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Ventilatory Effect of Proprioceptive Neuromuscular Facilitation Patterns in Critically Ill Patients: A Brief Review

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ABSTRACT

Background: The Intensive Care Unit (ICU) plays a crucial role in managing patients with life-threatening conditions, and the mortality rate of mechanically ventilated patients in developed countries is on the rise. Chest complications during ICU stays, such as respiratory failure and pneumonia, pose significant challenges in patient care, requiring continuous and vigilant medical and physiotherapy intervention.
Objective: This narrative review explores the role of Proprioceptive Neuromuscular Facilitation (PNF) techniques in chest physiotherapy for mechanically ventilated patients, aiming to assess their impact on respiratory parameters and overall patient outcomes.
Method: A comprehensive analysis of relevant literature was conducted, focusing on studies investigating the ventilatory effects of PNF in different patient populations, including neurological injuries, organophosphorus poisoning, and chronic obstructive pulmonary disease (COPD).
Results: The reviewed studies demonstrated that incorporating PNF techniques, such as intercostal stretch and anterior basal lift, alongside conventional chest physiotherapy, positively influenced respiratory rates, oxygen saturation, and pulmonary compliance. These findings suggest that PNF can be an effective adjunct in preventing pulmonary complications and improving outcomes in mechanically ventilated patients.
Conclusion: The evidence presented in this narrative review supports the integration of PNF techniques into chest physiotherapy for mechanically ventilated patients. The positive outcomes reported in the literature suggest that PNF can be a valuable adjunct to conventional care, contributing to better respiratory function and potentially reducing complications associated with immobility.

Keywords: Intensive Care Unit (ICU), Mechanical ventilation, Physiotherapy intervention, Chest complications, Chest physiotherapy techniques, PNF techniques

INTRODUCTION

Intensive Care Unit (ICU) is a unit especially dedicated for the patients with life-threatening conditions, injuries or complications that specialize in management for the same. In developed countries, the mortality rate of patients on mechanical ventilation is increasing beyond 35% particularly in non-surgical patients requiring frequent ventilation. Patients in ICU are predominantly admitted for severe clinical manifestations. In special situations patients may also be kept for monitoring of vital signs like in postoperative cases or systemic abnormalities like hypertension.[1]

The chest care of unconscious and recumbent patients are difficult and challenging because they lack self (voluntary) breathing effort. Common chest complications during ICU stay are respiratory failure, atelectasis, acute lung injury, pneumonia, pneumothorax, pneumonitis, exacerbation COPD, atelectasis due to secretions retained secretions, abnormal breathing pattern due to primary or secondary pulmonary dysfunction and musculoskeletal deformity that makes breathing pattern and cough ineffective. [2]

ICU management require continuous and vigilant medical care and physiotherapy care to keep patient chest clear and maintain mobility in bed ridden patients and also assist in weaning the patient off the ventilator. It is a team effort irrespective of specialty.[1]

Physiotherapists in ICU are involved in preventing functional impairment in the patient on mechanical ventilation support. It starts with detail assessment of the patient including history, current status, investigations and monitoring of vitals which go hand in hand during treatment and planning of treatment goals according to patient condition. Physiotherapy is aimed at maintaining bronchial hygiene through positioning, percussion, vibration, mobilization, and endotracheal suctioning in order to prevent and reduce potential pulmonary complications such as hypoventilation, hypoxemia and infection and restore muscular and pulmonary function as far as possible. [1]

A mechanical ventilator is a machine designed to move breathable air into and out of the lungs to provide mechanism of breathing for a patient who is suffering from breathing insufficiency. In Intensive Care Unit ventilator is a lifesaving intervention for immune-compromised patients. The chest care of unconscious and recombinant patients are difficult and challenging because they lack self (voluntary) breathing effort. In such cases mechanical ventilation helps in reducing work of breathing by preventing hypoxemia. Assist control ventilator delivers a set tidal volume when triggered by the patient's inspiratory effort and helps in weaning process.[3]

