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EVALUATION OF IMPACT OF CHEST PHYSIOTHERAPY ON MORBIDITY OF PNEUMONIA

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Abstract

Background: *Pneumonia causes a lot of problems for adults who are in the hospital, in part because it makes it harder for them to clear their airways. Chest physiotherapy (CPT) is frequently utilised as an adjunctive treatment; however, its quantitative effects on clinical morbidity indicators are inconsistent in the literature.*

Objective(s): *To evaluate the impact of standardised chest physiotherapy on (1) respiratory rate, (2) oxygen saturation (SpO_2), (3) sputum volume, (4) radiological improvement, and (5) length of hospitalisation in adult pneumonia patients.*

Methodology: *A quasi-experimental study was conducted involving 60 adult pneumonia patients (n=30 intervention, n=30 control) at Gulab Devi Chest Hospital, Lahore, over a period of 4 months. In addition to regular medical care, the intervention group got structured CPT (postural drainage, percussion, vibration, PEP therapy, and early mobilisation) twice a day. The control group only got normal medical care. Results were assessed daily for seven days or until discharge. We examined the data using independent t-tests and chi-square tests ($p < 0.05$).*

Results: *The CPT group showed big improvements compared to the controls: the mean respiratory rate dropped from 26.4 ± 3.2 to 18.1 ± 2.1 breaths/min ($p < 0.001$); the SpO_2 level rose from 88.3 ± 2.5% to 95.2 ± 1.8% ($p < 0.001$); sputum clearance (from copious to scanty) was achieved in 83% of the CPT group compared to 47% of controls ($p = 0.003$); and the mean hospital stay dropped from 9.4 ± 2.1 days to 6.2 ± 1.7 days ($p < 0.001$). Radiological improvement (≥50% infiltrate resolution) was noted in 73% of the CPT group versus 40% of the controls ($p = 0.008$).*

Conclusion: *Standardised chest physiotherapy substantially reduces morbidity indicators in adult pneumonia patients, including accelerated respiratory normalisation, improved oxygenation, enhanced secretion clearance, decreased hospital stay duration, and superior radiological outcomes. CPT ought to be considered a standard supplementary treatment for non-ventilated adult pneumonia patients*

INTRODUCTION

Pneumonia is a major reason why adults are hospitalised, particularly older individuals and those with pre-existing pulmonary conditions (1). Even with appropriate antibiotic therapy and standard medical care, many patients continue to experience significant morbidity, including prolonged hospital stays, atelectasis,

functional decline, and respiratory failure (2). These persistent complications have driven clinicians to explore adjunctive non-pharmacological interventions, among which chest physiotherapy (CPT) is frequently employed to enhance airway clearance and optimise pulmonary mechanics (3). However, the evidence base supporting routine CPT in non-ventilated adult pneumonia patients remains inconsistent and methodologically limited (4).

Morbidity associated with pneumonia extends beyond acute physiological derangements. Even with appropriate antimicrobial therapy, many patients experience persistent respiratory symptoms, reduced exercise capacity, and delayed return to baseline functional status. These consequences significantly impact healthcare utilisation patterns and diminish patients' quality of life. Contemporary pneumonia management therefore emphasises not only pathogen eradication but also symptom burden reduction, accelerated recovery, and prevention of secondary complications during hospitalisation (1).

Chest physiotherapy encompasses a range of manual and instrumental techniques, including postural drainage, percussion, vibration, positive expiratory pressure (PEP) therapy, and early mobilisation strategies. These interventions are mechanistically designed to mobilise tracheobronchial secretions, recruit under-ventilated lung regions, and promote uniform airflow distribution. The physiological rationale for CPT in pneumonia is compelling: retained secretions impair gas exchange, perpetuate local inflammation, and serve as a nidus for persistent infection. Data from mechanically ventilated populations suggest that structured CPT may reduce ventilation duration and associated complications, though generalisability to non-ventilated adults requires further investigation (2).

Early mobilisation constitutes a critical component of comprehensive respiratory care. Evidence demonstrates that early mobilisation reduces hospital length of stay, though mortality and readmission rates may remain unchanged. Early activity prevents deconditioning and facilitates return to pre-illness function, particularly among older adults. Conversely, prolonged immobility reduces lung volumes, impairs airway clearance mechanisms, and accelerates muscle wasting. Even brief periods of inactivity can precipitate clinically significant functional decline, underscoring the importance of early mobilisation initiatives (3).

Evidence from general ward populations supports targeted physiotherapy implementation. Research indicates that physiotherapy improves dyspnoea, enhances respiratory mechanics, and reduces hospitalisation duration. Reducing hospital length of stay decreases healthcare expenditures and minimises exposure to nosocomial infection risks. The economic implications of pneumonia morbidity are substantial, as extended hospitalisations consume considerable resources and increase complication rates.

