International Journal of Research in Medical Sciences
Nandre BS et al. Int J Res Med Sci. 2023 Dec;11(12):4334-4340
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20233696

Original Research Article

Effect of manually assisted cough technique on cough strength in extubated patients with organophosphorus poisoning

Bhagyasha Shamkant Nandre*, Sambhaji B. Gunjal

Department of Cardio-Respiratory, Dr. APJ Abdul Kalam College of Physiotherapy, Loni, Maharashtra, India

Received: 14 March 2023
Accepted: 22 November 2023

***Correspondence:**
Dr. Bhagyasha Shamkant Nandre,
E-mail: Bhagyashanandre@gmail.com

ABSTRACT

Background: Organophosphate (OP) ingestion is one of the most common emergencies treated at poisoning control centers worldwide. In an extubated patient with OPP, the abdomen and chest muscles are affected, it also affects a person's ability to breathe on their own, rendering them dependent on a ventilator. Intubation weakens the abdominal muscles and diaphragm making it difficult to cough and clear the chest. A manual cough-assisted technique is used to enhance the cough strength, to help with the clearance of secretions it can be carried out in lying, side-lying, or sitting positions. Objectives were to find the effect of a manually assisted cough (MAC) technique on cough strength (Peak cough flow (PCF) and maximum expiratory pressure) in extubated patients with organophosphorus poisoning.
Methods: According to the selection criteria, 50 participants extubated with organophosphorus poisoning were included. A baseline assessment was done of all individuals and MAC techniques were given. outcome measures were assessed with PCF meter and PE_{max} manometer. MAC techniques are given for 1 week to each patient.
Results: Pre and post-intervention PCF and maximal expiratory pressure (MEP) was compared and analyzed with paired t tests and which shows an extremely significant difference with $p<0.0001$ which indicates significant improvement in cough strength after 1 week of MAC techniques.
Conclusions: This study concluded that the MAC. Technique improved the cough strength (PCF and MEP) in extubated patients with organophosphorus poisoning.

Keywords: Organophosphorus poisoning, PCF, MEP, MAC techniques

INTRODUCTION

Organophosphorus compounds (OPCs) are extremely dangerous and have a wide variety of chemical structures mainly presented by phosphotriester, thiophosphotriester, and phosphorothioate. Pesticides currently approved for the application of OPCs contain sulfur instead of phosphoryl oxygen. Such substitution is believed to reduce the level of acute toxicity of these compounds to human beings.[1]

The mortality rate of OP poisoning is high: the fatal issue is often related to a delay in diagnosis or improper management, and deaths occur within hours of pesticide ingestion during the acute cholinergic crisis, either before or soon after reaching medical care.[2] MEP are quick, easy, and non-invasive tests for direct measurement to check the strength of respiratory muscles. MIP primarily reflects the strength of the diaphragm and secondary chest wall muscles and elasticity, whereas MEP reflects a group of expiratory muscles, primarily abdominal and chest wall muscles.[3] Normally, MEP is expressed as absolute values in cmH_2O^3s.

Intubation weakens the abdominal muscles and diaphragm making it difficult to cough and clear the chest. Chronic accumulation of secretions in the lungs, as it is typically seen in patients with OPP increases the chances of respiratory complications such as pneumonia,

atelectasis, respiratory failure and it also occurs death. The air passages can be cleaned by artificial means, such as positioning, suction, or MAC. However, because these methods require assistance, the lungs may not be cleared frequently enough. The inability to cough freely and effectively severely compromises a patient's health.[4]

OPP affects ability to cough and effectiveness of mucus clearance. PFM and Pi. Max manometer is used to assess the ability to cough. Airway clearance techniques used are incentive spirometry, balloon blowing exercise, MAC technique, active cycle of breathing exercise, postural drainage, and positive expiratory pressure. A manual cough-assisted technique is used to enhance cough strength, to help with clearance of secretions it can be carried out in lying, side-lying/ sitting positions. OPP leads to weakness in the respiratory and abdominal muscles which usually helps people to cough.[4]

This results in difficulty in clearing secretions from chest. It is important to clear secretions in order to maintain clear and healthy lungs. By using MAC technique, the risk of repeated chest infections and complications can be reduced which can improve one's quality of life. To maximize airway clearance, several techniques can be used to stimulate a stronger cough, make coughing more comfortable or improve clearance of secretions.[5]