Indications for mechanical ventilation may vary from patient to patient that may include apnoea and impending respiratory arrest, acute exacerbation of COPD, cardiogenic shock etc. Utilization of mechanical ventilation extends from short term and long-term care in the hospital to care at home. There are many impediments associated with mechanical ventilation including pneumothorax, pneumonia, airway injury, alveolar damage, and reduction in cardiac output, disuse atrophy of diaphragm and oxygen toxicity.[1]

Mechanically ventilated patients are prone to develop all the disorders of immobility, such as hypostatic pneumonia, muscle wasting, limb contractures and pressure sores. All such problems are multiplied by infections and patients who are intubated are very prone to chest infections in particular. It is often the case that good chest physiotherapy can prevent or treat chest complications without recourse to antibiotics, and its frequent application is vital. Even the mechanically ventilated patient are having chances to develop other complications like retention and collection of secretions, reduced depth of breathing, broncho spasm and dependency. The roll of chest physiotherapy is vital.[4]

Chest physiotherapy works by improving mucus clearance, decreasing the risk of pulmonary infection and thus enhancing quality of life. Viscous secretions, cuffed tracheal tube, dehydration, reduced normal respiratory efforts of the patient; hypoxemia, immobility and poor humidification all contribute to hamper mucociliary activity and impeding clearance of secretions. Optimum mucociliary activity and an effective cough are needed for normal airway clearance. Therefore, to bring improvement in pulmonary and hemodynamic parameters regular chest physiotherapy must be advocated. Even in absence of primary or significant lung disease chest physiotherapy is a key factor in respiratory care of mechanically ventilated patients. Percussion and vibration are manual techniques of chest

physiotherapy that are used for manipulation of thorax to apply intermittent kinetic energy to dislodge bronchial secretions. It has been established that chest physiotherapy is beneficial in improving lung compliance and preventing lung collapsed.[1]

PNF: Proprioceptive Neuromuscular Facilitation (PNF) is a facilitator technique that can be used to improve chest wall mobility and thus improving expansion of chest. For restoring normal breathing pattern intercostal stretch is the most effective proprioceptive facilitator technique, other techniques include vertebral pressure to the upper thoracic spine, vertebral pressure to the lower thoracic spine, anterior stretch lift to the posterior basal area, moderate manual pressure, perioral pressure, abdominal co-contraction. PNF lays base for the restoration of function by improving muscle strength, endurance, facilitate mobility, stability, control and coordinated movement.[1]

Many studies have described a number of PNF techniques reported to increase the depth of breathing, decrease the respiratory rate and increase the arousal in patient with a decreased level of consciousness.

Authors, Journal, Year	**Objectives**	**Design**	**Characteristics of participant's sample size**	**Methods**	**Outcome measures**	**Results**	**Limitation**
Chang A. et al.2012[5]	Ventilatory effects of neurophysiological facilitation in and passive movement in patients with neurological injury	Experimental study	Thirteen intubated, high dependency patients with neurological injuries were studied to investigate the short-term respiratory effects of neurophysiological facilitation and passive movement on tidal volume (VT), minute ventilation (VE), respiratory rate (VR), and oxygen saturation (SpO_2).	The subjects were studied under four conditions: no intervention (control) and during periods of neurophysiological facilitation, passive movement and sensory stimulation. All periods were standardized to three minutes duration and all parameters were recorded before and after each intervention.	SPO_2, Tidal volume, Minute volume and Respiration rate.	The results of this study indicate that neurophysiological facilitation can increase ventilation in patients with decreased consciousness.	Some limitations of the study include the small sample, the ceiling effect of the SpO_2 measurements, and the lack of follow-up respiratory measurements to see the duration of the observed increases in V_e[minute volume].
Gupta P. et al.2014[3]	Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in	Experimental study	The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were	Patients were given the intervention according to their allocated group for 3 days and effects of these techniques on RR, SpO2 and HR parameters were observed. Data were taken at baseline and after 3 days of intervention.	Respiration rate, Heart rate and SpO2.	The results of this study indicate that IC stretch is more effective in reduction of respiratory rate and heart rate and improving oxygen saturation over anterior basal lift technique.	Some limitations of the study were no follow up was done. To reach the significant conclusion. There was limited information available regarding anterior basal lift technique attributing to study limitation

	mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Effect of intercostal stretch technique and anterior basal lift technique on respiration rate, saturation rate of peripheral oxygen and heart rate among ICU patients		excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and				

			Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. Indian Journal of Basic and Applied Medical Research; March 2014: Vol.-3, Issue- 2, P.461-466 www.ijbamr.com P ISSN: 2250-284X, E ISSN :2250-2858463 This study was commenced by January 2013 and completed by August 2013. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were				

			excluded from the study 30 patients from ICU of C.U. Shah medical hospital were taken for the study who fulfilled the eligibility criteria and were systematically divided into Group A (IC stretch) and Group B (ABL)				
Seo K. C. et al.2014[6]	Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients The Effects on the pulmonary function of	Random sampling	The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study. Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age,	Over the course of four weeks, the experimental group participated in PNF respiration pattern exercises for 30 minutes three times per week. Subjects were assessed pre-test and post-test by measurement of pulmonary function (tidal volume, inspiratory reserve volume, expiratory reserve volume, inspiratory capacity, and vital capacity).	Tidal volume, inspiratory reserve volume, expiratory reserve volume, inspiratory capacity, and vital capacity	In this study, the experimental group showed greater improvement in pulmonary function than the control group, which indicates that the PNF respiration exercise is effective at increasing the pulmonary function of normal adults.	

	normal adults proprioceptive neuromuscular function respiration pattern exercise.		with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. Indian Journal of Basic and Applied Medical				

			Research; March 2014: Vol.-3, Issue- 2, P.461-466 www.ijbamr.com P ISSN: 2250-284X , E ISSN :2250-2858 463 This study was commenced by January 2013 and completed by August 2013. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study Twenty-eight normal adults in their 20s were randomly assigned to an experimental group (n=14) or control group (n=14).				

Authors, Journal, Year	**Objectives**	**Design**	**Characteristics of participants sample size**	**Methods**	**Outcome measures**	**Results**	**Limitation**
Chordiya S. et al. 2017[7]	Effect of respiratory proprioceptive neuromuscular facilitation technique with chest physiotherapy in mechanically ventilated organophosphorus poisoning patients.	Experimental comparative study	A total of 30 participants with OP poisoning in the age group of 15-85 years were included in the study.	A total of 30 participants with OP poisoning in the age group of 15-85 years were included in the study. On 1st, 2nd and 3rd day static compliance, dynamic compliance, Minute ventilation, Heart Rate, Systolic	Static compliance, dynamic compliance, Minute ventilation, Heart Rate, Systolic Blood Pressure and Diastolic Blood Pressure.	The study concluded that Chest Physiotherapy along with PNF technique in the management of mechanically ventilated patients with pulmonary complication proved efficient for preventing pulmonary complications, clearing the mucous	They said it was difficult to manage the timing for intervention due to workload in ICU therefore patients receive intervention in different times some receive in morning,

