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Effect of Adding Different Physiotherapy Modalities to Standard Chest Physiotherapy for Critical Ill Patients.

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ABSTRACT

Physical therapy a part of icu patients care and it can help in prevention and treatment of respiratory complications like secretion retention, atelectasis, pneumonia, weaning difficulties and impaired mobility. The purpose of our study was to investigate the effect of different physiotherapy modalities for critical ill patients. Forty-five patients with respiratory failure were randomly selected from critical care department Cairo university hospitals .These patients were divided into three groups A,B and C ,15 patients for each group , group A assigned to chest physiotherapy only , group B assigned chest physiotherapy in addition to manual hyperinflation ,while group C assigned standard chest physiotherapy , manual hyperinflation and respiratory muscles training .oxygenation parameters , strength of respiratory muscles and sputum amount for each patient of the three groups were recorded. Showed significant improvement in the three groups , improvement was higher in group C more than group A and B regarding to oxygenation, respiratory muscles strength and the sputum amount because of adding other modalities to chest physiotherapy .**Conclusion**: adding of manual hyperinflation and respiratory muscles strength training to chest physiotherapy could be a helpful tool to improve oxygenation and respiratory muscles power and increase sputum clearance in critical ill patients .

Keywords: critical ill patients, chest physiotherapy, manual hyperinflation, respiratory muscles training.

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INTRODUCTION

Prolonged mechanical ventilation Patients, may suffer from ''chronic critical illness'' physical de-conditioning, recurrent symptoms, mood alterations and poor quality of life. [1]

The role of physical therapists in an ICU is different and important in the short- and long-term care of patients admitted to ICUs [2, 3].The clinical results of a physiotherapy program in these medical and surgical areas are recovery of physical and respiratory functions, discontinuation of mechanical ventilation and improvement in health status. [4]

The aims of physical therapy program in ICU is to apply advanced therapeutic tools to decrease complications associated with bed-rest and the patient's ventilator dependency to improve residual function and the health status and quality of life [5, 6]

METHODS AND MATERIAL

This randomized study was conducted on 45 ICU patients on mechanical ventilation.

Forty five Patients were assigned into three groups : A,B and C ,15 patients for each group .group **A** assigned to chest physiotherapy only ,group **B** assigned to chest physiotherapy with manual hyperinflation , group **C** assigned to chest physiotherapy , manual hyperinflation and respiratory muscle training .

Only Patients included in our study should be vitally stable during the study period, conscious and respond to verbal command. The patients should be accepting, stable and can tolerate Spontaneous breathing trial, with this setting FiO_2 0.4 or less, PEEP less than $5CmH_2O$, SpO_2 more than 90 %. **The study excludes** unstable Patients like (neurological problems, chest trauma, lack of attention) and skipping of any sessions for any cause.

METHODS

the following parameters were measured before and after treatment For all patients ,blood gas analysis measuring (O_2 %, PaO_2, and calculating PaO_2/FiO_2),Muscle strength parameters (NIP)negative inspiratory pressure were measured through ventilator reading and amount of sputum.

Chest physiotherapy

Chest physiotherapy in the form of percussion, vibrations, suction and various breathing exercises and muscle training (for limbs) was applied three times per day for all patients for one week.

Procedure of manual hyperinflation technique:

Manual hyperinflation technique MHI was performed using resuscitation bag locked at 45 CmH2O by using a larger than normal volume at a low inspiratory flow followed by an inspiratory hold of approximately 2-3 seconds and expiration with a high expiratory flow where inspiratory: expiratory ratio of approximately 1/2 was followed by an uninterrupted expiration during which the bag was held compressed then a 'quick release' of the bag [7, 8].

The patient should be reconnected to the ventilator and check the patient's signs of distress (tachypnea, cyanosis, tachycardia), and position of the endotracheal tube [9].

