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 lifethreatening 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% in particularly 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 bronchial hygiene through maintaining positioning. percussion. vibration, mobilization, and endotracheal suctioning in order to prevent and reduce potential complications pulmonary 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 longterm care in the hospital to care at home. There are many impediments associated with ventilation mechanical 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 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 cocontraction. 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.

Author s, Journal	Objectives	Design	Characteristics of participant's sample size	Methods	Outcome measures	Results	Limitation
Year Chang A. et al.2012 ⁵	Ventilatory effects of neurophysiologi cal facilitation in and passive movement in patients with neurological injury	Experiment al study	Thirteen intubated, high dependency patients with neurological injuries were studied to investigate the short-term respiratory effects of neurophysiologi cal facilitation and passive movement on tidal volume (VT), minute ventilation (VE), respiratory rate (VR), and oxygen saturation	The subjects were studied under four conditions: no intervention (control) and during periods of neurophysiologi cal 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 Respiratio n rate.	The results of this study indicate that neurophysiologi cal 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 measurement s, and the lack of follow-up respiratory measurement s 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 organophosphor us poisoning patients Determine the significance of proprioceptive neuro muscular facilitation technique with conventional chest physiotherapy in	Experiment al study	(SpO ₂). 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.	Respiratio n 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

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	males and			
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	between 20-40			
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	Chronic			
	obstructive			
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	diseases were			
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			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				
C V		D 1	Group B (ABL)	0 4	TT' 1 1	T (1' (1 (1	
Seo K.	Determine the	Random	The sample size	Over the course	Tidal	In this study, the	
C. et al.2014 ⁶	significance of	sampling	was 30. Both	of four weeks,	volume,	experimental	
al.2014*	proprioceptive neuro muscular		males and	the experimental	inspiratory	group showed	
			females,	group	reserve	greater	
	facilitation		between 20-40	participated in	volume,	improvement in	
	technique with conventional		years of age, with the history	PNF respiration	expiratory	pulmonary	
	conventional		of OP	pattern exercises for 30 minutes	reserve volume,	function than the control group,	
	physiotherapy in			three times per	inspiratory	control group, which indicates	
	mechanically		poisoning and within 48 hours	week. Subjects	capacity,	that the PNF	
	ventilated		of Endotracheal	were assessed	and vital	respiration	
	organophosphor		intubation and	pre-test and post-	capacity	exercise is	
	us poisoning		ventilation were	test by	capacity	effective at	
	patients		selected for the	measurement of		increasing the	
	Determine the		study. Patients	pulmonary		pulmonary	
	significance of		with fracture	function (tidal		function of	
	proprioceptive		rib/vertebrae [in	volume,		normal adults.	
	neuro muscular		case	inspiratory		normai adults.	
	facilitation		of associated	reserve volume,			
	technique with		injuries] and	expiratory			
	conventional		Chronic	reserve volume,			
	chest		obstructive	inspiratory			
	physiotherapy in		pulmonary	capacity, and			
	mechanically		diseases were	vital capacity).			
	ventilated		excluded from	vital capacity).			
	organophosphor		the study.				
	us poisoning		The sample size				
	patients		was 30. Both				
	Determine the		males and				
	significance of		females,				
	proprioceptive		between 20-40				
1	neuro muscular		years of age,				
1	facilitation		with the history				
1	technique with		of OP				
1	conventional		poisoning and				
	chest		within 48 hours				
	physiotherapy in		of Endotracheal				
	mechanically		intubation and				
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	organophosphor		selected for the				
	us poisoning		study. Patients				
	patients		with fracture				
	Determine the		rib/vertebrae [in				
	significance of		case				
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	neuro muscular		injuries] and				
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	technique with		obstructive				
1	conventional		pulmonary				
1	chest		diseases were				
1	physiotherapy in		excluded from				
1	mechanically		the study.				
1	ventilated		The sample size				
	organophosphor		was 30. Both				
	us poisoning		males and				
	patients		females,				
	The Effects on		between 20-40				
	the pulmonary		years of age,				
	function of						
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normal adults with the history proprioceptive of OP neuromuscular poisoning and function within 48 hours respiration of Endotracheal pattern exercise. intubation and ventilation were selected for the study Patients with fracture rib/vertebrae [in case of of and Chronic obstructive	
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diseases were	
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the study.	
The sample size	
was 30. Both	
males and	
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years of age,	
with the history	
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	within 48 hours	
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	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	
	assigned to an	
	experimental	
	group (n=14) or	
	control group	
	(n=14).	

Authors, Journal,	Objectives	Design	Characteristics of participants	Methods	Outcome measures	Results	Limitation
Year			sample size		meusures		
Chordiya S. et al. 2017 ⁷	Effect of respiratory proprioceptive neuromuscular facilitation technique with chest physiotherapy in mechanically ventilated organophosphoru s poisoning patients.	Experimenta l 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 interventio n due to workload in ICU therefore patients receive interventio n 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.
Ashtanka r 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	Experimenta l 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 physiotherap y & Group B received chest physiotherap y 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	-

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	s poisoning	intubation and	PNF	expiratory	mobility, in	
	patients	ventilation were	stretching 3	volume in	COPD patients.	
	Determine the	selected for the	times every	first second	1	
	significance of	study .Patients	training day.	$(FEV_1),$		
	proprioceptive	with fracture	Both groups	inspiratory		
		rib/vertebrae [in				
	neuro muscular		did their	capacity		
	facilitation	case	training in 5	(IC),		
	technique with	of associated	days per week	inspiratory		
	conventional	injuries] and	for 6 weeks.	reserve		
	chest	Chronic		volume		
	physiotherapy in	obstructive		(IRV), 6-		
	mechanically			minute walk		
		pulmonary				
	ventilated	diseases were		test		
	organophosphoru	excluded from		(6MWT),		
	s poisoning	the study.		the range of		
	patients	The sample size		motion		
	Determine the	was 30. Both		(ROM) of		
	significance of	males and		head		
		females,		protraction,		
	proprioceptive	,		•		
	neuro muscular	between 20-40		shoulder		
	facilitation	years of age,		flexion, and		
	technique with	with the history		the non-		
	conventional	of OP		dominant		
	chest	poisoning and		pectoralis		
	physiotherapy in	within 48 hours		minor		
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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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conflict of interest. The authors declare no conflict of interest.

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