

# Effects of Postural Drainage in Patients with Elderly Pneumonia

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## ABSTRACT

**Background:** Pneumonia is an acute infectious inflammation of the lung parenchyma frequently associated with hypoxemia and retained secretions, and adjunct respiratory physiotherapy may support airway clearance and recovery (1,2). **Objective:** To determine the effect of postural drainage with and without Active Cycle of Breathing Technique (ACBT) on oxygen saturation and sputum-related outcomes in patients with pneumonia. **Methods:** A randomized controlled trial enrolled adults diagnosed with pneumonia and allocated them to Group A (postural drainage) or Group B (postural drainage + ACBT). Outcomes included pulse oximetry, a chest X-ray severity score, and the Cough and Sputum Assessment Questionnaire (CASA-Q) measured at baseline and after 4 weeks (12 sessions; 3/week). Between-group comparisons were performed using independent-samples testing with statistical significance set at  $p < 0.05$ . **Results:** Thirty-two participants completed the study ( $n=16/\text{group}$ ). Baseline values were comparable for pulse oximetry ( $p=0.273$ ), chest X-ray score ( $p=1.000$ ), and CASA-Q ( $p=0.455$ ). At 4 weeks, Group B showed superior outcomes versus Group A: oxygen saturation  $91.12 \pm 2.47$  vs  $85.68 \pm 3.28$  (mean difference 5.44;  $p < 0.001$ ), chest X-ray score  $2.00 \pm 0.63$  vs  $4.68 \pm 0.79$  (mean difference  $-2.68$ ;  $p < 0.001$ ), and CASA-Q  $57.12 \pm 9.46$  vs  $46.06 \pm 7.62$  (mean difference 11.06;  $p=0.001$ ). **Conclusion:** Postural drainage improved oxygenation and secretion-related outcomes in pneumonia, and adding ACBT produced greater benefit across physiological, radiographic, and patient-reported measures. **Keywords:** Postural drainage; Pneumonia; Active cycle breathing technique; Oxygen saturation; CASA-Q.

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## INTRODUCTION

Pneumonia remains a major cause of morbidity and mortality worldwide, particularly among older adults, in whom age-related immunosenescence, multimorbidity, and reduced physiological reserve contribute to poor outcomes (1,5). It is defined as an acute inflammatory condition of the lung parenchyma, most commonly caused by infectious agents including bacteria, viruses, and fungi, and characterized radiographically by pulmonary infiltrates (1,2). Despite advances in antimicrobial therapy and supportive care, pneumonia continues to be associated with substantial hospitalization rates and functional decline, especially in elderly populations (5,17). Respiratory manifestations such as productive cough, dyspnea, and hypoxemia frequently coexist with impaired airway clearance, leading to retained secretions, ventilation-perfusion mismatch, and increased risk of complications including respiratory failure (10,16).

Airway clearance dysfunction represents a clinically relevant but often underemphasized therapeutic target in pneumonia management. Accumulation of bronchial secretions may exacerbate hypoxemia and prolong recovery, particularly in patients with reduced cough efficiency or diminished mobility

(9,14). Conventional medical management primarily addresses the infectious etiology; however, adjunctive physiotherapeutic interventions aim to optimize pulmonary mechanics, improve oxygenation, and enhance mucociliary clearance (18). Postural drainage is a gravity-assisted technique designed to facilitate the mobilization of secretions from specific bronchopulmonary segments. The Active Cycle of Breathing Technique (ACBT), comprising breathing control, thoracic expansion exercises, and forced expiratory techniques, is a patient-directed method intended to improve ventilation distribution and secretion clearance (18,22).