MAC technique can be performed if a patient has abdominal muscle weakness, manual pressure on the abdominal area assists in developing greater intra-abdominal pressure for a more forceful cough. Manual pressure for cough assistance can be applied by the therapist or the patient. Therapist-assisted techniques with the patient in a supine or semi-reclining position, the therapist places the heel of one hand on the patient's abdomen at the epigastric area just distal to the xiphoid process. The other hand is placed on top of the first, keeping the fingers open or interlocking them. After the patient inhales as deeply as possible, the therapist manually assists the patient as he or she attempts to cough. The abdomen is compressed with an inward and upward force, which pushes the diaphragm upward to cause a more forceful and effective cough. MAC is a technique using strong arms to assist cough.[6]

This may be helpful in neuromuscular disease and abdominal muscles. In patients with OPP as there is weakness in the respiratory and abdominal muscles. The patient is not able to cough effectively and the patient is having difficulty in clearing secretions from the lungs. So due to this PCF is reduced moderately. There is a chronic accumulation of cough in extubated patients with OPP which increases the risk for pulmonary complications. Inability to cough voluntarily and effectively severely compromises a patient's health and affects the ability to cough and the effectiveness of mucus clearance.[7]

Few research suggested that this technique improves the PCF and cough strength in patients with abdominal muscle weakness, as there is less literature available on this study, the purpose of the study was to find out the effectiveness of the MAC technique.

METHODS

Study design

Experimental study conducted on extubated patients with organophosphorus poisoning with 50 patients.

Participants source

The participants were selected from the intensive care unit of Pravara medical rural hospital, Loni (BK), Taluka-Rahata, Dist. Ahmednagar, Maharashtra, India.

Study duration

Study conducted from Feb.2022 to Feb. 2023.

Ethical approval

Ethical approval was taken with institutional ethical committee with (Ref. No. PIMS/DR.APJAKCOPT/ IEC/2022/45)

Inclusion criteria

Patients with organophosphorus Poisoning between 20 to 60 years, patient on a ventilator for at least 1 week, Intubation with ETT.

Exclusion criteria

Patient on intubated with tracheostomy, known cases of neurological, respiratory, or cardio conditions and hemodynamically unstable patients

Outcome measures

Cough strength was assessed with PCF and MEP.

PCF was assessed with peak flow meter and PE max was assessed with pressure manometer.

Intervention

MAC techniques: The patient was in a supine or semi-reclining position, therapist placed the heel of one hand on the patient's abdomen at the epigastric area just below the xiphoid process, and another hand was placed on top of the first keeping the fingers open or interlocking them after the patient inhaled as deeply as possible the therapist manually assisted patient as he /she attempted to cough the abdomen was compressed and an inward and upward force applied which pushed diaphragm upward to cause a more forceful and effective cough MAC technique using strong arms to assist your cough.

Protocol of intervention: 10-12 repetitions in one set with rest after 4 repetitions, 3 to 4 sets in one session, one session in a day and for 1 week.

RESULTS

The present study conducted on "effectiveness of MAC technique on PCF and MEP in extubated patients with organophosphorus poisoning (n=50) was selected to investigate the effects of a 1 week MAC technique on cough strength and MEP. The data was collected and used to analyze the results. The results for the study were obtained by pre. and post-measurement of PCF and MEP. All 50 participants completed 1 week of intervention. A parametric test (paired t test) was used with the CI=95%. Paired t test was used to compare the difference between pre and post-intervention values on different parameters.

Demographic data

The total number of participants selected for the study was 50 (35 male and 15 female) aged between 20 to 60 years after fulfilling the inclusion and exclusion criteria.

PCF

Pre-intervention PCF mean was 134.24 and after 1 week of intervention, the mean of PCF was 219.7 with a mean difference was 85.46.

Pre and post-intervention PCF was compared and analyzed with paired t tests and which shows an extremely significant difference with a t value of 13.963 and p<0.0001 Which indicated improvement in cough strength following 1-week MAC techniques.

MEP (PE_{max})

Pre-intervention MEP mean was 10.212 and after 1 week of intervention, the mean of MEP was 19.578 with a mean difference was 9.366.

Pre and post-intervention MEP were compared and analyzed with paired t tests and which shows an extremely significant difference with a t=4.969 and p<0.0001 Which indicated improvement expiration in the following 1-week MAC techniques.

Table 1: Mean and SD demographic data.

Variables	Mean ± SD
Age (In years)	43.38±11.940
Height (cm)	153.28±3.182
Weight (kg)	65.16±6.973
BMI (kg/m^2)	40.712±18.769
Days of intubation	3.78±1.130

Table 2: Gender distribution.