Procedure for respiratory muscles training: according to Cader SA et al., [10]

The resistance to inspiration through the use of a flow-independent one-way valve, generating a linear pressure. During expiration there is no resistance because the unidirectional valve opens, while during inspiration the valve closes, providing resistance to inspiration. The amount of resistance can be adjusted by increasing the compression on a spring mechanism in the device.

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Inspiratory muscle Training: (IMT)

Starting intensity was 30% of negative inspiratory pressure (NIP) of each patient which taken from ventilator itself then increase the load on IMT device by 1-2 CmH_2Oevery session .Training consists of 5 to 6 sets of repetitions through the trainer. This training breath was repeated six times in each training set, Training breaths was completed for a total of 18 to 30 times per session for about 10 minutes**.** Sessions were conducted 2/ day for about 3days for each patient. oxygen was used with the IMT device during training. Patients were reconnected to MV for rest between training sets as needed.

Assessment of the results:

variables was measured physiotherapy sessions for all study groups and at the end of the study ,study variables include arterial blood gas analysis to measure (O_2 %, PaO_2, and calculating PaO_2/FiO_2)Muscle strength parameters (negative inspiratory pressure) (NIP)and amount of sputum after suction in ml .

Data analysis

Statistical analysis was performed on the data obtained from 45 patients. All statistical analysis was performed using SPSS for Windows 16.0; paired t-test was carried out to determine the significance of the outcome measurements pre and post-study in the three groups, ANOVA test used to determine the significance difference between groups . P-value of less than 0.05 was used to determine the significance of the outcome measurements between the three groups for Oxygenation and muscle strength parameters and amount of sputum.

RESULTS

The study groups A,B and C composed of 45patients,15 patients for each group , their ages ranged from 50 to 60 years with a mean of 49.67 ±4.28years for group A, a mean of 45.80 ±5.62years for group Banda mean of 47.58 ±5.07years for group C .with no significant difference between groups regarding to age with (P value ; 0.107).

1-Pre- and Post-O_2% within and among each group A, B and C:

The obtained results in this study revealed no significant difference when comparing the pre-treatment mean values of the study groups regarding to O_2% (P value ; 0.251),but post treatment there was significant improvement in the mean values of O_2% in all groups A,B and C (P value ; 0.0001) , improvement percent was0.93% for group A ,then increased to 1.28% for group B due to adding of manual hyperinflation to standard chest physiotherapy, then increased to 2.05% for group C due to adding of manual hyperinflation and respiratory muscles training to standard chest physiotherapy see table (1) and figure (1)

Table 1: Mean pre- and post-O2% within and among groups A, B and C.

Items	O_2%			
	Pre-treatment	Post-treatment	(P-value) Within groups	(%) of improvement
Group A	95.70 ±0.67	96.59 ±0.70	0.0001	0.93%
Group B	96.10 ±0.63	97.33 ±0.48	0.0001	1.28%
Group C	96.03 ±0.76	98.00 ±0.75	0.0001	2.05%
F-value	1.430	17.22		
(P-value) among groups	0.251	0.0001		
Significance (P<0.05)	**NS**	**S**		

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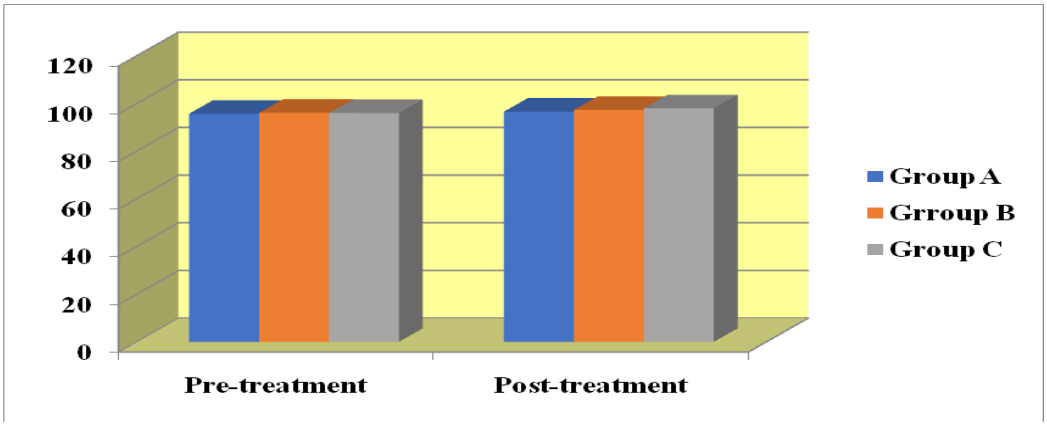