Previous investigations have explored chest physiotherapy modalities in various respiratory conditions, yielding heterogeneous findings. Studies evaluating chest physiotherapy in pneumonia have demonstrated potential improvements in clinical parameters, although comparative efficacy across techniques remains unclear (19,23). In bronchiectasis, ACBT combined with postural drainage has shown superior improvements in oxygenation and sputum clearance compared with conventional physiotherapy (22). Conversely, some evidence suggests limited differences between airway clearance techniques when directly compared (24). Systematic reviews examining early mobilization in pneumonia have reported reductions in length of hospital stay but inconsistent effects on mortality and clinical recovery, underscoring the need for targeted evaluation of specific physiotherapy components (21). Moreover, evidence from aspiration pneumonia management supports the role of structured chest physiotherapy in improving respiratory outcomes (20).

Despite these findings, there remains a knowledge gap regarding the additive benefit of ACBT when combined with postural drainage specifically in adult patients with pneumonia, particularly in structured randomized designs assessing objective measures such as oxygen saturation and validated sputum-related quality metrics. Most existing studies either evaluate single techniques, focus on non-pneumonia respiratory disorders, or lack robust comparative methodology (19,22,24). Consequently, the incremental therapeutic value of combining postural drainage with ACBT in this population remains insufficiently defined.

In adults diagnosed with pneumonia (Population), does postural drainage combined with Active Cycle of Breathing Technique (Intervention), compared with postural drainage alone (Comparison), lead to greater improvement in oxygen saturation and sputum-related outcomes (Outcomes) over a four-week treatment period (Time)? The present randomized controlled trial was designed to test the hypothesis that the addition of ACBT to postural drainage would result in superior improvements in oxygen saturation and sputum profile compared with postural drainage alone.

## MATERIAL AND METHODS

This study was designed as a parallel-group randomized controlled trial to evaluate the comparative efficacy of postural drainage alone versus postural drainage combined with the Active Cycle of Breathing Technique (ACBT) in adults diagnosed with pneumonia. The trial employed a two-arm superiority framework with equal allocation ratio (1:1). The rationale for selecting a randomized controlled design was to minimize allocation bias and allow causal inference regarding the additive effect of ACBT on oxygenation and secretion-related outcomes. The study was conducted at Sheikh Zayed Hospital, Lahore and District Headquarter (DHQ) Hospital, Narowal, over a six-month period following approval of the study protocol.

Eligible participants were adults aged 30–60 years with a confirmed clinical and radiographic diagnosis of pneumonia, established through physician evaluation and chest radiography demonstrating pulmonary infiltrates consistent with acute infection (1,10,14). Both male and female patients were considered. Exclusion criteria included significant cardiovascular disease, thoracic deformity or rib fracture that could interfere with postural positioning, neurological or cognitive impairment limiting instruction-following capacity, and severe visual or hearing impairment affecting participation. Participants were recruited through non-probability consecutive sampling from inpatient departments.

Written informed consent was obtained from all participants in either English or Urdu prior to enrollment.

Randomization was performed using a sealed opaque envelope technique prepared in advance to ensure allocation concealment. After baseline assessment, participants were assigned to either Group A (postural drainage only) or Group B (postural drainage combined with ACBT). Outcome assessors were not involved in intervention delivery to reduce measurement bias. All baseline and follow-up assessments were conducted using standardized procedures to ensure reproducibility.

The primary outcome was oxygen saturation measured using a calibrated pulse oximeter under resting conditions in a seated position. Secondary outcomes included radiographic severity assessed through a standardized chest X-ray scoring system and patient-reported cough and sputum burden measured using the validated Cough and Sputum Assessment Questionnaire (CASA-Q). The CASA-Q total score was calculated according to standardized scoring instructions, with higher scores indicating better respiratory-related health status. All outcomes were recorded at baseline (pre-intervention) and after completion of the 4-week intervention period.

Both groups received standardized breathing exercises as part of routine physiotherapy. Participants were instructed to sit comfortably with relaxed shoulders, place one hand on the abdomen, inhale slowly through the nose, and exhale with controlled abdominal contraction, emphasizing prolonged exhalation. This was performed for approximately five minutes per session.

Group A received postural drainage sessions lasting 15–30 minutes, delivered three times per week on alternate days for four consecutive weeks, totaling 12 sessions. Specific drainage positions were selected based on the involved lung segments identified on chest radiography. Gravity-assisted positioning was maintained to facilitate secretion mobilization.

