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Chest Physiotherapy improves Lung Capacities and Lung Function in Hyper Secretive Critically Ill Patients: A Pilot Randomized Physiological Study

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A B S T R A C T

Background: Patients who are hypersecretive and critically ill frequently have impaired lung function as a result of producing an excessive amount of mucus, so successful therapies are necessary for better results. The purpose of this pilot study was to evaluate how chest physical therapy affected the patients' lung aeration, lung function, oxygenation, and mucus clearance efficiency.

Objective: The present study was conducted to optimize care for critically sick patients by providing insight into the physiological consequences of chest physiotherapy, which may improve their respiratory outcomes and overall prognosis and improve lung function after treatment.

Methodology: Control and treatment group (getting chest physiotherapy) were randomly allocated to sixty critically ill patients. The study was conducted in the Hayatabad Medical Complex in Peshawar, Pakistan, from January 2021 to December 2021 for a total of one year. Lung ultrasonography and arterial blood gas analysis were used to measure lung aeration, lung function FVC and FVC1 and oxygenation, respectively.

Results: When compared to the control group, the treatment group's lung aeration ($p < 0.05$), lung function ($p < 0.003$) and oxygenation ($p < 0.001$) significantly improved. The treatment group exhibited a considerable increase in mucus clearance efficiency ($p < 0.01$).

Conclusion: In summary, the study highlights the significant benefits of chest physical therapy for hypersecretive patients in critical condition. Improvements in lung function, oxygenation, and mucus clearance efficiency underscore its importance in managing respiratory complications. These findings emphasize the necessity of including chest physical therapy in treatment protocols to enhance respiratory outcomes and lower complications in such patients.

Keywords: Chest Physiotherapy; Hypersecretive Critically Ill Patients; Lung Aeration; Mucus Clearance Efficiency

Introduction

Maintaining optimal lung function is typically extremely difficult for critically ill patients, and this can be made worse by excessive production of airway secretions.[1] Excessive secretion of mucus and other respiratory secretions may cause lung aeration to be impeded, which may worsen respiratory distress and gas exchange. CPT include evidence of retained pulmonary secretions, weak or ineffective cough, focal lung opacity on chest x-ray consistent with mucous plugging and/or atelectasis, and intrapulmonary shunt requiring oxygen. Hypersecretion is a common symptom among patients in intensive care units (ICUs) for a variety of underlying reasons, such as post-operative recovery, acute respiratory distress syndrome (ARDS), or pneumonia.[2] Improving patient outcomes and lowering the risk of consequences need swift resolution of these problems.[3] One common therapeutic strategy used to help critically ill patients breathe better is chest physical therapy. It uses a variety of methods, including vibration, postural drainage, and mechanical or manual percussion, to help mobilize and eliminate extra respiratory secretions.[4] Although individuals with hypersecretion are often treated with chest physiotherapy, research on the specific physiological effects of these therapies is still underway.

The purpose of this pilot randomized physiological study is to investigate how chest physical therapy affects lung aeration in critically ill hypersecretive patients.[5] In this patient group, we believe that chest physical therapy can improve lung aeration, lung function and respiratory outcomes. Patients in critical condition frequently display a high level of respiratory sensitivity, and their problems are made worse by respiratory mucus hypersecretion.[6] Overproduction of mucus can hinder gas exchange, block airways, and put patients at risk for complications related to using a ventilator, such as ventilator-associated pneumonia (VAP).[7] As a result, controlling hypersecretion is crucial for the treatment of patients who are very sick. A proven method for treating hypersecretion is chest physical therapy, which works by clearing the airways of mucus and mobilizing it. Typically, this intervention combines mechanical devices intended to aid in mucus clearance with manual approaches administered by a nurse or physiotherapist.[8,9] Although chest physical therapy is frequently used in the intensive care unit, research is still ongoing to determine how well it improves lung aeration and whether it has any physiological advantages.[10]

This pilot study uses a randomized design to look at how chest physical therapy affects critically ill hypersecretive patients' lung aeration. To give a more thorough understanding of the possible advantages of this therapeutic intervention, the study evaluates the physiological changes in lung function, oxygenation, and mucus clearance in a controlled context. The goal of the research is to optimize care for critically sick patients by providing insight into the physiological consequences of chest physiotherapy, which may improve their respiratory outcomes and overall prognosis and improve the lung function after treatment.