Gender	N (%)
Male	35 (70)
Female	15 (30)
Total	50

Table 3: Comparison of pre-intervention and post-intervention PCF.

PCF	Mean	SD	T value	P value	Level of significance
Pre. intervention	134.24	35.530	13.963	<0.0001	Extremely significant
Post. intervention	219.7	45.641			

Table 4: Comparison of pre-intervention and post-intervention of MEP.

MEP	Mean	SD	T value	P value	Level of significance
Pre. intervention	10.212	5.002	4.969	<0.0001	Extremely significant
Post. intervention	19.578	12.353			

Figure 1: PCF meter.

Figure 2: PE_{max} manometer.

Figure 3: Patient performing PCF in sitting position.

Figure 4: Patient performing MEP in sitting.

Figure 5: Therapist performing MAC technique on a patient in supine position.

Figure 6: Therapist performing MAC technique on a patient in sitting position.

DISCUSSION

The present study conducted on "effectiveness of MAC Technique on PCF and MEP in extubated patients with organophosphorus poisoning (n=50) was selected to investigate the effects of a 1-week MAC techniques program on cough strength and MEP. The data was collected and used to analyze the results. The results for the study were obtained by pre. and post-measurement of PCF and MEP. All 50 participants completed 1 week of intervention.

Many studies have shown, through the analysis of PCF and MEP and MAC technique in spinal cord injury patients, respiratory conditions. Also, many studies show great results in improving oxygenation with the help of the MAC technique. A review of the literature revealed that no specific analysis in extubated patients of organophosphorus poisoning after the use of MAC in humans has been described to date. Therefore, ours can be considered a groundbreaking study. In our study, we described the effectiveness of the MAC technique on PCF and MEP in extubated patients with organophosphorus poisoning.

Effects of MAC techniques on PCF

In our study, we found that pre-intervention PCF mean was 134.24 and after 1 week of intervention mean PCF was 219.7 with a mean difference was 85.46.

Pre and post-intervention PCF was compared and analyzed with paired t tests and which shows an extremely significant difference with a t value of 13.963 and $p<0.0001$ Which indicated improvement in cough strength following 1-week MAC techniques. The result of this study showed that there is an extremely significant difference in PCF after 1 week of MAC technique.

Effects of MAC techniques on MEP

In our study, we found pre-intervention MEP mean was 10.212 and after 1 week of intervention, the mean of MEP was 19.578 with a mean difference was 9.366.

Pre and post-intervention MEP were compared and analyzed with paired t-tests and which shows an extremely significant difference with a t value of 4.969 and p<0.0001 Which indicated improvement expiration in the following 1-week MAC techniques. The result of this study showed that there is an extremely significant difference in MEP after 1 week of MAC technique.

The present study shows that 1-week of MAC technique improved PCF and MEP (Cough strength) in extubated patients.

MAC technique

he present study showed that the MAC technique improves PCF in Extubated patients with organophosphorus poisoning and the mechanism behind this is when cough assisted technique was performed at that time the patient was in a sitting and semi-reclining position, the therapist one hand was placed on the patient's abdomen at the epigastric area just distal to the xiphoid process, the other hand placed on top of the first keeping the fingers open or interlocking them, as the patient inhales as deeply as possible the therapist manually assists the patient as he or she tries to cough which pushes the compressed with an inward and upward force, which pushes the diaphragm upward which causes a more forceful and effective cough. It Increases intraabdominal and intrathoracic pressure. It indirectly improves the strength of the abdominal muscle and diaphragmatic excursion.[8]

The utmost important objective of treatment is the expansion of the lungs and the clearing of secretions. The techniques regularly used to help remove secretions include assisted coughing, percussion, vibrations, aspiration, and assisted postural drainage. To increase ventilation, respiratory exercises can be used for muscle training, non-invasive positive air pressure support, and high tidal volumes in patients on mechanical ventilation. Interventions for mobilizing secretions are essential for preventing mucus plugs, atelectasis, pneumonia, and respiratory failure and should be started early after the extubation. For best results when using respiratory therapy techniques, it is essential to have proper pain treatment to facilitate patient cooperation. The goal of assisted coughing technique is to help generate effective cough strength. MAC, this maneuver consists of chest compressions coordinated with the patient's breathing. This attempts to reproduce the normal cough, helping to move secretions from the lowest areas of the lungs.[9,10]

The therapist performs the technique by placing the palm of the hand below the patient's rib cage, between the xiphoid process and the navel, exerting pressure upwards and inwards in order with the patient's voluntary expiration or cough. External compression acts in place of the abdominal muscles. Its efficiency can be improved with the prior administration of nebulized saline to thin the secretions.[11]