Figure 1: Mean O_2%of pre- and post-treatment within and among groups A, B and C.

2- **Pre- and Post-PaO_2value within and among each group A, B and C:**

The obtained results in this study revealed no significant difference when comparing the pre-treatment mean values of the study groups regarding to PO_2 (P value ; 0.99),but post treatment there was significant improvement in the mean values of PO_2 in all groups A,B and C (P value ; 0.0001) , improvement percent was 4.1% for group A ,then increased to 12.13% for group B due to adding of manual hyperinflation to standard chest physiotherapy, then increased to 22.91% for group C due to adding of manual hyperinflation and respiratory muscles training to standard chest physiotherapy see table (2) and figure (2).

Table 2: Mean pre- and post-PO_2 within and among groups A, B and C

Items	PO_2			
	Pre-treatment	Post-treatment	(P-value) Within groups	(%) of improvement
Group A	136.20 ±10.39	141.80 ±10.10	0.0001	4.11%
Group B	136.33 ±11.42	152.87 ±10.35	0.0001	12.13%
Group C	136.20 ±12.26	167.40 ±6.34	0.0001	22.91%
F-value	0.001	30.92		
(P-value) among groups	0.99	0.0001		
Significance (P<0.05)	NS	S		

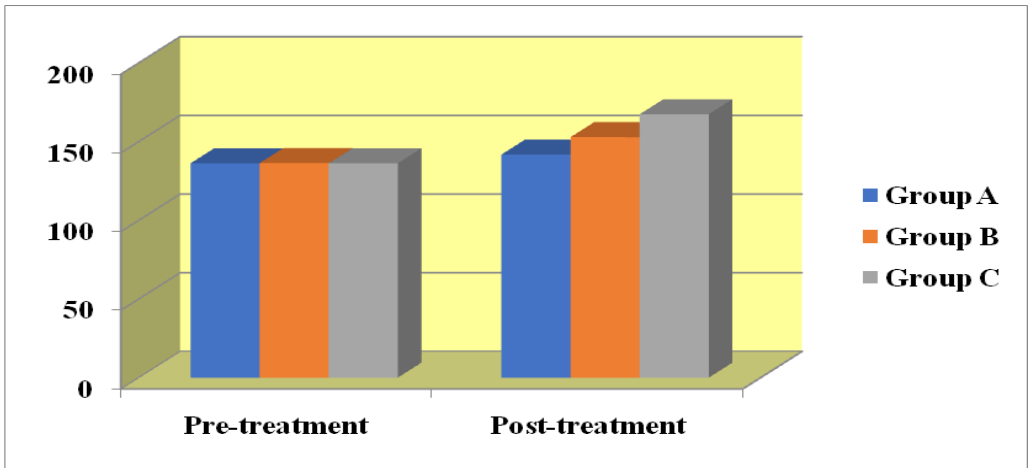

Figure 2: Mean $PO_2$of pre- and post-treatment within and among groups A, B and C.

