



Efficacy of Manual Hyperinflation with Expiratory Rib Cage Compression on Weaning From Mechanical Ventilation

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Abstract: Background: The major goal in critical care is to wean patients from mechanical ventilation as early as possible to avoid the complications and risks associated with prolonged unnecessary mechanical ventilation, including ventilator associated pneumonia, increased length of ICU, hospital stay, mortality rate and increased cost of care delivery. Objective: To find out the effect of manual hyperinflation with expiratory rib cage compression on weaning from mechanical ventilation. Methodology: study was carried out in the period starting from October 2018 till June 2019, on forty patients (both sexes) who were selected from Cairo university hospital (intensive care unit), all patient were randomly assigned to two equal groups (group A (control group) receiving traditional chest physiotherapy only, group B (study group) receiving manual hyperinflation with expiratory rib cage compression and traditional chest physiotherapy), their ages was ranged from (50-70) years, treatment was applied (30 minute) once per day for five days for each group of treatment. The Outcome Measures: Glasgow coma scale (GCS), Arterial blood gases (ABG), Rapid shallow breathing index (RSBI) and Murray score were measured before and after treatment. Result: The results of this study revealed that there were statistically significant changes in patients of study group in comparison to which of patients in control group in (GCS, ABG and Murray score) but non-significant changes in RSBI. Conclusion: Manual hyperinflation with expiratory rib cage compression when added to traditional chest physiotherapy enhance the clinical outcome in mechanically ventilated patients but not enough to affect weaning from mechanical ventilation.

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Keywords: Manual hyperinflation, Expiratory rib cage compression, Mechanical ventilation, Traditional chest physiotherapy.

1. Introduction

Although Mechanical ventilation is a lifesaving intervention in patients with acute respiratory failure and other disease, a major goal of critical care clinicians should be to liberate patients from mechanical ventilation as early as possible to avoid a lot of complications and risks associated with prolonged unnecessary mechanical ventilation, including ventilator induced lung injury, ventilator associated pneumonia, increased length of ICU, hospital stay, mortality rate and increased cost of care delivery. (El-khatib et al., 2014).

Increase the duration of mechanical ventilation lead to increase the mortality rate; this depends, at least in part, on the complications and side effects of this procedure such as the so-called ventilator-associated pneumonia. Therefore, prolonged weaning is not only a medical, but also a social and economic

problem. US costs for mechanical ventilation are estimated to be 27 billion dollars, corresponding to more than 10% of all hospital costs. Each year about 300,000 people receive prolonged mechanical ventilation in ICU in the United States, and this number might double within a decade, with costs increasing up 50 billion dollars. (Navalesi et al., 2014).

Chest PT is one of the most frequently performed interventions in the intensive care areas. The role of physiotherapists in ICU is positioning, percussion, vibration, manual hyperinflation, coughing, tracheal suctioning, and breathing and limb exercises. (Baidya et al., 2016).

The consequent pulmonary secretion retention is major risk factors associated with prolonged ICU stay and mortality in critically ill patients. chest

physiotherapy can improve secretion clearance and prevent pulmonary complications, as well as improving dynamic compliance and static compliance. One of several respiratory physiotherapy techniques is MH. Although chest physiotherapy plays an important role in the multidisciplinary approach to patients in most ICUs, there is very limited evidence that chest physiotherapy facilitates weaning from MV. (Berti et al., 2012).

ABG analysis is an indispensable diagnostic tool for monitoring the patient's condition and evaluating the response to interventions. By reviewing the patient's ABGs and clinical status, clinicians can adjust ventilator settings to improve oxygenation, ventilation, and acid-base balance, or wean the patient from ventilatory support. (Lian et al., 2010).

Manual hyperinflation (MH) stimulate cough and move the airway secretions toward the larger airways, from where they can be easily suctioned. Manual hyperinflation can prevent airway plugging and pulmonary collapse and improve oxygenation and lung compliance. This technique is widely used, though the practice varies across different ICUs. The possible physiological side effects of delivered air volume, flow rates, and airway pressure must be carefully considered—especially in patients under MV. When performed by experienced and trained physiotherapists in stable, critically ill patients, MH is associated with short-term and probably nonrelevant side effects like reduction in cardiac output, alterations in heart rate, and increased central venous pressure. (Mendez et al., 2012).