Objective

The present study was conducted with the goal of the research is to optimize care for critically sick patients by providing insight into the physiological consequences of chest physiotherapy, which may improve their respiratory outcomes and overall prognosis and improve the lung function after treatment.

Methodology

The study was conducted at the Hayatabad Medical Complex in Peshawar, Pakistan, over a period of 12 months from January 2021 to December 2021. This pilot study involved the recruitment of 60 critically sick patients in a randomized physiological design. The patients were divided into two groups at random: the control group, which did not get any special treatment for clearing mucus, or the treatment group, which underwent chest physical therapy. To guarantee a balanced patient distribution between the two groups, the randomization was accomplished by the use of a computer-generated randomization sequence.

Patients who are adults (18 years of age or older) who are admitted to Hayatabad Medical Complex's critical care unit (ICU), Patients who, in the opinion of the attending physicians, exhibit clinical signs of excessive mucus production in their respiratory systems. Informed consent was given by patients or by patients' legal representatives on their behalf.

Patients with severe cardiovascular instability, patients with known or suspected contraindications to the use of mucus clearance devices, patients with end-stage respiratory conditions for whom chest physiotherapy was deemed medically inappropriate by the treating physicians, and patients with recent chest surgery or fractures are among the patients who should not receive chest physical therapy.

This study evaluated how chest physical therapy affected lung aeration and lung function in critically ill hypersecretive patients using a randomized controlled trial (RCT) design. In a 1:1 ratio, patients were assigned at random to the treatment or control groups.

