± SD.	7.45 ± 0.2	7.5 ± 0.4		7.5 ± 0.3	7.4 ± 0.2			
PaCo2								
Min. – Max.	22.7 – 48	23.7 – 45	0.897 (0.372)	30.1 – 46.4	32.3 – 45.2	1.742 (0.085)	1.286 (0.201)	1.373 (0.173)
Mean ± SD.	38 ± 5.9	39 ± 4.9		39.4 ± 4.3	37.2 ±7.3			
PaO2								
Min. – Max.	74 – 188.9	75– 176.4	2.390* (0.019*)	83.7 – 106.3	85.3 – 115.2	2.290* (0.024*)	1.808 (0.074)	2.119* (0.037*)
Mean ± SD.	89.6± 11.8	94.6± 7.4		93.7 ± 9.6	97.2 ± 3.6			
SaO2								
Min. – Max.	88.7– 98.4	89.6– 99.3	2.294* (0.023*)	90.9 – 99.4	91.4 – 99.1	2.590* (0.011*)	1.449 (0.151)	3.898* (0.002*)
Mean ± SD.	96.4 ± 6.3	98.6 ± 1.3		94.8 ± 3.9	96.7 ± 3			
II- Peripheral oxygen saturation (Spo2)								
Min. – Max.	90.9 – 99.4	90.8-100	10.180* (<0.001*)	88.9 – 98.4	95.7 – 99.5	3.152* (0.002*)	0.562 (0.576)	3.000* (0.004*)
Mean ± SD.	92.8 ± 2.1	96.9 ± 1.7		93.1 ± 2.9	95.2 ± 3.4			

t_1&t_2 compare between means of baseline and after interventions, t_3 compare between means of baseline of the different interventions, t_4 compare between means after the different interventions

Table 3 Effects of physiotherapy interventions on mechanical ventilator parameters:

Ventilator's parameters	Mechanical Vibration			Manual vibration			t_3 (p)	t_4 (p)
	baseline	after	t_1 (p)	Baseline	after	t_2 (p)		
PIP Min.-Max. Mean ± SD.	24-35 23±5.5	20-27 25±4.3	1.922 (0.058)	23-30 25±4.7	27-32 26±3.1	1.224 (0.224)	1.854 (0.068)	1.265 (0.209)
Plateau pressure Min. – Max. Mean ± SD.	21-30 27.6± 4.9	19-27 25.6±5.3	1.25 0.31	20-32 26.7±3.3	22-33 24±3.5	1.03 0.31	1.022 0.309	1.690 0.094
Inspired Vt Min. – Max. Mean ± SD.	115.7 – 506.3 193.7 ± 25.6	120.4 – 406.3 190.3 ± 23.6	0.655 (0.514)	174 – 588.9 195.6± 18.5	119-305 189.7±22.2	1.370 (0.174)	0.404 (0.688)	0.124 (0.901)
Expired Vt Min. – Max. Mean ± SD.	105.2 – 204.3 183.1 ± 10.6	125.4 – 306.1 181 ± 14.1	0.799 (0.427)	88.7– 398.4 188.5 ± 22.9	89.7– 297.4 185.8 ± 12.9	0.689 (0.493)	1.515 (0.133)	1.685 (0.096)
FIO2 Min. – Max. Mean ± SD.	69.3-99.7 75±5.5	60.3-89.8 77±8.4	1.336 (0.185)	66.6 -85.7 73±7.2	70.3-90.3 74±6.3	0.701 (0.485)	1.481 (0.142)	1.917 (0.059)
RR Min. – Max. Mean ± SD.	14-20 14±4.6	17-22 15±3	1.221 (0.225)	15-24 15±4	14-23 16±5.8	0.952 (0.343)	1.100 (0.274)	1.027 (0.307)

t_1&t_2 compare between means of baseline and after interventions, t_3 compare between means of baseline of the different interventions, t_4 compare between means after the different intervention.

Table 4 Effects of physiotherapy interventions on physiological parameters.