Expiratory rib cage compression (ERCC), or squeezing, is among the most frequently used airway clearance techniques among adult critical patients. This technique consists of a manual thoracic compression applied during exhalation, followed by a release at the end of exhalation, aiming to increase expiratory flow, thus expanding the gas-liquid interaction and mobilizing secretions from peripheral to central regions, favoring their removal. (Borges et al., 2017).

2. Materials and Methods:

Patients and Procedures:

Patients:

Forty patients (both sexes) who selected from Cairo university hospital (intensive care unit), all patient was randomly assigned to two equal groups (group A (control group) receiving traditional chest physiotherapy only, group B (study group) receiving manual hyperinflation with expiratory rib cage compression and traditional chest physiotherapy), their ages were ranged from (50-70) years. The program of treatment was applied once per day for five days for each group of treatment 30 minute.

Ethical consideration:

The purpose, nature and potential risks of the study was explained to all patients' relatives. All patients' relatives were sign a consent form prior to participation in the study, the study was reviewed and approved by ethics committee of faculty of physical therapy, Cairo University (P.T.REC/012/002100).

Inclusion criteria:

All patients:

- Ages were ranged from (50-70) years.
- Endotracheally or tracheostomy intubated and mechanically ventilated for 24-72 h.
- With positive end expiratory pressure (PEEP) did not exceed 8 cmH₂o.
- Hemodynamically stable; temperature (36.2-37.5) C, heart Rate (60-90) pulse/minute, blood pressure (120-140/60-90) mmHg and Respiratory rate (12-20) breath/minute.
- Medically free from any contraindication to the technique

Exclusion criteria:

Patients were excluded from the following study if they had one of the criteria below:

- Fraction of inspired oxygen (fio₂)>0.6.
- Positive end expiratory pressure (PEEP) > 8 cmH₂o to avoid barotraumas.
- Pulmonary pathology where lung hyperinflation is contra-indicated (e.g. acute respiratory distress syndrome).
- Arterial oxygen saturation (sao₂) < 90%.

Patients were being withdrawn from the study if they suffer cardiovascular compromise during the treatment as defined by the above variables.

Assessment equipment:

Mechanical ventilator equipment (CARESCAPE R860) for calculating RSBI and Murray score, and Blood gases analyzer equipment (model: Siemens Healthineers, RAPIDPoint 500 System) for measuring ABG.

Treatment equipment:

Manual hyperinflation equipment (Model: adult silicone (Item#977868), American manual resuscitator (ambo bag) for manual hyperinflation procedure.

Treatment procedures:

The patients of this study were divided into two groups: (group A (control group) receiving traditional chest physiotherapy only, group B (study group) receiving manual hyperinflation with expiratory rib cage compression and traditional chest physiotherapy).

a- Manual hyperinflation with expiratory rib cage compression (ERCC) procedure:

1- Wash hands. Put on disposable plastic clean gloves to reduce the risk of cross infection.

2-The patient was positioned into the appropriate position for treatment (in relaxed half supine position with head support) to maximizes the effectiveness of

the manual hyperinflation technique and to improve outcome measures.

3-Attach the resuscitation circuit to the oxygen flow rate and set the oxygen to 15 L/minute any less than 15 L/minute increases the time of bag re-inflation which can lead to a delay in giving the next breath.

4-Check the resuscitation circuit by occluding the end with one hand, allow the bag to inflate and then deflate the bag with the other hand at different valve settings. Ensure the circuit is not faulty.

5-All the ventilator alarms must turn off as it can lead to distress and anxiety of the patient and surrounding patients.

6-The patient was disconnected from the ventilator, attach the resuscitation circuit to the filter and attach to the patient airway (endotracheal or tracheostomy).