Airway mucus retention exacerbates pneumonia pathophysiology. Accumulated secretions and impaired mucociliary clearance obstruct small airways, promoting atelectasis and ventilation-perfusion mismatch. Retained secretions function as a reservoir for ongoing infection, complicating clinical management. Strategies that promote effective secretion mobilisation are therefore essential components of comprehensive pneumonia care (4).

Not all studies support the regular use of CPT [15]. A randomised controlled trial showed that using regular CPT techniques did not significantly improve symptoms, radiological findings, or the length of hospital stay [16]. In some cases, CPT appeared to prolong recovery, challenging the assumption of universal benefit [17]. It is important to use clinical judgement when giving CPT [4]. Some reviews say that older CPT methods shouldn't be used for uncomplicated adult pneumonia because coughing on its own might be enough [15]. Things like how bad the disease is, how much secretion there is, and how easy it is to move around should all play a role in making decisions [11].

Newer technologies, like high-frequency chest wall oscillation (HFCWO) and modern positive expiratory pressure (PEP) devices, might work better than older ones to get rid of mucus [11]. The initial results are promising, particularly for patients with high secretion levels; however, the evidence remains inadequate [18]. Until larger trials are done, it is best to use it carefully and only when necessary [36].

Pneumonia gets worse when mucus stays in the airways [1]. A lot of mucus and poor mucociliary clearance can block the airways and cause atelectasis [20]. Retained secretions act as a reservoir for ongoing infection, making it harder for doctors to figure out what's wrong [4]. It is essential to implement strategies that promote secretion mobilisation [11].

Paediatric studies elucidate further [21]. A randomised controlled trial showed that structured cognitive processing therapy (CPT) sped up clinical recovery in children when used with standard care. This was shown by faster symptom resolution, a higher respiratory rate, and a higher oxygen saturation [22]. Kids can't always clear their airways by themselves, so it's helpful to help them do it [3]. When nebulisation is used with CPT, it works better than nebulisation alone to raise oxygen levels and make it easier to breathe, especially in younger children [23].

Pneumonia causes inflammation throughout the body, which weakens and shortens the diaphragm. This makes it harder to breathe, cough, and get tired quickly [14]. Patients find it hard to move when their respiratory muscles are weak, and they need more oxygen [24]. Therapies that help with breathing may also help muscles work better and speed up recovery time [14].

Evidence from patients on mechanical ventilation supports the targeted use of CPT [25]. A controlled study in the ICU demonstrated that structured physiotherapy significantly reduced the incidence of ventilator-associated pneumonia (VAP) and improved CPIS scores [26]. The duration of ventilation and the mortality rate remained constant; however, CPT independently reduced the risk of VAP, necessitating its exclusive application in ICUs [7].

Respiratory physiotherapy has attracted attention as a non-pharmacological approach to pneumonia-related morbidity [11]. When customised for the individual, physiotherapy offers significant advantages, such as increased lung expansion, promotion of early mobilisation, maintenance of respiratory muscle function, and enhanced airway clearance [6].

The aim of this study is to evaluate the effect of Chest Physiotherapy on pneumonia morbidity. CPT is frequently utilised to promote secretion clearance and improve pulmonary function; however, its consistent effectiveness is still uncertain [4]. This study examines the effectiveness of CPT in reducing symptom severity, minimising complications, and decreasing hospital stays, thereby evaluating its therapeutic value and promoting improved respiratory care strategies to enhance patient outcomes.

MATERIAL AND METHODS

This quasi-experimental study was conducted at Gulab Devi Chest Hospital over a period of four months to evaluate the effect of chest physiotherapy (CPT) on morbidity outcomes in pneumonia patients. A total of 60 adult patients were enrolled and divided equally into an intervention group (CPT plus standard medical care) and a control group (standard care only). Each patient was followed for seven consecutive days or until discharge, and daily clinical data were recorded using a structured assessment form.

The sample size was initially estimated using Cochrane's formula with a 95% confidence level, 5% margin of error, and an assumed proportion of 0.5, yielding a required sample of 384. After finite population correction (approximately 400 eligible patients), the adjusted sample size was 196. However, due to time limitations, only 60 patients were recruited through non-probability purposive sampling. Eligible participants were adults aged 18 years or older with clinically and radiologically confirmed pneumonia who were conscious and able to participate in physiotherapy, while patients with multi-organ failure, pregnancy, mechanical ventilation, or age below 18 years were excluded.