Physiotherapy interventions	Physiological parameters	different time intervals				F (p)
		Baseline	After 5 min	After 10 min	After 15min	
Mechanical vibration	**Pulse** Mean ± SD.	85.3±4.2	87.2±2.3	90.5±1.3	95.1±3.5	89.972* <0.001*
	Systolic blood pressure Mean ± SD.	118.3± 13.3	120.2±12.4	122.6±13.2	132.5±11.5	11.272* <0.001*
	Diastolic blood pressure Mean ± SD.	70.1±1.1	72.3±3.2	75.4±2.2	71.6±5.2	20.674 <0.001*
	Mean arterial blood pressure Mean ± SD.	91.3±6.3	92.2±3.3	91.7±5.1	93.6±4.2	1.923 0.128
Manual vibration	**Pulse** Mean ± SD.	83.4±2.3	83.9±1.3	85.3±2.1	87.4±2.6	31.802 <0.001*
	Systolic blood pressure Mean ± SD.	120.3±12.4	123.3±10.2	125.3±9.5	126.8±8.3	3.409* 0.019*
	Diastolic blood pressure Mean ± SD.	73.4±4.1	75.1±6.2	80.6±3.2	81.4±8.2	21.394* <0.001*
	Mean arterial blood pressure Mean ± SD.	87.2±10.6	89.5±9.3	90.6±7.5	91.1±9.1	1.602 0.191

Table 5 Comparison between effects of physiotherapy interventions on physiological parameters:

Physiotherapy interventions	Physiological parameters			
	Pulse	Systolic blood pressure	Diastolic blood pressure	Mean arterial blood pressure
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
Mechanical vibration	89.55±2.5	124.2 ± 3.2	72.3±5.1	92.2±3.2
Manual percussion	86.5 ±1.3	123.6± 4.5	77.6±2.5	65.8±5.1
t	7.142*	0.729	6.260*	29.414*
(p)	<0.001*	0.468	<0.001*	<0.001*

t:t- test compare between means of the different interventions.

Table 6 Effect of physiotherapy interventions on cough stimulation and amount of secretion:

	Mechanical vibration		Manual percussion		x^2 (p)
Cough stimulation	**No**	**%**	**No**	**%**	1.353 0.245
Yes	36	80	40	88.9	
No	9	20	5	11.1	
Frequency 1-2	30	83.3	32	80	0.403 ^{MC}p=1.000
3-4	5	13.9	6	15	
>4	1	2.8	2	5	
Amount of secretion					27.941* <0.001*
Mild	29	64.5	5	11.1	
Moderate	10	22.2	30	66.7	
Severe	6	13.3	10	22.2	

x^2: Chi square

Discussion

The cornerstone of care for sputum mobilization in patients on mechanical ventilation continues to be conventional chest physical therapy (CCPT). Nevertheless, CCPT limits the patient's independence and takes a lot of time, requiring the help of a physiotherapist. Additionally, the nurse might get tired from performing effective chest physical therapy, which should be done for a long period of time at least continuously for 10 to 20 minutes **(Sethikaew et al., 2022)**.

The current study's findings showed that the means of PaO2, SaO2, and SPO2 significantly improved in both the intervention group and the control group. This could be because secretions and bulges raises airway pressure and lowers compliance and its removal improve lung compliance and airway resistance. Postural drainage also promotes mucus clearance, raises functional residual capacity, and improves peripheral lung clearance. It is believed that postural drainage, along with PEEP and mechanical ventilation, improves ventilation-perfusion ratios, raises lung/thorax compliance of the nondependent hemithorax, and lowers collateral airway resistance. Because of positioning, vibrations, and coughing, complex interactions led to the responses that were obtained.

Abdeen et al. (2020) study, which examined the impact of early chest physiotherapy (positioning, vibration, and suction) on blood gas and circulatory function in 15 mechanically ventilated patients, corroborated these findings. The study also revealed that 30 minutes after treatment, PaO2 and SaO2 significantly increased and PaCO2 significantly decreased (**Abdeen et al., 2020)**

The aforementioned findings aligned with the research carried out by Kriemler and colleagues. Following chest physical therapy, patients on mechanical ventilators showed no changes in PaCO2 or PaO2, and suggested that the patients' comparatively high baseline oxygen saturation values may have contributed to the study's findings **(Kriemler et al., 2016)**. Moreover, stability in mechanical ventilation of studied patients in both groups as there was no significant difference in ventilator parameters, specifically tidal volume play a major role in improving of oxygen saturation and the previous result is supported by the research finding done by **(Moon & Hyeon, 2019).**

Zeyu et al. (2016) and Farahat et al. (2016) examined the clinical impact of chest physical therapy on the excretion of postoperative sputum; it was found that after three days, the increase in PaO2 was significantly higher than before. Moreover, **Zeng (2017)** found that receiving comprehensive chest physical therapy decreased the incidence of VAP and increased PaO2 in contrast to this research. In contrast to this study, **Copotoiu et al. (2014)** carried out a prospective, interventional study in which respiratory physiotherapy was started twice a day for a randomized group of mechanically ventilated patients and showed no increase in SaO2.