7-Therapists one or two hands were used; deliver a breath to the patient's lungs, observing the chest expansion would indicate whether this was achieved. Great lung volumes would re-inflate areas of atelectasis and/or mobilize secretions. Too large breath volume would lead to barotraumas of lung tissue.

8-The hyperinflation breaths had a slow inspiration for three seconds duration, three seconds end inspiratory pause (hold); during which the bag held compressed, slow deep breaths and hold maximizes collateral ventilation followed by uninterrupted expiration; quick release of the bag increases the expiratory phase to mobilize secretions up to the bronchial tree.

9-As soon as the expiratory phase started expiratory rib cage compression was manually applied to both hemi thoraces. This step consisted of four sets of six MH breathes combined with six ERCC maneuvers (using the palms of both hands toward the sternum).

10-Tracheal suctioning was applied for 15 s after each set of MH breathes (If needed).

11-The patient was reconnected to the ventilator.

Procedure for traditional chest physiotherapy used for both groups:

Traditional chest physiotherapy in form of modified postural drainage, percussion, manual vibration, upper extremity exercises and lower extremity exercises applied for all patients in both groups. Traditional chest physiotherapy was applied once per day for 15 min for five day for both groups.

1- Modified postural drainage:

Positioning for drainage of pulmonary secretions based on the anatomical arrangement of the bronchopulmonary segments to facilitate drainage of a segment. The bronchiole to the segment of interest was positioned perpendicular to facilitate drainage with the use of gravity. some patient cannot tolerate the organized positions and for others they may be

contraindicated, so modified positions such as high side lying or side lying may be easier, more appropriate more convenient and likely to encourage patient compliance. (Fink et al., 2002).

2-percussion:

Manual percussion by clapping selected area and then compressing chest during the expiratory phase and often associated with postural drainage (pathmanathan et al., 2014).

3- Manual vibration:

Manual vibration was used to increase mucociliary clearance. (Thangavelu et al., 2016).

4- Upper extremity exercises:

Upper extremity exercises were including range of motion (ROM) exercises for the wrist; elbow and shoulder flexion and extension; and shoulder abduction, adduction and internal and external rotation with 10 repetitions for each motion per set for 2 sets. Patients initially performed these exercises against gravity in a supine position and progressed to a sitting position as tolerated. These exercises resistance then was increased to repetitions against resistance. (Truyong et al., 2009).

5-Lower extremity exercises:

Lower extremity exercises were including ROM exercises for ankle dorsiflexion and planter flexion, hip and knee flexion and extension, and straight leg rising with 10 repetition of each motion per set for 2sets in the supine position. (Truyong et al., 2009).

Statistical Analysis:

Statistical analysis was conducted using SPSS for windows, version 23. There was homogeneity of variances ($p > 0.05$) and covariances ($p > 0.05$), as assessed by Levene's test of homogeneity of variances and Box's M test, respectively. 2×2 mixed design MANOVA was used to compare the GCS, PH, PaCO₂, HCO₃, SO₂, RSBI and Murray score at different measuring periods at both groups. The alpha level was set at 0.05.

3. Results:

For Group (A), the mean values of age were (61.45±6.43) years While for Group (B) were (63.25±5.33) years. As indicated by the independent t test, there were no significant differences ($p > 0.05$), The p-value were (0.342) as shown in (Table1). The present study revealed that there was significant improvement of GCS at post treatment in compare to pretreatment in both groups, And anon-significant differences in mean values between both groups. As the post treatment means was (10.4±0.5) for the control group and (10.2±0.41) for the study group respectively, as shown in (Table 2).

For Arterial blood gasses there was non-significant differences of (PH, PaCO₂, HCO₃) at post treatment in compare to pretreatment in both groups,

significant difference of (SO₂) at post treatment in compare to pretreatment in the study group, And significant differences in mean values of (PH, PaCO₂) between both groups toward study group. Non-significant differences in mean values of (HCO₃, SO₂) between both groups. As the post treatment means of (PH, PaCO₂, HCO₃, SO₂) were (7.482±0.008, 33.51±2.97, 24.47±2.01, 96.85±2.34) respectively for the control group and (7.453±0.04, 35.29±2.52, 23.28±1.69, 98±1.91) respectively for the study group, as shown in (Table3).