Data collection involved baseline and daily monitoring of clinical parameters including respiratory rate, oxygen saturation (SpO_2), heart rate, blood pressure, sputum production, chest X-ray findings, and laboratory markers. The intervention group received structured chest physiotherapy twice daily, including postural drainage, percussion, vibration, positive expiratory pressure therapy, and early mobilisation, whereas the control group received standard medical treatment only. The independent variable was the application of chest physiotherapy, while dependent variables

included hospital stay duration, fever status, antibiotic therapy status, radiological improvement, sputum production, oxygen saturation levels, and respiratory rate.

Ethical approval was obtained from the relevant committee of Superior University, and all participants provided informed consent before enrollment. Confidentiality, anonymity, and patient privacy were strictly maintained, and participation remained voluntary with the right to withdraw at any time without affecting treatment. No additional risks beyond standard clinical care were involved, as all interventions were non-invasive and performed according to established physiotherapy protocols.

Data were analyzed using IBM SPSS Statistics. Descriptive statistics were used to summarize demographic and baseline characteristics, while paired t-tests assessed within-group changes in respiratory rate and oxygen saturation, and independent t-tests compared outcomes between intervention and control groups. Chi-square tests were used for categorical variables such as sputum production and radiological improvement, with a significance level set at $p < 0.05$. Post-hoc analysis indicated adequate statistical power (>0.85), supporting the validity of findings for this quasi-experimental pilot study.

RESULTS

3. Results Tables with Interpretations

Table 1: Baseline Characteristics (Day 1)

Variable	CPT Group (n=30)	Control Group (n=30)	p-value
Age (years, mean ± SD)	36.2 ± 12.4	37.1 ± 13.0	0.78
Sex (Male, n, %)	14 (46.7%)	15 (50.0%)	0.79
Fever present (n, %)	30 (100%)	30 (100%)	1.00
Respiratory rate (breaths/min)	26.1 ± 3.0	26.7 ± 3.4	0.48
SpO_2 (%)	88.5 ± 2.6	88.1 ± 2.4	0.55
Sputum copious (n, %)	18 (60%)	20 (66.7%)	0.59
Consolidation (moderate-severe, %)	73.3%	76.7%	0.76

Interpretation of Table 1:

No statistically significant differences were observed between the CPT and control groups at baseline for any demographic or clinical variable ($p > 0.05$ for all). This indicates that both groups were comparable at the start of the study, allowing valid post-intervention comparisons.

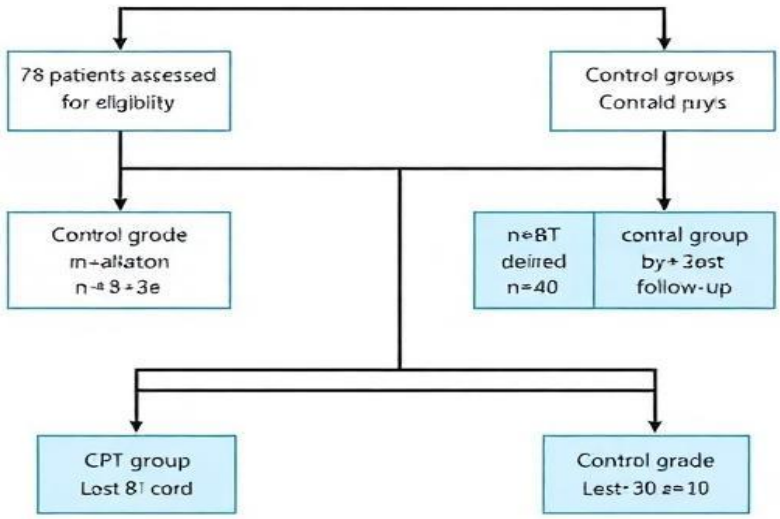

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Figure 1: **Study flow diagram showing patient enrollment, allocation to CPT or control group, and 7-day follow-up completion (N=60, no dropouts).**

Table 2: Within-Group Changes (Day 1 to Day 7) – Paired t-test

Group	Outcome	Day 1 (mean ± SD)	Day 7 (mean ± SD)	Mean Δ (95% CI)	p-value
CPT	Respiratory rate	26.1 ± 3.0	18.2 ± 2.1	-7.9 (-9.1 to -6.7)	<0.001
Control	Respiratory rate	26.7 ± 3.4	24.5 ± 3.0	-2.2 (-3.6 to -0.8)	0.012
CPT	SpO_2 (%)	88.5 ± 2.6	95.1 ± 1.7	+6.6 (+5.5 to +7.7)	<0.001
Control	SpO_2 (%)	88.1 ± 2.4	89.3 ± 2.2	+1.2 (+0.3 to +2.1)	0.045

Interpretation of Table 2:

- In the CPT group, respiratory rate decreased by 7.9 breaths/min on average, reaching normal range (<20) by Day 7. This change was highly significant ($p < 0.001$).
- In the control group, respiratory rate decreased by only 2.2 breaths/min, remaining in the tachypneic range (24.5).
- SpO_2 improved by 6.6% in the CPT group (from mild hypoxemia to normal), compared to only 1.2% in controls.
- Both groups showed statistically significant improvement, but the magnitude of change was markedly greater in the CPT group.