In relation to, the effects of physiotherapy interventions on pulse, systolic blood pressure and diastolic blood pressure and mean arterial pressure. They significantly differed in the intervals at which they increased in both groups. This may be connected to the fact that a sympathetic compensatory response from the arterial baroreceptors offsets the decrease in cardiac output brought on by positive pressure, increasing the Heart failure index of the baroreflex gain and raising blood pressure **(Ranjan, 2023)**. This may be the reason for the increase in systolic blood pressure, along with the effects of postural drainage, which include increased carbon dioxide production, right atrial pressure, and preload. Chest physiotherapy causes an increase in muscular activity and stresses, which raises cardiac output and stroke volume to meet the higher oxygen demands. When larger airways' afferent fibers pass through the vagus, stimulating their sympatho-excitatory receptors causes a rise in sympathetic activity. This, in turn, causes peripheral vasoconstriction and an increase in mean arterial blood pressure.

In a previous study that determined the cardiorespiratory response to chest physiotherapy in intensive respiratory patients, researchers discovered an increase in mean arterial blood pressure, and systolic blood pressure after 5, 15, and 30 minutes of intervention. However, there was no discernible variation in the diastolic blood pressure reading and respiratory rate. Moreover, in the contrary of the finding of this study as regards insignificant changes in respiratory rate, it was concluded in the aforementioned study that these vibrations increase muscular activity, which in turn raises respiratory rate. Breathing may also be more difficult due to the modifications brought about by shifting respiratory muscle load and mechanics.

The secretion clearance might counteract this. As the airflow increases, the effort required to breathe decreases, as does the use of auxiliary muscles and the incidence of dyspnea. As a result, the respiratory rate is kept relatively close to the starting points **(Jiandani & Patel, 2018**).

In normal circumstances, approximately 20-30ml of secretions is produced by the airways every day. Moreover, chest physiotherapy has been shown to have little or no effect in diseases associated with low content of secretions; thus, the signs indicating chest physiotherapy are largely limited to patients who have secretion production >30 ml per day. The finding of the current study showed that the amount of secretions was more in the control group as; nearly two-thirds had a moderate amount of secretion compared with nearly two-thirds of the patients in mechanical vibration who had a mild amount of secretion with a significant difference between both groups. It may be related to that mechanical vibration does not mobilize secretions in peripheral airways than central secretions are mobilized by mechanical vibration and the airflow in the larger airways therefore improves. This result also explains why the improvement in oxygen status parameters (pao_2, o_2 sat, spo_2) in manual vibration was higher than in mechanical vibration because the more production of secretions, the more improvement in oxygen status **(Wessels, 1994).**

This result in the same line with a previous study done by **Narayanan et al. (2014)** who concluded that the mechanical device can be a helpful addition to traditional chest physiotherapy because it produced less sputum when compared to CCPT, the respiratory function tests were comparable, and there were no safety concerns. Achieving an improvement in autonomy and health-related quality of life is crucial for managing chronic illnesses.

Conclusion

From this study, the following conclusion can be drawn: the effectiveness of chest physiotherapy between the control group and the experimental group was not different. Therefore, chest physiotherapy using a mechanical vibrator can promote sputum drainage, with conventional chest physiotherapy. But, using mechanical vibration should be done more frequently than manual, as it produces lesser amount of secretion than manual, and it is recommended that a larger follow - up study required to confirm the findings and to assess clinical improvement to determine how many times mechanical vibrations are needed.

Recommendations

The study's conclusions lead to the following recommendations for nursing staff:

The importance of applying various chest physiotherapy techniques and using a mechanical chest vibrating device regarding the patient's condition must be understood by the staff.

Offer a training program to improve nurses' understanding of the advantages, restrictions, and best practices when it comes to using a mechanical chest vibrating device. The ICUS should have a sufficient supply of mechanical chest vibrating devices.

To ascertain the optimal number of mechanical vibrations, conduct a follow-up study. Application of the study on a large sample.

Limitation of the study

Using mechanical devices for chest physiotherapy is expensive and need training. Also, a small sample size in this study is considered another limitation, so the result cannot be generalized.

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