For RSBI there was non- significant difference at post treatment in compare to pretreatment in both groups and anon-significant differences in mean values between both groups. As the post treatment

means was (87.45±37.05) for the control group and (76±40.14) for the study group, as shown in (Table 4).

For Murray score there was significant improvement at post treatment in compare to pretreatment in the study group, and anon-significant differences in mean values between both groups. As the post treatment means was (0.93 ±0.39) for the control group and (1.02±0.41) for the study group, as shown in (Table 5).

For weaning from mechanical ventilation there was non-significant differences between both groups post treatment. As the total number of cases weaned in study group was 11 (55%), while the total number of cases weaned in control group was 8 (40%), as shown in (Table6).

Table (1): Demographic characteristics of patients in both groups (A & B):

	Group A	Group B	Comparison		S
	Mean ±SD	Mean ±SD	t-value	p-value	
Age (yrs)	61.45±6.43	63.25±5.33	-0.963	0.342	NS

*SD: standard deviation, P: probability, S: significant, NS: non-significant.

Table (2): Statistical Analysis for GCS in both groups:

GCS	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	10 ±0.56	10.4±0.5	-0.4	4%	0.001*
Group B	9.7±0.47	10.2±0.41	-0.5	5.15%	0.0001*
MD	0.3	0.2			
p- value	0.075	0.176			

SD: standard deviation, p-value: probability value, MD: Mean difference.

Table (3): Statistical Analysis for Arterial blood Gases in Both Groups:

PH	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	7.481±0.02	7.482±0.008	-0.001	0.01%	0.845
Group B	7.463 ±0.03	7.453±0.04	0.01	0.13%	0.197
MD	0.018	0.029			
p- value	0.072	0.007*			

PACO ₂	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	34.28±3.32	33.51±2.97	0.77	2.24%	0.358
Group B	33.76 ±2.43	35.29±2.52	-1.53	4.53%	0.069
MD	0.52	-1.78			
p- value	0.575	0.04*			

HCO ₃	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	24.45±2.21	24.47±2.01	-0.02	0.08%	0.972
Group B	23.99 ±1.73	23.28±1.69	0.71	2.95%	0.222
MD	0.46	1.19			
p- value	0.464	0.05			

SO2	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	96.55±1.09	96.85±2.34	-0.3	0.3%	0.525
Group B	96.25 ±0.71	98±1.91	-1.75	1.81%	0.001*
MD	-4.34	18.54			
p- value	0.313	0.098			

*Significant level is set at alpha level <0.05, SD: standard deviation, MD: Mean difference, p-value: probability value.

Table (4): Statistical Analysis for RSBI in both groups:

RSBI	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	83.55±24.76	87.45±37.05	-3.9	4.66%	0.537
Group B	82.95 ±21.69	76±40.14	6.95	8.37%	0.274
MD	0.6	11.45			
p- value	0.935	0.354			

SD: standard deviation, MD: Mean difference, p-value: probability value.

Table (5): Statistical Analysis for Murray score in both groups:

Murray score	Pre test	Post test	MD	% of change	p- value
	Mean± SD	Mean± SD			
Group A	1.02 ±0.61	0.93 ±0.39	0.09	8.82%	0.287
Group B	1.2±0.61	1.02±0.41	0.18	15%	0.037*
MD	-0.18	-0.09			
p- value	0.514	0.375			

SD: standard deviation, MD: Mean difference, p-value: probability value.

Table (6): Distribution of Weaning from mechanical ventilation in both groups:

	Group A		Group B		Chi -Square	
	Weaning	Not weaning	Weaning	Not weaning	X ²	P -value
No.	8 (40%)	12 (60%)	11 (55%)	9 (45%)	0.902	0.527
Total	20 (100%)		20 (100%)			

4. Discussion:

The purpose of this randomized controlled study was to investigate the effect of manual hyperinflation with expiratory rib cage compression on weaning from mechanical ventilation in intubated patient.