Group B received the same postural drainage protocol combined with the Active Cycle of Breathing Technique. ACBT consisted of three sequential components: breathing control (gentle tidal breathing), thoracic expansion exercises (deep inhalations with inspiratory hold), and forced expiratory technique (huffing), repeated in cycles as per established respiratory physiotherapy guidelines (18,22). Sessions were delivered by trained physiotherapists to ensure protocol adherence.

To address potential bias and confounding, baseline comparability of demographic and clinical variables was evaluated. Intervention fidelity was maintained through standardized therapist training and uniform treatment duration across groups. Missing data were minimized through supervised follow-up and session attendance monitoring; analyses were conducted on participants who completed the intervention period.

Sample size estimation was performed using Epitools software based on expected differences in oxygen saturation between groups, incorporating a 10% anticipated attrition rate. A total recruitment target of 36 participants was established, with 32 completing the study and included in the final analysis.

Data were entered and analyzed using SPSS version 22 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed using the Shapiro–Wilk test. As data were normally distributed ( $p > 0.05$ ), parametric tests were applied. Independent-samples t-tests were used for between-group comparisons, and paired-samples t-tests were used for within-group comparisons. Effect sizes were calculated to quantify the magnitude of differences. Statistical significance was set at a two-tailed p-value of  $< 0.05$ .

Ethical approval was obtained from the institutional review authorities of the participating centers prior to study initiation. The study adhered to principles of confidentiality, voluntary participation, and the Declaration of Helsinki. Data integrity was ensured through double-entry verification and secure storage

of study records. The detailed intervention protocol, outcome measures, and statistical analysis procedures are described to permit full reproducibility by independent investigators.

## RESULTS

A total of 36 participants were recruited, and 32 completed the trial and were analyzed (n=16 per group). Baseline comparability was confirmed for all outcomes (all p>0.05). Post-intervention (4 weeks), both groups improved; however, Group B (postural drainage + ACBT) demonstrated greater improvement across oxygen saturation, radiographic severity score, and CASA-Q total score.

*Table 1. Baseline Outcome Measures (Between-Group Comparability; n=16 per group)*

Outcome	Group A: Postural Drainage Mean±SD	Group B: Postural Drainage + ACBT Mean±SD	Mean Difference (B–A)	95% CI for Mean Difference	p-value
Pulse oximetry (%)	79.50±3.98	77.81±4.55	-1.69	-4.78 to 1.40	0.273
Chest X-ray score	6.43±0.96	6.43±0.96	0.00	-0.69 to 0.69	1.000
CASA-Q total	38.06±6.40	36.37±6.20	-1.69	-6.24 to 2.86	0.455

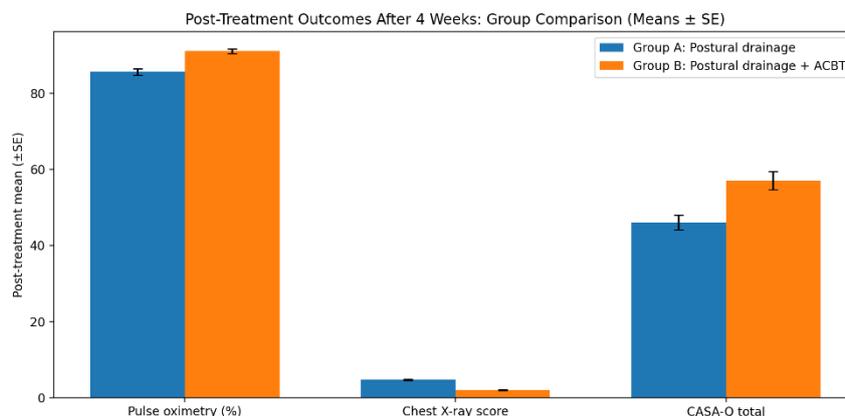
*Table 2. Post-Treatment Outcomes at 4 Weeks (Primary Between-Group Effects; n=16 per group)*