3-Pre- and Post-PaO_2/FiO_2 ratio within and among each group A, B and C:

The obtained results in this study revealed no significant difference when comparing the pre-treatment mean values of the study groups regarding to PaO2/FiO2 (P value ; 0.99),but post treatment there

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was significant improvement in the mean values of PaO_2/FiO_2 in all groups A,B and C (P value ; 0.0001) , improvement percent was 4.1% for group A ,then increased to 12.13% for group B due to adding of manual hyperinflation to standard chest physiotherapy, then increased to 22.67% for group C due to adding of manual hyperinflation and respiratory muscles training to standard chest physiotherapy see table (3) and figure (3).

Table 3: Mean pre- and post- PaO_2/FiO_2 within and among groups A, B and C.

Items	PaO_2/FiO_2			
	Pre-treatment	Post-treatment	(P-value) Within groups	(%) of improvement
Group A	340.50 ±25.98	354.50 ±25.25	0.0001	4.11%
Group B	340.83 ±28.56	382.17 ±25.87	0.0001	12.13%
Group C	341.17 ±29.74	418.50 ±15.86	0.0001	22.67%
F-value	0.002	29.74		
(P-value) among groups	0.998	0.0001		
Significance (P<0.05)	NS	S		

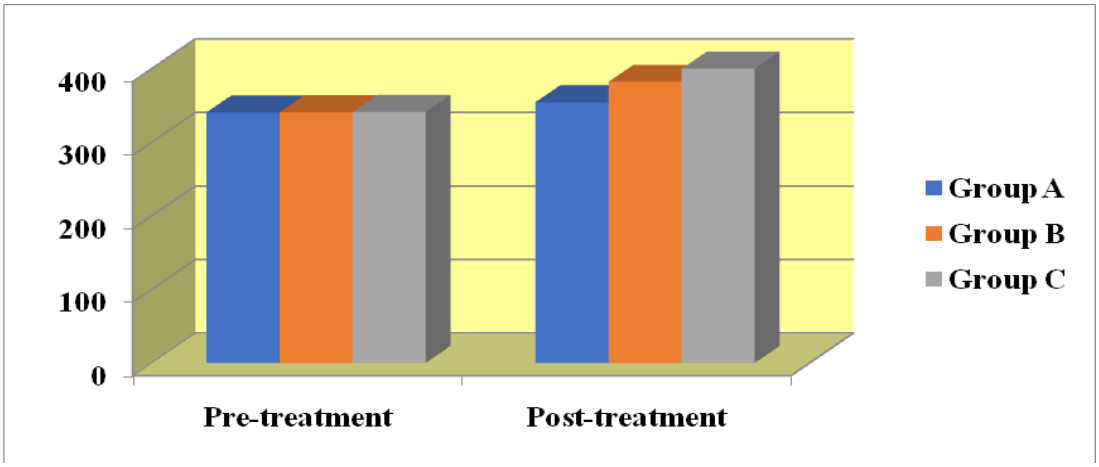

Figure 3: Mean PaO_2/FiO_2 pre- and post-treatment within and among groups A, B and C.

4- Pre- and Post-NIP value within and among groups A, B and C:

The obtained results in this study revealed no significant difference when comparing the pre-treatment mean values of the study groups regarding to NIP (P value ; 0.57),but post treatment there was significant improvement in the mean values of NIP in all groups A,B and C (P value ; 0.0001) , improvement percent was 6.44 % for group A ,then increased to 20.11% for group B due to adding of manual hyperinflation to standard chest physiotherapy, then increased to 33.86 % for group C due to adding of manual hyperinflation and respiratory muscles training to standard chest physiotherapy see table (4) and figure (4).

Table 4: Mean pre- and post- NIP within and among groups A, B and C.