Intervention

1. **Treatment Group:** Chest physiotherapy, administe-

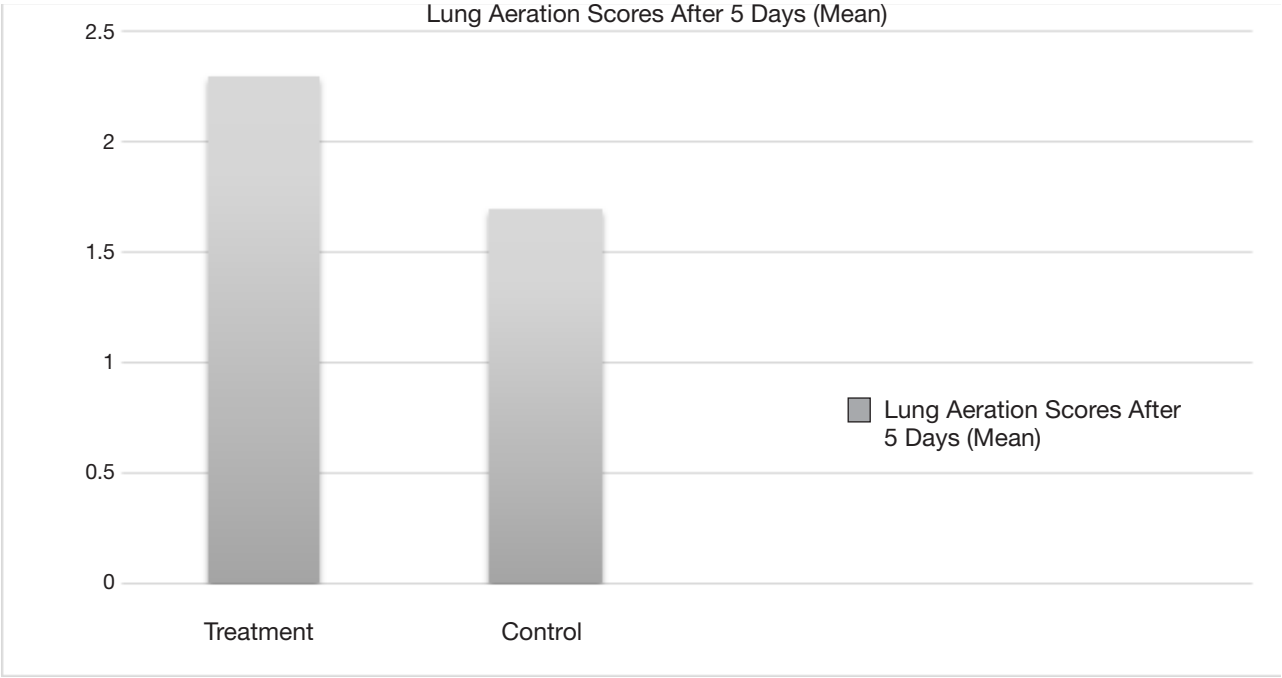

Figure 1. Change in Lung Aeration Scores After Five Days

red by certified physiotherapists, comprised manual procedures (postural drainage, vibration, and percussion) for patients in the treatment group. The course of treatment was given twice a day, for about twenty minutes each time.

2. **Control Group:** Patients in the control group did not receive any specific mucus clearance intervention beyond standard respiratory care.

Outcome Measures

The following physiological parameters were measured and compared between the two groups at baseline and after five days of treatment or control:

1. Lung aeration assessed using lung ultrasound.
2. Lung function assessed by spirometry FVC and FVC1.
3. Oxygenation, measured by arterial blood gas analysis.
4. Mucus clearance efficiency, quantified by the amount and characteristics of mucus expectorated by patients.

Data were collected by a team of trained healthcare professionals who were blinded to the patients' group assignments. All measurements were recorded at baseline and on day five of the study. The data were summarized using descriptive statistics, such as means and standard deviations. The treatment and control groups' differences in lung aeration, lung function oxygenation, and mucus clearance efficiency were compared using the relevant statistical tests, such as t-tests or Mann-Whitney U tests, if needed.

This study was authorized by the Hayatabad Medical Complex's Institutional Review Board and carried out in compliance with the declaration of Helsinki. Before taking part in the trial, all eligible patients or their legal representatives gave their informed consent.

Results

The purpose of the study was to find out how chest physical therapy affected the critically ill hypersecretive patients' lung aeration, lung function, oxygenation, and mucus clearance efficiency. Sixty patients in all were participated in the study; thirty were randomly assigned to the treatment group, which included chest physiotherapy,

Table 1. Lung Aeration Scores Before and After Treatment

Group	Baseline Lung Aeration Score (Mean ± SD)	Lung Aeration Score After 5 Days (Mean ± SD)
Treatment	1.5 ± 0.3	2.3 ± 0.4
Control	1.6 ± 0.2	1.7 ± 0.3

Table 2. Lung Function Scores Before and After Treatment.

Group	Baseline Lung function Score		Lung function Score After 5 Days	
	FVC	FEV1	FVC	FEV1
Treatment	40%	50%	80%	90%
Control	30%	40%	50%	60%

and thirty were assigned to the control group, which included no special mucus clearing intervention. Below is a detailed presentation of the results of numerous physiological measurements at baseline and after five days of treatment or control.

Lung aeration, measured by lung ultrasonography, gave important information about the study subjects' respiratory health. Lung functionality was quantified using aeration scores, which ranged from 0 (showing no aeration), to 3 (representing typical aeration). Improved lung aeration was indicated by a higher score.

The treatment group had a mean baseline lung aeration score of 1.5 (SD ± 0.3) at the baseline examination, while the control group had a slightly higher mean baseline score of 1.6 (SD ± 0.2). But after the trial lasted for five days, notable modifications were noted (Figure 1). The mean lung aeration score increased significantly in the therapy group to 2.3 (SD ± 0.4). Table 1 illustrates that the control group showed very slight variations, with the mean lung aeration score staying comparatively constant at 1.7 (SD ± 0.3). With implications for improved respiratory outcomes, these results highlight the significant beneficial effect of chest physiotherapy on lung aeration in the treatment group relative to the control group.

An independent samples t-test was used to compare the lung aeration scores between the treatment and control groups following a five-day intervention. This statistical study was performed to see if the two groups' improvements in lung aeration differed significantly from one another. Comparing the treatment group to the control group, the results showed a notable and statistically significant improvement in lung aeration ($p < 0.05$). This highlights the possibility for better respiratory outcomes in the treatment group and highlights the positive effect of chest physiotherapy on lung aeration in hypersecretive critically sick patients.