Outcome	Group A Mean±SD	Group B Mean±SD	Mean (B–A)	95% CI for Mean Difference	p-value	Effect Size (Hedges g)	95% CI
Pulse oximetry (%)	85.68±3.28	91.12±2.47	5.44	3.34 to 7.54	<0.001	1.83	0.99 to 2.66
Chest X-ray score	4.68±0.79	2.00±0.63	-2.68	-3.20 to -2.16	<0.001	-3.66	-4.81 to -2.50
CASA-Q total	46.06±7.62	57.12±9.46	11.06	4.85 to 17.27	0.001	1.26	0.49 to 2.02

*Table 3. Mean Change Over 4 Weeks (Descriptive Improvement Gradient)*

Outcome	Group A Δ (Post–Pre)	Group B Δ (Post–Pre)	Difference-in-Change (ΔB–ΔA)
Pulse oximetry (%)	+6.18	+13.31	+7.13
Chest X-ray score	-1.75	-4.43	-2.68
CASA-Q total	+8.00	+20.75	+12.75

At baseline, the two groups were statistically comparable across all measured outcomes. Pulse oximetry did not differ between Group A (79.50±3.98) and Group B (77.81±4.55), with a mean difference of -1.69 (95% CI -4.78 to 1.40; p=0.273). Similarly, the baseline chest X-ray score was identical (6.43±0.96 in both groups; p=1.000), and CASA-Q total scores were comparable (38.06±6.40 vs 36.37±6.20; mean difference -1.69, 95% CI -6.24 to 2.86; p=0.455) (Table 1).



*Figure 1. Post-treatment outcomes after 4 weeks (means ± SE) comparing Group A vs Group B across oxygen saturation, radiographic severity score, and CASA-Q total.*

After 4 weeks, Group B achieved substantially higher oxygen saturation than Group A (91.12±2.47 vs 85.68±3.28), producing a mean between-group difference of 5.44 percentage points (95% CI 3.34 to 7.54; p<0.001) with a large standardized effect (Hedges g=1.83, 95% CI 0.99 to 2.66) (Table 2). Radiographic

severity (chest X-ray score) improved more in Group B ( $2.00 \pm 0.63$ ) than Group A ( $4.68 \pm 0.79$ ), with a mean difference of  $-2.68$  (95% CI  $-3.20$  to  $-2.16$ ;  $p < 0.001$ ) and an extremely large effect magnitude ( $g = -3.66$ , 95% CI  $-4.81$  to  $-2.50$ ) (Table 2). Symptom and sputum impact measured via CASA-Q also favored Group B ( $57.12 \pm 9.46$ ) over Group A ( $46.06 \pm 7.62$ ), with an 11.06-point difference (95% CI 4.85 to 17.27;  $p = 0.001$ ) and a large effect size ( $g = 1.26$ , 95% CI 0.49 to 2.02) (Table 2). In descriptive change terms, Group B demonstrated a larger improvement gradient across all outcomes, including  $+13.31$  vs  $+6.18$  in oxygen saturation,  $-4.43$  vs  $-1.75$  in chest X-ray score, and  $+20.75$  vs  $+8.00$  in CASA-Q total score (Table 3).

Figure description (single paragraph, numeric-rich): At 4 weeks, Group B (postural drainage + ACBT) demonstrated consistently superior post-treatment outcomes compared with Group A, with higher oxygen saturation (91.12 vs 85.68), lower chest X-ray severity score (2.00 vs 4.68), and higher CASA-Q total score (57.12 vs 46.06), indicating a clinically coherent improvement pattern favoring combined airway clearance therapy across physiological oxygenation, radiographic recovery, and patient-reported cough/sputum impact.