				Blood Pressure and Diastolic Blood Pressure were assessed. Group A received Chest Physiotherapy and Group B received Chest Physiotherapy and PNF technique. Intervention was given twice in a day, 3days and each session lasts for 15-30 minutes.		secretions and better prognosis in patients with OP poisoning.	some receive in afternoon and some receive in evening.
Ashtankar A P et al. 2019[2]	comparative effect of proprioceptive neuromuscular facilitation (PNF) and chest physiotherapy with chest physiotherapy alone on SP02, heart rate, respiratory rate, & lung compliance in mechanically ventilated patient	Experimental comparative study	The total number of participants were n=30 in ICU on Synchronized Intermittent Mechanical Ventilation (SIMV) mode of ventilator.	30 participants from Intensive Care Unit (MICU) were included in the study and divided into two groups: Group A received PNF and chest physiotherapy & Group B received chest physiotherapy alone. Patients were given the intervention according to their allocated group for 5 days and effects of these techniques on RR, SpO2 and HR and lung compliance parameters were observed. Data were taken at baseline and after 5 days of intervention.	Static compliance, dynamic compliance, Heart Rate, Respiration rate, saturation of oxygen, heart rate.	The present study concludes that PNF alone with chest Physiotherapy are better and effective in improving saturation of oxygen, pulmonary compliance and reduction of Heart Rate, Respiratory Rate and lead to early extubation of patients.	There is limited data on anterior basal life technique of PNF.
Kai L. et al. 2021[8]	Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphoru	A Randomized controlled trial	The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal	On the basis of conventional treatment, the control group performed 30 min aerobic training on a treadmill, while the PNF group added 10-minute	COPD Assessment Test (CAT), dyspnea Visual Analog Scale (VAS), forced vital capacity (FVC), forced	PNF stretching combined with aerobic training reduces dyspnea and improves some pulmonary function measures, which is associated with neck/shoulder	–

	s poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Effects of proprioceptive neuromuscular facilitation stretching combine with aerobic training on pulmonary function in COPD patients		intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP	PNF stretching 3 times every training day. Both groups did their training in 5 days per week for 6 weeks.	expiratory volume in first second (FEV_1), inspiratory capacity (IC), inspiratory reserve volume (IRV), 6-minute walk test (6MWT), the range of motion (ROM) of head protraction, shoulder flexion, and the non-dominant pectoralis minor muscle (PmM) length were measured.	mobility, in COPD patients.	

			poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. Indian Journal of Basic and Applied Medical Research; March 2014: Vol.-3, Issue- 2, P.461-466 www.ijbamr.com P ISSN: 2250-284X , E ISSN :2250-2858 463 This study was commenced by January 2013 and completed by August 2013. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal				

			intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study Fifty-five COPD patients were randomly divided into PNF group (n=28) and control group (n=27).				
Renata janaina pereira de souza et al. 2020[9]	Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated organophosphorus poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in mechanically ventilated	A Randomized controlled trial	The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study.	Individuals will be evaluated at three different times (pretreatment, after 20 days of treatment and 1 month after the end of treatment). The treatment protocol consists of respiratory exercises, 30 min of CRT (cycle ergometer) and then repetition of the respiratory exercises, performed three times a week over a period of 20 days.	Primary measures were quality of life, gait, balance, peak oxygen uptake and rib cage compartment volumes. As secondary outcomes, respiratory function and maximal inspiratory and expiratory pressures will be measured.	The association of PNF with CRT may be a viable and accessible alternative to increase cardiorespiratory function in patients with stroke.	–

	organophosphorus poisoning patients Addition of proprioceptive neuromuscular facilitation to cardiorespiratory training in patients post stroke : study protocol for a randomized controlled trial		The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive pulmonary diseases were excluded from the study. The sample size was 30. Both males and females, between 20-40 years of age, with the history of OP poisoning and within 48 hours of Endotracheal intubation and ventilation were selected for the study .Patients with fracture rib/vertebrae [in case of associated injuries] and Chronic obstructive				

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CONCLUSION

The studies discussed in this narrative review highlight the positive impact of PNF patterns on pulmonary ventilation and other related outcomes. The findings suggest that incorporating PNF techniques in physiotherapy interventions can contribute to improved chest wall mobility, increased chest expansion, and enhanced respiratory parameters. Various PNF techniques, such as intercostal stretch and anterior basal lift, have shown effectiveness in reducing respiratory rates, improving oxygen saturation, and promoting better pulmonary compliance.

Summary

The evidence presented in this review supports the integration of PNF techniques into chest physiotherapy for mechanically ventilated patients. The positive outcomes reported in the literature suggest that PNF can be a valuable adjunct to conventional care, contributing to better respiratory function and potentially reducing complications associated with immobility.

Declaration by Authors

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