Items	NIP			
	Pre-treatment	Post-treatment	(P-value) Within groups	(%) of improvement
Group A	15.53 ±3.33	16.53 ±2.97	0.0001	6.44%
Group B	15.27 ±2.96	18.33 ±2.16	0.0001	20.11%
Group C	16.33 ±2.19	21.87 ±3.11	0.0001	33.86%
F-value	0.561	14.28		
(P-value) among groups	0.575	0.0001		
Significance (P<0.05)	NS	S		

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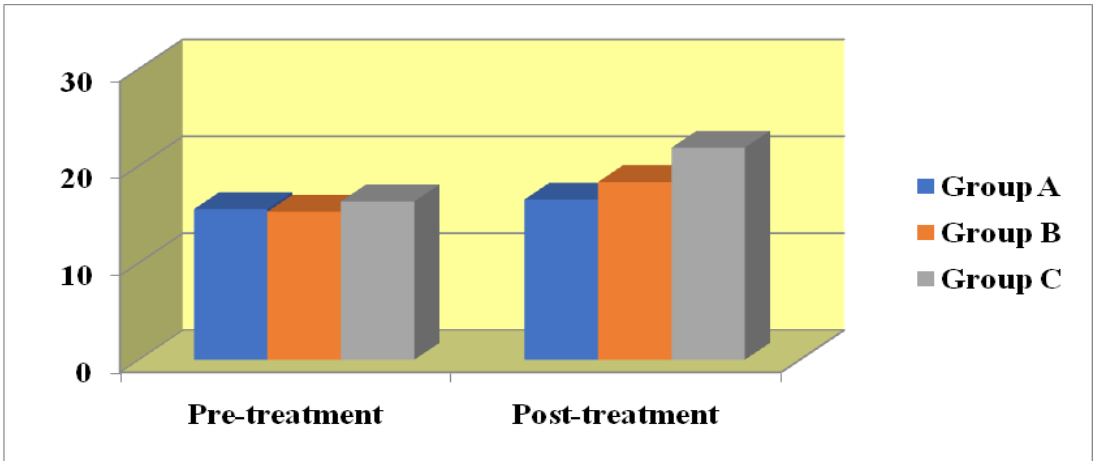

Figure 4: Mean NIP pre- and post-treatment within and among groups A, B and C.

4- Pre- and Post-Sputum amount among groups A, B and C:

The obtained results in this study revealed that there was significant improvement in the mean values of Sputum clearance amount of all groups A,B and C (P value ; 0.0001) ,this improvement was higher in group C more than A and B ,see table (5) and figure (5)

Table 5: Mean Sputum amount value among groups A, B and C.

Items	Sputum amount
Group A	13.27 ±3.19
Group B	20.00 ±6.26
Group C	27.33 ±6.55
F-value	24.09
Level of significance (P-value)	0.0001
Significance (P<0.05)	**S**

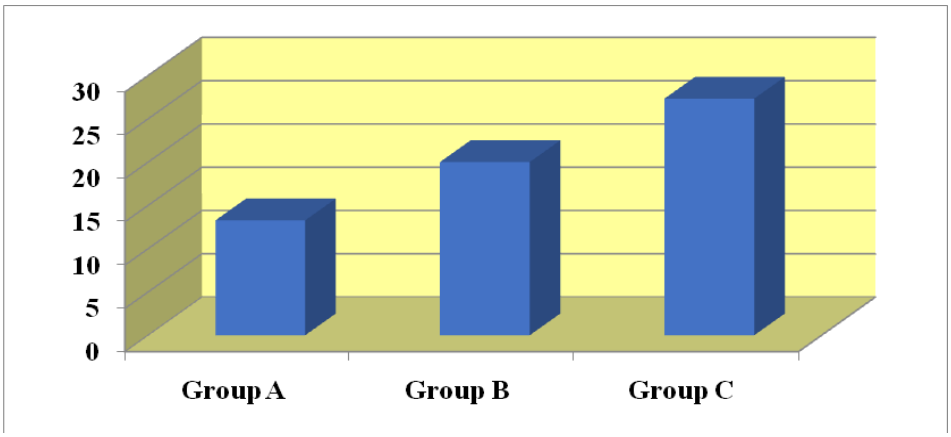

Figure 5: Mean Sputum amount value among groups A, B and C.