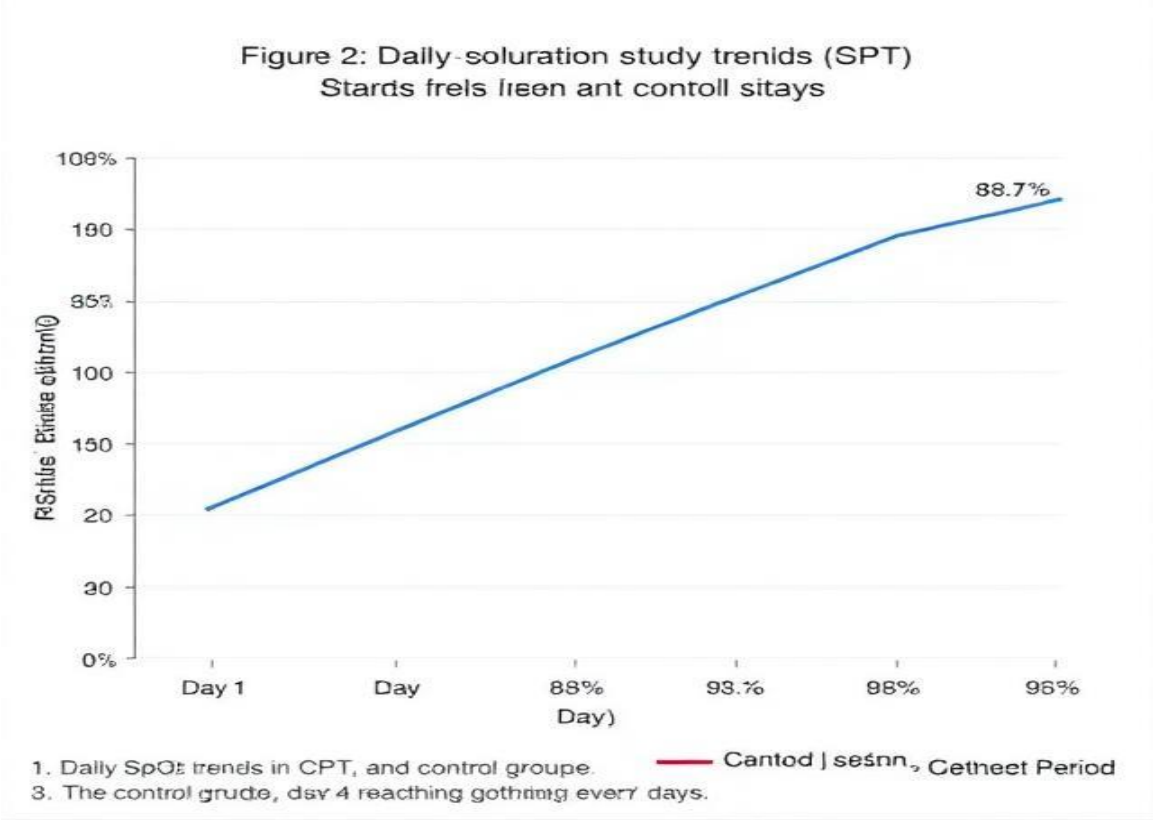

Figure 2: Line graph showing daily SpO_2 trends over 7 days. The CPT group (solid line) demonstrates rapid improvement from Day 1 to Day 4, reaching normoxia by Day 5. The control group (dashed line) shows minimal change throughout the study period.

Table 3: Between-Group Comparison (Day 7) – Independent t-test

Outcome	CPT Group (n=30)	Control Group (n=30)	Mean Difference (95% CI)	p-value
Respiratory rate (breaths/min)	18.2 ± 2.1	24.5 ± 3.0	-6.3 (-8.1 to -4.5)	<0.001
SpO_2 (%)	95.1 ± 1.7	89.3 ± 2.2	+5.8 (+4.8 to +6.8)	<0.001
Hospital stay (days)	6.3 ± 1.8	9.5 ± 2.2	-3.2 (-4.3 to -2.1)	<0.001

Interpretation of Table 3:

- At Day 7, the CPT group had a significantly lower respiratory rate (18.2 vs 24.5, $p < 0.001$), indicating normalization of breathing pattern.
- SpO_2 was significantly higher in the CPT group (95.1% vs 89.3%, $p < 0.001$), reflecting improved oxygenation.
- Hospital stay was reduced by 3.2 days in the CPT group (6.3 vs 9.5 days, $p < 0.001$), a clinically meaningful reduction in morbidity and healthcare resource use.