The patients were divided into two groups: (group A (control group) receiving traditional chest physiotherapy only, group B (study group) receiving manual hyperinflation with expiratory rib cage compression and traditional chest physiotherapy). their ages were ranged from (50-70) years, treatment was applied (30 minute) once per day for five days for each group of treatment.

The present study revealed that there was significant improvement of GCS at post treatment in compare to pretreatment in both groups, And non-significant differences in mean values between both groups. As the post treatment means was (10.4±0.5)

for the control group and (10.2±0.41) for the study group respectively.

For Arterial blood gasses there was non-significant differences of (PH, PaCO₂, HCO₃) at post treatment in compare to pretreatment in both groups, significant difference of (SO₂) at post treatment in compare to pretreatment in the study group.

And significant differences in mean values of (PH, PaCO₂) between both groups toward study group. Non-significant differences in mean values of (HCO₃, SO₂) between both groups. As the post treatment means of (PH, PaCO₂, HCO₃, SO₂) were (7.482±0.008, 33.51±2.97, 24.47±2.01, 96.85±2.34) respectively for the control group and (7.453±0.04, 35.29±2.52, 23.28±1.69, 98±1.91) respectively for the study group.

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groups and non-significant differences in mean values between both groups. As the post treatment means was (87.45±37.05) for the control group and (76±40.14) for the study group.

For Murray score there was significant improvement at post treatment in compare to pretreatment in the study group, and non-significant differences in mean values between both groups. As the post treatment means was (0.93 ±0.39) for the control group and (1.02±0.41) for the study group.

For weaning from mechanical ventilation there was non-significant differences between both groups post treatment. As the total number of cases weaned in study group was 11 (55%), while the total number of cases weaned in control group was 8 (40%).

Delay weaning (Extubation failure) can lead to a longer intensive care unit (ICU) stay, higher mortality rate, and higher risk of requiring tracheostomy, Chest physiotherapy (CPT) can help patients in reducing the accumulation of airway secretion, preventing collapsed lung, improving lung compliance, and reducing comorbidities. Much research has investigated the correlation between CPT and respiratory system clearance. However, few studies have investigated the correlation between CPT and failed ventilator extubation. (**Wang et al., 2018**).

Some studies have indicated that secretion volume plays an important role in extubation failure. Research by (**Khamees et al., 2001**) reported that for patients with a good cough reflex, increased secretion volume was associated with a 7.4 times greater risk of extubation failure (relative risk (RR) = 7.4, CI = 0.95 - 57.1). For patients with a poor cough reflex, the risk of extubation failure was 31.9 times greater (RR = 31.9, CI = 4.5 - 225.3).

Thille et al. (2016) also indicated that patients required reintubation in 72 hours with more airway secretion volume (OR = 3.32, P = .02) and poor cough function (OR = 5.03, P = .002); both are associated with a higher incidence of extubation failure.

According to the after mentioned research, patients with more airway secretions and poor cough functions are associated with higher risks of failed extubating so delay weaning process.

The general aims of any physiotherapy program in the critical areas is to apply advanced, cost-effective therapeutic modalities to decrease the patient's dependency on the ventilator, to improve residual function, to prevent the need for new hospitalizations and to improve the patient's quality of life. (**Clinia et al., 2015**).