DISCUSSION

Medical ICUs are special areas where health professionals may properly and specifically care for this population of patients, including the good physiotherapy programs done to these patients, so increasing the chance of weaning from mechanical ventilation [11]

Patients receiving mechanical ventilation for a long time are frequently de-conditioned because of the adverse effects of medications, and a period of immobilization, weakness of the respiratory and limb muscles that further impairs their functional status and health-related quality of life [12].

The aims of any physiotherapy program in the ICU is to apply advanced therapeutic modalities to decrease the patient's dependency on ventilator, improve residual function, prevent the need for new hospitalizations and so improve the patient's quality of life .

Atelectasis is a common clinical problem in the intubated and ventilated patient and, if prolonged, may lead to hypoxemia, pulmonary infection and fibrosis. In addition, atelectasis lead to a progressive reduction in pulmonary compliance. Manual hyperinflation have been shown to improve both atelectasis and static pulmonary compliance [13]

In addition, mechanical ventilation patients demonstrate a decrease in respiratory muscle endurance and risk of respiratory muscle fatigue. Inspiratory muscle training (IMT) is a procedure that targets the muscles of inspiration with the aim of increasing respiratory muscle power and endurance [14]**.**

Our present investigation was studied the effect of adding of different physiotherapy modalities to chest physiotherapy for ICU patients with the hypothesis that there may be no effect of different physiotherapy modalities on oxygenation, respiratory muscle power and sputum clearance amount for ICU patients . The results in the present investigation showed significant improvement in all study groups in Oxygenation (O_2%,PaO_2, and PaO_2 / FiO_2) ,respiratory muscles strength parameters (NIP) and sputum clearance amount, this improvement significantly increased when we added physiotherapy modalities to chest physiotherapy.

Regarding to the effect of standards chest physiotherapy

Few studies have investigated the benefits and efficacy of physiotherapeutic intervention for patients on mechanical ventilation, resulted in very large effect on oxygenation. The study made by **Hodgson et al.,** [15] stated that when they used chest physiotherapy on eighteen ventilated patients, results revealed a high improvement oxygenation in 90% of these patients, our study revealed that physiotherapy interventions improved oxygen saturation of all study groups, with a tendency towards more improvement in group C more than group B and A because of adding more modalities in group C (hyperinflation and respiratory muscles training in addition to standards chest physiotherapy)**.**

The study done **by Maa** S **et al.,** [16] to examine the potential benefits of physiotherapy in a group of intubated patients, had significant improvement in respiratory system capacity and oxygenation(PaO2 / FiO_2)compared to the control groups**.** These results emphasized our result that showed the improvement in PaO_2/FiO_2 of all groups.

In contrast to the above mentioned positive findings, the study done by **Paratz, and Lipman ,** [17] established that when chest physiotherapy was performed to seven ventilated patients with septic and cardiogenic shock , oxygenation were recorded , the results showed that there were no changes in oxygenation parameters. This may be due to hemodynamic instability of these cases. In our study the careful selection of patients , and exclusion of unstable patients excluded such effects on oxygenation parameters .

Regarding to the effect of adding manual hyperinflation (MHI) to standards chest physiotherapy

Jeffrey Lipman, 2002 [18] investigated the effects of MHI on the ratio of (PaO_2 / FiO_2) and the alveolar-arterial oxygen tension difference (A-a) PO_2 in 100 medically stable mechanically ventilated subjects .results: After MHI there were significant improvements in PaO_2 / $FiO_2$and (A-a) PO_2. The mean improvement for PaO_2 / $FiO_2$was approximately 17% and for (A-a) $PO_2$was approximately 17% immediately post-intervention. Their findings were similar to results of our study ,in our study we used MHI in addition to chest physiotherapy(group B) in mechanically ventilated stable patients and resulted in great improvement in oxygenation (PaO_2,SaO_2% and PaO_2/ FiO_2) in all cases of group B and C more than group A when we add MHI. Percentage of improvement was increased in group B and C more than group A, For O_2 % improvement was

0.93% , 1.28% , 2.05% respectively, for PaO_2percentage of improvement was 4.1% , 12.13% , 22.91% respectively and for PaO_2 / FiO_2 percentage of improvement was 4.1% , 12.13% , 22.67% respectively.