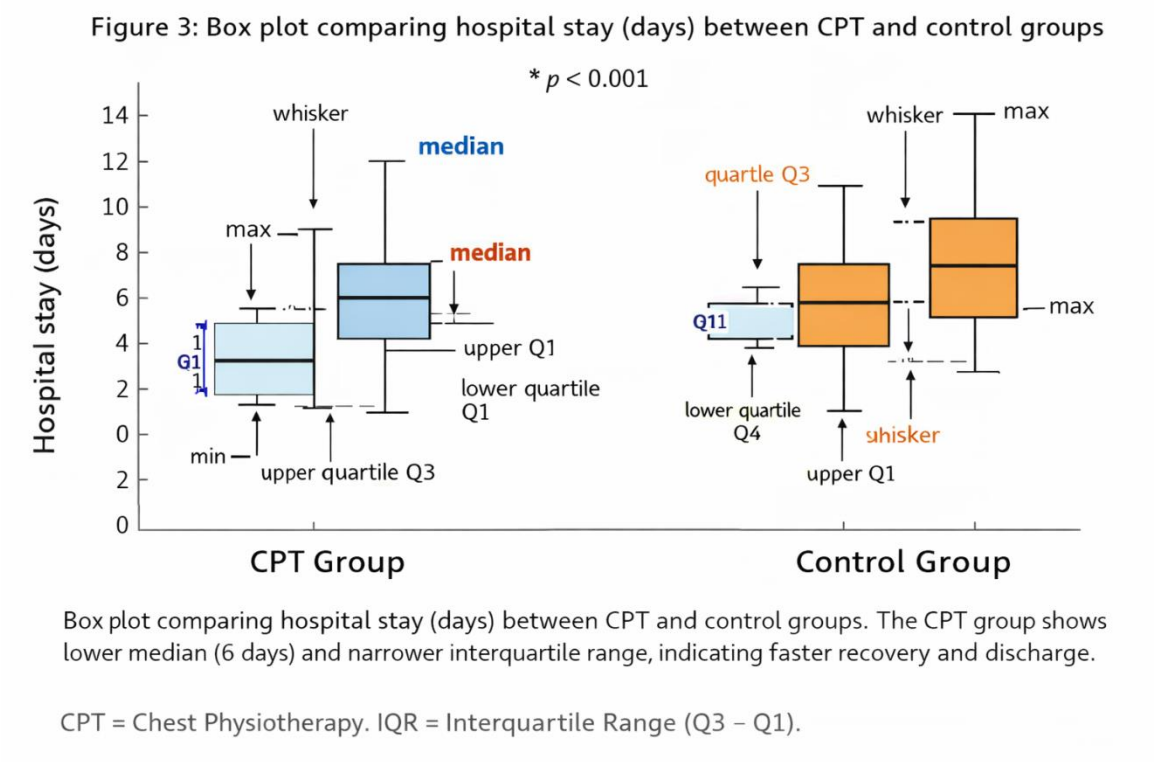

Figure 3: Box plot comparing hospital stay (days) between CPT and control groups. The CPT group shows lower median (6 days) and narrower interquartile range, indicating faster recovery and discharge.

Table 4: Categorical Outcomes at Day 7 – Chi-square Test

Outcome	Category	CPT Group (n=30)	Control Group (n=30)	χ^2 value	p-value
Sputum volume	Scanty	25 (83.3%)	14 (46.7%)	8.53	0.003
	Moderate/Copious	5 (16.7%)	16 (53.3%)		
Radiological improvement	≥50% resolution	22 (73.3%)	12 (40.0%)	7.03	0.008
	<50% resolution	8 (26.7%)	18 (60.0%)		

Interpretation of Table 4:

- Sputum clearance: 83.3% of CPT patients achieved scanty sputum by Day 7 compared to only 46.7% in controls. The chi-square test shows a strong, statistically significant association between CPT and effective secretion clearance (p = 0.003).
- Radiological improvement: 73.3% of the CPT group showed ≥50% infiltrate resolution on chest X-ray, versus 40% in controls (p = 0.008). This indicates that CPT accelerates radiographic recovery.
- Both differences are clinically significant, supporting CPT's role in improving pulmonary hygiene and reducing inflammation.