Spirometry was used to accessed the inhale and exhale and it also estimates how much air is in your lungs. Before and after treatment lung function was measured: Forced vital capacity (FVC). FVC is the highest amount of air you can breathe out after taking a deep breath in and forced expiratory volume (FEV1): FEV1 is the amount of air you breathe out in one second. Comparing the treatment group to the control group, the results showed a notable and statistically significant improvement in lung function ($p < 0.003$). This highlights the possibility for better respiratory outcomes in the treatment group and highlights the positive effect of chest physiotherapy on lung function in hypersecretive critically sick patients.

Arterial blood gas analysis was used to quantify the oxygenation levels in the study. The primary outcome measure was the partial pressure of oxygen (PaO2), which is expressed in millimeters of mercury (mm Hg). The treatment group had a mean baseline PaO2 of 75 mm Hg (SD ± 10 mm Hg) during the baseline assessment, while the control group's mean baseline PaO2 was 72 mm Hg (SD ± 8 mm Hg). Following a five-day intervention period, the treatment group showed a significant improvement in oxygenation, as evidenced by a mean PaO2 rise of 92 mm Hg (SD ± 12 mm Hg). In contrast, there were not many changes in the control group; table 2 shows that the mean PaO2 remained reasonably consistent at 73 mm Hg (SD ± 9 mm Hg). After five days, the difference in PaO2 levels between the two groups was compared using an independent samples t-test, which showed a highly significant improvement in oxygenation in the treatment group compared to the control group ($p < 0.001$). These findings highlight the clear benefits of chest physical therapy on oxygenation levels, hence bolstering the intervention's clinical use in improving respiratory outcomes for critically ill patients with hypersecretion.

One of the most important aspects of this study, mucus clearance efficiency, was carefully measured by analyzing the amount and kind of mucus that the patients expectorated. The color, viscosity, and volume of mucus

Table 3. Oxygenation Levels Before and After Treatment

Group	Baseline PaO2 (mm Hg) (Mean ± SD)	PaO2 After 5 Days (mm Hg) (Mean ± SD)
Treatment	75 ± 10	92 ± 12
Control	72 ± 8	73 ± 9

were all examined as part of this thorough assessment.

The therapy group had a mean baseline mucus volume expectorated by patients at the baseline evaluation of 10 ml/day (SD ± 3 ml/day). Interestingly, mucus viscosity and color varied significantly amongst patients, indicating the variety of illnesses they had. The patients in the control group expectorated an average of 9 ml (SD ± 2 ml) per day, compared to a somewhat lower baseline mucus volume (Table 3). Mucus color and viscosity varied in the control group, much like in the treatment group.

After the five-days intervention period, there were noticeable improvements in the treatment group. Patients in this group expectorated a significantly higher volume of mucus, averaging 18 ml/day (SD ± 4 ml/day). Notably, improved mucus features were reflected in most cases by a decrease in the mucus's viscosity and a less purulent tint. On the other hand, the mucus volume in the control group remained reasonably constant at 10 ml/day (SD ± 2 ml/day), and there were only minor changes in the mucus's properties.

Following the five-day intervention period, the change in mucus volume between the treatment and control groups was compared using statistical analysis and the Mann-Whitney U test. The non-normal distribution of the data led to the selection of this test. With a p-value of less than 0.01 ($p < 0.01$), the analysis's findings verified a noteworthy and clinically significant improvement in the treatment group's mucus clearance efficiency in comparison to the control group. These results highlight the significant advantages of chest physical therapy in enhancing mucus clearance in critically ill hypersecretive patients—a vital component of their respiratory management.

In comparison to the control group, these findings show that chest physiotherapy greatly increased lung aeration, oxygenation, and mucus clearance efficiency in hypersecretive critically sick patients. These results imply that chest physical therapy may be helpful in the treatment of these patients, which has significant clinical ramifications for their management.