Stiller et al., 2004 [19] used 40 ventilated patient's with acute lobar atelectasis and were taken chest physiotherapy regimens for treatment. Treatment was given was for six hours. After the intensive six-hour treatment period, the difference between the groups was marginally statistically significant.

In our study we used MHI with chest physiotherapy for ventilated patients and resulted in great increase in amount of sputum clearance by means 13.27 ±3.19 for group A, 20.00 ±2.26 for group B and 27.33 ±6.55 for group C.

In contrast to the abovementioned findings, an investigation done by **ParatzLipman**, 2006 [17] established that when MHI was applied to seven ventilated patients with cardiogenic shock and arterial blood gases were recorded, the results showed that there were no changes in PaO_2/FiO_2 this may be due to the instability of these cases. In our study we were selected the haemodynamics stable cases only, so our results was so better than that study.

Regarding to the effect of adding respiratory muscle strength (IMT) to standards chest physiotherapy

After treatment there was significant improvement in respiratory muscle power(NIP) in all groups A,B and C (P value ; 0.0001) , improvement percent was 6.44 % for group A ,then increased to 20.11% for group B due to adding of MHI to chest physiotherapy, then increased to 33.86 % for group C due to adding of MHI and respiratory muscles training to chest physiotherapy, These results go in hand with the randomized controlled study done by **Martin AD et al,** [20] to test whether inspiratory muscle training (IMT) would improve weaning outcome in failure to wean (FTW) patients. Results revealed that a higher percent of improvement of respiratory muscles strength and weaning time in IMT patients than of control group.

The study done **Bissett, B and leditscke, IA**. [21] described the use of specific inspiratory muscle training to enhance weaning from mechanical ventilation in patients who had failed conventional weaning strategies. They concluded that respiratory muscle training can be implemented effectively in the difficult to wean patient and should be considered for patients who have failed conventional weaning strategies.

On the other hand **Notoumenopoulas G et al.** [22] carried out a study on 46 patients who were receiving mechanical ventilation after trauma and were randomly allocated to a group that received standard nursing care and chest physiotherapy, or standard nursing care alone. The outcome measurements included blood gas analysis, the incidence of nasocomial pneumonia, the number of days when mechanical ventilation was provided and the stay in the ICU. No statistical differences were found between the groups in the length of time when mechanical ventilation was provided (mean 6.1 days physiotherapy group 5.2 days control group), the length of stay in the ICU (mean 7.4 days physiotherapy group, 6.8 days control group) or the mortality rate (for both groups). This differs from our study findings mostly due to that the patients of our study were subjected to chest physiotherapy treatment, so improvement done to both groups but higher and significant in the study group.

REFERENCES

[1] Nelson JE, Cox CE, Hope AA, Carson SS.; Concise clinical review: chronic critical illness. Am J RespirCrit Care Med.2010;182:446---54.

[2] Gosselink R, Bott J, Johnson M, Dean E, Nava S, Norrenberg et al.;Physiotherapy for adult patients with critical illness :recommendations of the European Respiratory Society European Society of Intensive Care Medicine Task Force on physiotherapy for critically ill patients. Intensive Care Med.m2008;34:1188---99.

[3] Hanekom S, Gosselink R, Dean E, van Aswegen H, RoosR,Ambrosino N, et al. The development of a clinical management algorithm for early physical activity and mobilization of critically ill patients: synthesis of evidence and expert opinion and its translation into practice. ClinRehabil. 2011;(April)[Epub ahead of print].