Kang et al conducted a study on the relationships between coughing to respiratory muscle strength and pulmonary compliance in tetraplegic patients the objective of the study was to analyze the factors influencing the capacity of cough, the relationships between maximal respiratory pressure, lung compliance, the capacity of cough, and assisted cough technique were evaluated in tetraplegics, tetraplegic patients were included in the study, unassisted and assisted PCF at two different conditions (a volume assisted method by the mechanical insufflation and the manual assistance by abdominal compression) were evaluated the result of the study showed that both volume and manual assisted method showed significantly higher PCF than unassisted PCF, they concluded that the therapists apply manual pressure only to increase the capacity of cough which assist the expulsive phase. The results of the study showed that both inspiratory and expulsive phases should be assisted to enhance the effectiveness of cough.[12]

Lacombe et al investigated the PCF, a parameter generally used to assess cough efficiency, increased consistently as exsufflation pressure decreased. However, despite increasing PCF values, 15 of the 27 patients exhibited flow-volume curve findings indicating upper airway collapse and coinciding with decrease in effective cough volume (defined as the volume coughed at a flow >3 L/s), suggesting impaired cough efficiency. In contrast, when flow volume curve showed no evidence of upper airway collapse, effective cough volume increased steadily as exsufflation pressure decreased.[13]

Almeida et al investigated cough peak flow was significantly lower in patients with failed extubation (p<0.0001; effect size >2.2 in all cough stimulation methods). To identify the best way to obtain the CPF in intubated subjects, we compared three forms of cough stimulation: with the instillation of saline, with mechanical stimulation by catheter, and by means of verbal stimulation. There was no difference between these methods with respect to diagnostic accuracy; however, the saline stimulation presented the best combination of sensitivity and specificity. Moreover, a measure of CPF done after extubation also had high accuracy PCF.[20] To identify the best way to obtain the CPF in intubated subjects, we compared three forms of cough stimulation: with the instillation of saline, with mechanical stimulation by catheter, and by means of verbal stimulation. There was no difference between these methods with respect to diagnostic accuracy; however, saline stimulation presented best combination of sensitivity and specificity. Moreover, a measure of CPF done after extubation also had high accuracy.[14]

Chakravarthy et al investigated the findings and revealed a significant gender effect, which is consistent with previous findings in the literature, in which males had higher MIP and MEP values than females. Men had MRP values that were 10-15% higher than female participants in our study. MIP and MEP values of 115.3 and 125.23 cm H2O in males and 86.2 and 88.6 cm H_2O in females were found in studies across different populations by Smith et al anatomical, structural, and hormonal factors could all be contributing to the observed differences.[10]

Combret et al present results showed that higher MEP values were associated with a lower risk of extubation failure. The primary reason for this result could be the key role of the expiratory muscles in generating a sufficiently effective cough to ensure airway clearance following extubation. Indeed, previous work based on multivariate analysis adjusted for MV duration, the presence of chronic respiratory failure, and ICU-Aw indicated that higher MEP values are associated with a reduction of extubation failure [OR 0.98 95% CI (0.97-1.0); p=0.04]. Furthermore, in that study by Terzi et al patients who required respiratory support, non-invasive ventilation (NIV) due to respiratory distress, or mechanical cough assistance due to an inability to clear secretions also had lower MEP values than those who underwent simple extubation (30 vs 53 cm H_2O). Indeed, ineffective cough is a factor associated with extubation failure, even though MEP is not the only factor contributing to cough efficiency. Noteworthy, the cough was not directly measured in the present study, and the use of mechanical cough assistance after extubation was not reported. The use of such devices was, however, based on clinicians' decisions and was not influenced by the measures undertaken for the present study.[15]

Limitations

Our study did not include a comparison group or a control group. We did not provide any control for dietary changes during the study and noted the effects of diet-extubated patients with OPP. However, the participants were told to maintain their daily dietary pattern and their activities of daily living.

CONCLUSION

This study concluded that the 1-week exercise program of the MAC technique improved the cough strength (PCF and MEP) in extubated patients with organophosphorus poisoning, MAC technique should be considered a routine physiotherapy treatment protocol in extubated OPP patients.

ACKNOWLEDGMENTS

The author would like to thanks to the management of the Pravara institute of medical sciences.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Nandre BS, Gunjal SB. Effect of manually assisted cough technique on cough strength in extubated patients with organophosphorus poisoning. Int J Res Med Sci 2023;11:4334-40.