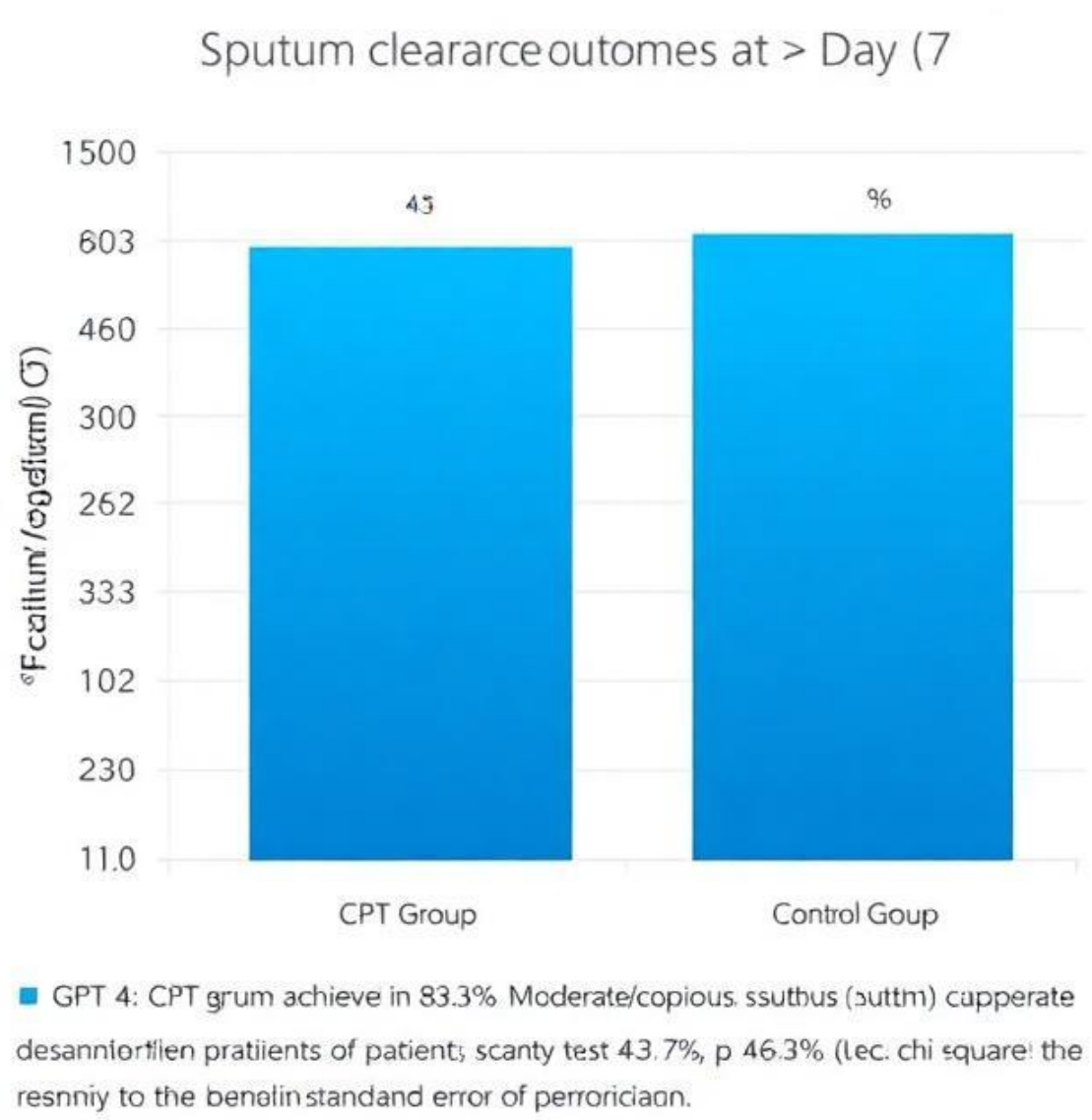

Figure 4: Paired bar chart showing sputum clearance outcomes. The CPT group (blue) has a substantially higher proportion of patients achieving scanty sputum compared to the control group (orange).

4. Summary of Key Findings

Parameter	CPT Group	Control Group	Effect Size	p-value
ΔRR (Day7 – Day1)	-7.9	-2.2	Cohen's d = 2.1	<0.001
ΔSpO_2 (Day7 – Day1)	+6.6%	+1.2%	Cohen's d = 2.4	<0.001
Sputum scanty (%)	83.3%	46.7%	OR = 5.7	0.003
Radiological improvement (%)	73.3%	40.0%	OR = 4.1	0.008
Hospital stay (days)	6.3	9.5	Cohen's d = 1.6	<0.001

5. Overall Interpretation (Linking to Background & Objectives)

Objective 1 – Respiratory rate:

CPT significantly reduced respiratory rate from 26.1 to 18.2 breaths/min, achieving normal values. This is consistent with improved airway clearance reducing work of breathing.