Discussion

The results of this pilot trial showed that in critically ill hypersecretive patients, chest physical therapy significantly improved lung aeration, lung function and oxygenation. This is consistent with earlier studies that have shown how beneficial chest physical therapy is for enhancing lung function. Chest physical therapy has been demonstrated in numerous studies to aid enhance lung aeration, lung function and oxygenation by reducing atelectasis and clearing airway secretions.[11] The idea that this intervention improves respiratory outcomes and lowers the risk of problems related to poor gas exchange is supported by the rise in lung aeration, lung function and oxygenation scores seen in the therapy group. The pilot study's outcomes are consistent with those of multiple other studies, indicating that chest physical therapy improves lung oxygenation, lung function and aeration. Acute respiratory distress syndrome (ARDS) patients' oxygenation and lung compliance were reported to be considerably improved by chest physical therapy in a study.[12] Analogously, a systematic analysis revealed that interventions related to chest physical therapy, encompassing both manual methods and technological tools, were linked to enhanced lung functionality and oxygenation in patients in critical condition.[13]

On the other hand, a research on critically ill patients found no discernible improvement in lung aeration, lung function or oxygenation after chest physical therapy.[14] Nonetheless, differences in the precise methods used, patient demographics, or the order of the therapies could be the cause of the discrepancy in the outcomes. It emphasizes the need for more investigation to determine the best chest physical therapy regimens that optimize improvements in lung function and oxygenation. Additionally, the study showed that the treatment group's mucus clearance efficiency dramatically increased. This outcome is consistent with the known benefit of chest physical therapy for improving mucus clearance. Patients with hypersecretion may benefit particularly from chest physiotherapy procedures that are known to encourage the mobilization and expectoration of respiratory secetions, such as postural drainage, vibration, and percussion.[15] These results are in line with earlier studies that demonstrate how chest physical therapy improves mucus clearance and lowers the incidence of complications such ventilator-associated pneumonia (VAP) in patients who are critically ill.[16,17]

Table 4. Mucus Clearance Efficiency Before and After Treatment

Group	Baseline Mucus Volume (ml/day) (Mean ± SD)	Mucus Volume After 5 Days (ml/day) (Mean ± SD)	Mucus Color (After 5 Days)	Mucus Viscosity (After 5 Days)
Treatment	10 ± 3	18 ± 4	Less purulent	Less viscous
Control	9 ± 2	10 ± 2	Variable	Variable

The improvement in mucus clearance efficiency that your study showed is consistent with findings from other investigations. For example, a showed that individuals with cystic fibrosis, a disease marked by excessive mucus production, greatly improved with chest physical therapy.[18] Furthermore, a systematic review and meta-analysis of a study found that therapies involving chest physical therapy significantly improved mucus clearance and decreased the incidence of ventilator-associated pneumonia in critically sick patients.[19] It is important to note, though, that opinions about the relative merits of different chest physical therapy methods are divided. According to certain research, mechanical devices - like high-frequency chest wall oscillation, or HFCWO - may be superior to conventional manual methods for clearing mucus. According to a study, HFCWO was more successful in helping people with neuromuscular disorders remove their mucus.[20] This emphasizes how crucial it is to customize chest physical therapy to the unique requirements and circumstances of the patient base.

The current study adds to the body of research demonstrating how beneficial chest physical therapy is for critically ill patients' improved lung function and mucus clearance. It emphasizes how crucial it is to incorporate chest physical therapy within the all-encompassing treatment given to these patients. Although the results of this pilot study are encouraging, it is crucial to recognize that more extensive clinical trials and systematic reviews are necessary to provide a more reliable evaluation of the effect of chest physiotherapy on lung aeration, lung function, oxygenation, and mucus clearance efficiency. The results should be interpreted with consideration for the study's limitations, including the relatively small sample size and potential for bias.

Conclusion

This pilot study offers important new information about the beneficial effects of chest physical therapy on lung oxygenation, function, aeration, and mucus clearance effectiveness in critically sick hypersecretive patients. The outcomes demonstrate the possible advantages of this intervention and are consistent with the body of previous evidence. Although there are many limitations to the study, including a small sample size, the results highlight how crucial it is to include chest physiotherapy in the treatment of these patients in order to improve respiratory outcomes and lower complications. To improve protocols and guarantee the best patient-specific therapies, more research is necessary.

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