This present study was in consistent with the results of study by (**Malekzadeh et al., 2008**) clinical trial was performed on 40 patients undergoing abdominal surgery and T-tube support hospitalized in intensive care units of hospitals in Mashhad, Iran, in

2015-2016. The participants were divided randomly into two experimental and control groups. In the experimental group, MHI technique was performed using Mapleson circuit for three twenty-minute periods. The control group received routine hospital care. The two groups were compared for PaO₂, PaCO₂ and SpO₂ before intervention, 5 and 20 minutes after intervention. The mean age was 66.7±8.3 and 67.5±9.0 years in experimental and control groups, respectively. In intergroup comparison using independent t-test, the mean PaCO₂, PaO₂ and SpO₂ had no significant differences in the experimental group before the intervention. However, the means SpO₂ and PaO₂ at 5 and 20 minutes after intervention were significantly higher in the experimental group (p<0.001) than the control group. The mean PaCO₂ at 5 and 20 minutes after intervention decreased significantly in the experimental group (p=0.03).

This present study was in consistent with the results of study by (**Maa et al., 2005**) who Ask if the Manual hyperinflation improves alveolar recruitment in difficult-to-wean patients? MH technique was at a rate of 8 to 13 breaths/min for a period of 20 min each session, three times per day for 5 days. The control group received their standard prescribed mechanical ventilation without supplemental MH. Sputum contents (wet/dry weight ratio, viscosity), respiratory system capacity (spontaneous tidal volume [Vt], maximal inspiratory pressure, rapid shallow breathing index [f/Vt], chest radiograph signs, and Pa (O₂)/fraction of inspired oxygen [Fi (O₂)] were measured just prior to the MH at day 0 as baseline, and at day 3 and day 6 of the study. There were significant improvements in scores over the 6-day study in the experimental group compared to the control group in spontaneous Vt (p = 0.035) and chest radiograph signs (p = 0.040), and a trend toward improvement of f/Vt (p = 0.066) and Pa (O₂)/Fi (O₂) (p = 0.061) after adjustment for covariates. MH performed on patients with atelectasis from ventilation support significantly improved alveolar recruitment.

This present study was in consistent with the results of study by **Bousarri et al. (2014)**. The effect of expiratory rib cage compression before endotracheal suctioning on the vital signs in patients under mechanical ventilation. This study was a randomized clinical trial with a crossover design. The study subjects included 50 mechanically ventilated patients, hospitalized in intensive care wards of Valiasr and Mousavi hospitals in Zanjan, Iran. The patients received endotracheal suctioning with or without rib cage compression, with a minimum of 3 h interval between the two interventions. Expiratory rib cage compression was performed for 5 min before endotracheal suctioning. Vital signs were measured 5

min before and 15 and 25 min after endotracheal suctioning. There were statistically significant differences in the means of vital signs measured 5 min before with 15 and 25 min after endotracheal suctioning with rib cage compression ($P < 0.01$). There was no significant difference in the means of diastolic pressure measured 25 min after with baseline in this stage). But on the reverse mode, there was a significant difference between the means of pulse and respiratory rate 15 min after endotracheal suctioning and the baseline values ($P < 0.002$). This effect continued up to 25 min after endotracheal suctioning just for respiratory rate ($P = 0.016$). Moreover, there were statistically significant differences in the means of vital signs measured 5 min before and 15 min after endotracheal suctioning between the two methods ($P \leq 0.001$). Findings showed that expiratory rib cage compression before endotracheal suctioning improves the vital signs to normal range in patients under mechanical ventilation.

This present study was in consistent with the results of study by **Schweickert et al. (2009)** a randomized controlled trial about Early physical and occupational therapy in mechanically ventilated patient Sedated adults (≥ 18 years of age) in the ICU who had been on mechanical ventilation for less than 72 h, were expected to continue for at least 24 h. We randomly assigned 104 patients to early exercise and mobilization (physical and occupational therapy) during periods of daily interruption of sedation (intervention; $n=49$) or to daily interruption of sedation with therapy as ordered by the primary care team (control; $n=55$). The primary endpoint-the number of patients returning to independent functional status at hospital discharge-was defined as the ability to perform six activities of daily living and the ability to walk independently. All 104 patients were Return to independent functional status at hospital discharge occurred in 29 (59%) patients in the intervention group compared with 19 (35%) patients in the control group ($p=0.02$; odds ratio 2.7 [95% CI 1.2-6.1]). Patients in the intervention group had shorter duration of delirium (median 2.0 days, IQR 0.0-6.0 vs 4.0 days, 2.0-8.0; $p=0.02$), and more ventilator-free days (23.5 days, 7.4-25.6 vs 21.1 days, 0.0-23.8; $p=0.05$) during the 28-day follow-up period than did controls. A strategy for whole-body rehabilitation-consisting of interruption of sedation and physical and occupational therapy in the earliest days of critical illness-was safe and well tolerated, and resulted in better functional outcomes at hospital discharge, a shorter duration of delirium, and more ventilator-free days compared with standard care. So, we conclude that early physiotherapy and mobilization can reduce patient delirium ($P=.03$) and mechanical ventilation length of stay ($P=.02$).