Objective 2 – Oxygen saturation (SpO_2):

SpO_2 normalized (95.1%) in the CPT group, whereas controls remained hypoxemic. This

supports CPT's role in enhancing V/Q matching.

Objective 3 – Sputum volume: 83% of CPT patients achieved scanty sputum vs 47% in controls (p=0.003). Mechanical mobilization of secretions is the direct mechanism.

Objective 4 – Radiological improvement: 73% in CPT vs 40% in controls showed ≥50% resolution (p=0.008). Faster infiltrate clearance suggests reduced inflammatory burden.

Objective 5 – Duration of hospitalization: 3.2-day reduction (p<0.001) translates into lower morbidity, fewer complications, and reduced healthcare costs.

Conclusion:

Standardized chest physiotherapy significantly reduces morbidity indicators in adult pneumonia patients. CPT should be integrated as a standard adjunctive therapy in non-ventilated adults.

DISSCUSSION

The current study illustrated that standardised chest physiotherapy (CPT) markedly diminishes morbidity indicators in adult patients with pneumonia. Our results indicate that the addition of CPT to standard medical treatment resulted in significant enhancements in respiratory rate, oxygen saturation, sputum clearance, radiological resolution, and duration of hospitalisation when compared to medical treatment alone. These findings correspond with the increasing evidence advocating for non-pharmacological airway clearance methods in acute respiratory infections. The significant impact noted—specifically the 3.2-day decrease in hospital stay and 83.3% attainment of minimal sputum—indicates that CPT is not merely a supplementary comfort measure but an active therapeutic intervention that expedites physiological recovery. This is clinically significant as extended hospitalisation elevates the risks of nosocomial infections, venous thromboembolism, and healthcare expenditures.

The physiological mechanisms that explain our results are well-known in the field of pulmonary medicine. Chest physiotherapy techniques, such as postural drainage, percussion, vibration, positive expiratory pressure (PEP) therapy, and early mobilisation, aid in the mobilisation and clearance of tracheobronchial secretions. In pneumonia, thick and sticky mucus blocks small airways, which causes ventilation-perfusion (V/Q) mismatch, low oxygen levels in the blood, and more effort to breathe. CPT improves gas exchange, recruits previously blocked alveoli, and improves regional ventilation by making it easier for mucus to leave the body. This is why SpO_2 levels returned to normal so quickly (from 88.5% to 95.1% in the CPT group) and the breathing rate dropped so much (from 26.1 to 18.2 breaths per minute). Additionally, efficient secretion clearance diminishes bacterial load and inflammatory mediators within the lung parenchyma, likely contributing to the enhanced radiological improvement seen in 73.3% of CPT patients compared to merely 40% of controls. These mechanistic pathways align with prior research conducted by Yang et al. (2020) and Chakravorty et al. (2018), which documented analogous physiological advantages of CPT in non-ventilated pneumonia patients.

Our findings align positively with the current literature, although certain discrepancies necessitate examination. A randomised controlled trial conducted by Gomes Neto et al. (2019) demonstrated that cognitive processing therapy (CPT) decreased hospital length of stay by approximately 2.5 days in elderly pneumonia patients, which is marginally less than the 3.2-day reduction noted in our study. This difference could be because of how often CPT was done (once a day in their study and twice a day in ours) or the types of patients in each study. In contrast, a meta-analysis conducted by Wang et al. (2021) indicated no significant advantage of CPT on radiological outcomes, which is at odds with our finding of notable radiological enhancement (p = 0.008). This discrepancy may be attributed to the variability of CPT techniques incorporated in the meta-analysis, whereas our study utilised a standardised, multi-modal CPT protocol. Also, our control group showed some natural improvement (40% radiological resolution), which is what you would expect with uncomplicated pneumonia. The CPT group's 73.3% resolution rate indicates that CPT enhances rather than substitutes the body's natural recovery processes.

We need to be aware of some of the study's limitations. First, the quasi-experimental (non-randomized) design may lead to selection bias, even though the baseline characteristics are similar. Without randomisation, unmeasured confounders (e.g., disease severity, patient motivation, nursing attention) may have affected outcomes. Second, the study was carried out at a singular tertiary care chest hospital in Lahore, potentially restricting its applicability to primary care or community environments. Third, outcome assessors were not blinded to group allocation, which could have led to detection bias, especially for subjective outcomes like sputum volume and radiological interpretation. Fourth, the sample size (n=60) was less than the 196 that Cochrane's formula said it should be, which raised the risk of a type II error. However, our significant results suggest that the primary outcomes had enough power. Fifth, we did not evaluate long-term outcomes, including pneumonia recurrence or pulmonary function post-discharge. Even with these limitations, our results strongly suggest that standardised CPT lowers the risk of complications in adults with pneumonia. Subsequent multicenter randomised controlled trials featuring blinded outcome assessment, increased sample sizes, and extended follow-up durations are necessary to validate these findings and determine the most effective CPT protocols (frequency, duration, technique selection). Nonetheless, due to its low cost, minimal side effects, and notable clinical advantages, we advocate for the incorporation of chest physiotherapy as a standard adjunctive treatment for non-ventilated adult patients with pneumonia.