[4] Novoa N, Ballesteros E, Jiménez MF, Aranda JL, Varela G.;Chest physiotherapy revisited: evaluation of its influence onthe pulmonary morbidity after pulmonary resection. Eur J CardiothoracSurg. 2011;40(Jul (1)):130---4.
[5] Ambrosino N, Gabbrielli L. Physiotherapy in the perioperativeperiod. Best Pract Res ClinAnaesthesiol. 2010;24:283---9.
[6] Pohlman MC, Schweickert WD, Pohlman AS, Nigos C, PawlikAJ,Esbrook CL, et al. Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation. CritCare Med. 2010;38:2089---94.
[7] Ciesla N. : Chest Physical Therapy for Patients in the Intensive Care Unit. Physical Therapy 1996, Vol 76, No.:6.
[8] DenehyL .: The use of manual hyperinflation in airway clearance. EurRespir J 1999, 14: 958-965.
[9] Suzanne E.:Improving Adherence to mechanical Ventilation, Weaning Protocol for Critically Adult: Outcomes after Implantation Program. American Journal of Critical Care, May 2006, Vol 15, No.:3.
[10] Cader SA, Vale RG, Castro JC, et al.(2010); Inspiratory muscle training improves maximal inspiratory pressure and may assist weaning in older intubated patients: a randomised trial. J Physiother;56:171e7.
[11] Chiang ,: Effects of Physical Training on Functional Status in Patients With Prolonged Mechanical Ventilation. Physical Therapy; 2006;86(9).pp 324-344.
[12] Hodgson, C. Denehy, L. Ntoumenopoulos, G. Santamaria, J. and Carroll, S.: An investigation of the early effects of manual lung hyperinflation in critically ill patients. Anaesthesia and Intensive Care; 2000 ;(28): 255–261.
[13] Branson, RD.: Functional principles of positive pressure ventilators: implications for patient-ventilator interaction. Respir Care Clin North Am;2005; (11):119–145.
[14] Petrof BJ, Jaber S and Matecki S.; Ventilator-induced diaphragmatic dysfunction .CurrOpinCrit Care, 2010; 16:19-25.
[15] Hodgson, C. Denehy, L. Ntoumenopoulos, G. Santamaria, J. and Carroll, S,;An investigation of the early effects of manual lung hyperinflation in critically ill patients. Anaesthesia and Intensive Care.,2000; (28): 255–261.
[16] Maa, S. Hung, T. Hsu, K. Hsieh, Y. Wang, K. and Wang, C.; Manual hyperinflation improves alveolar recruitment in difficult to wean patients. Chest ,2005; (128):2714–2721.
[17] Paratz, J. and Lipman, J, Manual hyperinflation causes nor epinephrine release .The Journal of Acute and Critical Care , 2006; , Vol 35 , (4): pp 262 - 268 J .
[18] Jeffrey Lipman , : Effect of Manual Hyperinflation on Hemodynamics, Gas Exchange, and Respiratory Mechanics in Ventilated Patients; Journal of Intensive Care Medicine, Vol. 17, No. ;2002;(6): 317-324 .
[19] Stiller, K.: Physiotherapy in Intensive Care : Towards an Evidence-Based Practice Chest ;2000;(118);1801-1813.
[20] Martin AD, Smith BK, Davenport PD, et al. ; Inspiratory muscle strength training improves weaning outcome in failure to wean patients: a randomized trial. Crit Care 2011;15:R84.
[21] Bissett B, Leditschke IA.: Inspiratory muscle training to enhance weaning from mechanical ventilation. AnaesthIntens Care,2007; 35(5):776-779.
[22] Notoumenopoulas G, Gild A and CooferDJ .; The effect of manual lung hyperinflation and postural drainage on pulmonary complications in mechanically ventilated trauma patients. Anaesth Intensive Care,1998;26:492–496.