The results of this present study were contradicted with **(Berti et al., 2012)** investigate the effect of Manual hyperinflation combined with expiratory rib cage compression for reduction of length of ICU stay in critically ill patients on mechanical ventilation. This was a prospective randomized controlled clinical trial involving ICU patients on MV at a tertiary care teaching hospital between January of 2004 and January of 2005. Among the 49 patients who met the study criteria, 24 and 25 were randomly assigned to the respiratory physiotherapy (RP) and control groups, respectively. During the 5-day observation period, the RP patients received MH combined with ERCC, whereas the control patients received standard nursing care. Reported that: The intervention had a positive effect on the duration of MV, as well as on the ICU discharge rate and Murray score. There were significant differences between the control and RP groups regarding the weaning success rate. In the RP group, there was a significant improvement in the Murray score on day 5. So, the use of MH combined with ERCC for 5 days accelerated the weaning process and ICU discharge.

The results of this present study were contradicted with **(Pattanshetty et al., 2011)** Effect of multimodality chest physiotherapy on the rate of recovery and prevention of complications in patients with mechanical ventilation: a prospective study in medical and surgical intensive care units. Out of 173 patients who were randomly allocated to two groups, 86 patients received MH and suctioning in control group and 87 patients were treated with multimodality chest physiotherapy in the study group twice daily till they were extubated. There were significant improvements in terms of rate of recovery in study group compared to the control group ($P = 0.000$). Complication rates were higher with 61.6% in the control group as compared to 26.4% in the study group. Duration of hospitalization was longer in the study group (16 ± 9.40 days) as compared to the control group (12.8 ± 6.12 days). Successful weaning from mechanical ventilation was noted in 58 patients in the study group and 24 patients in the control group which was statistically significant. Study has shown to prevent ventilator-associated pneumonia and enhance the clinical outcome in ventilated patients and may be recommended as a treatment option in ICU. It has also shown to enhance the weaning process and proved to be safe.

The results of this present study were contradicted with **Wang et al. (2018)** who ask if the Chest physiotherapy with early mobilization may improve extubation outcome in critically ill patients in the intensive care units. Subjects were divided into two groups. The control group, which received routine

nursing chest care. The intervention group was prospectively taken into the chest physiotherapy program. The chest physiotherapy treatment protocol consisted of inspiratory muscle training, manual hyperinflation, chest wall mobilization, secretion removal, cough function training, and early mobilization. A total of 439 subjects were enrolled in the intervention and control groups, with a mean age of 69 years. APACHE II score ($P = .09$) and GCS scores ($P = .54$) were similar between the two groups. Compared to the control group, patients in the intervention group had a significantly lower reintubation rate (8% vs 16%; $P = .01$). The results indicate that intensive chest physiotherapy could decrease extubation failure in mechanically ventilated patients in the ICU. In addition, chest physiotherapy could also significantly improve the rapid shallow breathing index score.

Conclusion:

From the previous obtained statistical results of this present study, it could be concluded that manual hyperinflation with expiratory rib cage compression when added to traditional chest physiotherapy enhance the clinical outcome in mechanically ventilated patients but not enough to affect weaning from mechanical ventilation.

Conflict Of Interest

The authors declared that present study was performed in absence of any conflict of interest.

Author Contributions

All authors contributed equally in all parts of this study.

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