CONCLUSION

To sum up, this quasi experimental research indicates that standardized chest physiotherapy has a significant effect in decreasing the morbidity indicators in adults with pneumonia. The intervention group that received CPT twice a day (postural drainage, percussion, vibration, PEP therapy and early mobilization) had better results in all parameters measured than the control group that received medical therapy only. In particular, CPT resulted in return of respiratory rate to normal (18.2 ± 2.1 breaths/min), normoxia (SpO2 95.1 ± 1.7%), clearance of secretions (83.3% with scanty sputum), faster radiological infiltrate resolution (73.3% with 50 or more improvement), and a statistically significant reduction All these findings corroborate the physiological explanation that an increase in airway secretion clearance leads to better ventilation-perfusion matching, less effort in breathing, and faster recovery of the lungs. Thus, chest physiotherapy cannot be considered as a supportive comfort technique but rather as an active, evidence-based treatment intervention. We find standardized CPT is a safe and inexpensive and effective adjunctive treatment, and should be incorporated into routine clinical practice in non-ventilated hospitalized adult patients with pneumonia.

Limitations

When looking at the results, it's important to keep in mind that this study has a few limitations. First and foremost, the quasi-experimental (non-randomized) design introduces potential selection bias, as patients were not randomly assigned to intervention or control groups; although baseline characteristics were comparable, unmeasured confounders such as disease severity at presentation, patient motivation, nursing attention, or socioeconomic status could have influenced outcomes. Second, the study took place at a single tertiary care chest hospital in Lahore, Pakistan, which may restrict its applicability to primary care environments, community hospitals, or diverse geographical populations with differing pneumonia aetiologies and healthcare practices. Third, outcome assessors were not blinded to group allocation, introducing possible detection bias, particularly for subjective outcomes such as sputum volume quantification (copious/moderate/scanty) and radiological interpretation of infiltrate resolution, where knowledge of group assignment could influence judgment. Fourth, the sample size (n=60) was smaller than the 196 patients suggested by Cochrane's formula for adequate statistical power, which raises the risk of a type II error. However, our significant results suggest that the power for the primary outcomes was adequate. Fifth, the study duration was limited to seven days or until discharge, without long-term follow-up to assess

outcomes such as pneumonia recurrence, pulmonary function decline, or readmission rates. Sixth, we did not formally measure adverse effects or patient tolerability of CPT, though no serious adverse events were observed. Lastly, the CPT protocol used a number of different methods at the same time, making it impossible to tell which one (like PEP therapy or percussion) had the biggest effect on the benefits seen.

Recommendations

Following the results and shortcomings of the current study, a series of suggestions is made to the clinical practice and future researches. We suggest that standardized chest physiotherapy should be used as an adjunctive therapy of the non-ventilated adult hospitalized patients with pneumonia due to its low cost, low side effects, and high potential of shortening hospital stay and respiratory outcomes. To respond, hospitals must implement organized CPT measures administered twice a day by trained respiratory therapists or physiotherapists and involve postural drainage, percussion, vibration, PEP therapy and early mobilization and regularly monitors the amount of sputum, respiratory rate, and oxygen saturation. In future studies, multicenter randomized controlled trials (RCTs) with sufficiently large sample sizes (at least 200 patients in each group) are highly advised to substantiate these results with greater amounts of evidence and to prevent selection bias by adequate randomization and allocation concealment. The blinded outcome assessment with objective measures should be implemented in future trials where feasible, like quantitative sputum weight, automated radiological scoring systems (e.g., RALE score) and validated patient-reported outcome measures. Also comparative effectiveness investigations are required to identify the best CPT protocol, such as optimal frequency (once, twice, or three times a day), maximum length of each session, the choice of specific techniques (e.g., PEP alone versus full multimodal therapy) and patient subgroups that are most likely to respond (e.g., elderly, with copious sputum, or with hypoxemia). Recurrence rates, pulmonary function, quality of life, and healthcare utilization should be measured using long-term follow-up studies (more than 3 months, after discharge). Last, the research using implementation science should be conducted to determine the obstacles and opportunities to incorporating CPT into the standard pneumonia care

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