## DISCUSSION

This randomized controlled trial evaluated whether adding the Active Cycle of Breathing Technique (ACBT) to postural drainage yields superior improvements in oxygenation and secretion-related outcomes in adults with pneumonia. The principal finding is a consistent and clinically coherent advantage for the combined intervention at 4 weeks: Group B demonstrated higher oxygen saturation (mean difference 5.44 percentage points, 95% CI 3.34 to 7.54), lower radiographic severity score (mean difference  $-2.68$ , 95% CI  $-3.20$  to  $-2.16$ ), and higher CASA-Q total score (mean difference 11.06 points, 95% CI 4.85 to 17.27), each with large standardized effects. Mechanistically, this pattern is plausible because pneumonia-related inflammation and airway secretions impair ventilation–perfusion matching and gas exchange, making secretion mobilization and improved ventilation distribution clinically relevant adjunct targets alongside antimicrobial therapy and routine care (1,2,10,14). Postural drainage supports gravity-assisted secretion movement, while ACBT adds active thoracic expansion and forced expiratory techniques that may enhance peripheral ventilation, mobilize mucus toward central airways, and improve effective clearance, thereby supporting oxygenation recovery and symptom improvement (18,22).

The between-group oxygenation difference observed at 4 weeks aligns with the concept that airway clearance strategies can contribute to improved respiratory function when secretion burden and cough inefficiency are present. Although the evidence base in pneumonia is mixed, prior work has examined chest physiotherapy approaches and reported outcomes comparable to other rehabilitation strategies in pneumonia contexts, with clinical recovery influenced by multiple factors including mobility, general conditioning, and disease severity (19,21). Importantly, our results emphasize that a targeted airway clearance component (ACBT) added to postural drainage produced a stronger improvement gradient than postural drainage alone across physiological ( $SpO_2$ ), radiographic, and patient-reported secretion impact domains. This is directionally consistent with studies in productive airway disease (e.g., bronchiectasis) where ACBT with postural drainage has demonstrated improvements in oxygenation measures and sputum-related outcomes compared with conventional chest physiotherapy, supporting the biological plausibility of additive benefit when secretion clearance is central to clinical impairment (22). Related evidence in aspiration pneumonia management and broader chest physiotherapy bundles also suggests potential benefit for secretion clearance and respiratory outcomes, reinforcing that airway clearance may be particularly relevant in populations at risk of retained secretions (9,20).

A key strength of the present analysis is that treatment effects are presented with effect sizes and confidence intervals, facilitating clinical interpretability beyond p-values. The magnitude of differences at 4 weeks suggests not only statistical significance but also clinically meaningful separation between groups, particularly for oxygen saturation and CASA-Q total score, which reflect both physiological

recovery and symptom burden. That said, the manuscript requires careful alignment of reporting elements to minimize ambiguity and maximize reproducibility. The title currently frames “elderly pneumonia,” while the stated eligibility criteria include ages 30–60 years; this mismatch should be corrected by either revising the title to reflect the included age range or revising eligibility to match an elderly population, because age is a major prognostic and treatment-response modifier in pneumonia (5,17). Additionally, the radiographic outcome is reported as a “chest X-ray score,” but the scoring rubric, range, and clinical anchors are not defined; without this operational definition, interpretability and external comparability are constrained (10,14). The manuscript should also explicitly state the prespecified primary endpoint (e.g., SpO<sub>2</sub> at 4 weeks), clarify the hierarchy of outcomes, and describe how multiple comparisons were handled to reduce inflation of type I error when analyzing several endpoints (standard practice in trials reporting multiple outcomes). Finally, terminology must be standardized throughout: the intervention should be consistently described as “postural drainage + ACBT,” and pneumonia (not COVID-19) should remain the stated target condition across all sections to preserve internal consistency.

In clinical terms, the findings support use of postural drainage as a beneficial adjunct modality and suggest that combining it with ACBT may offer additional advantage for secretion-related symptom burden and oxygenation recovery in adults with pneumonia. Given the pragmatic delivery schedule (12 sessions over 4 weeks) and the observed multi-domain improvement pattern, the combined approach may be considered where physiotherapy resources and patient tolerance allow, while recognizing that future studies should confirm these effects using clearly defined radiographic scoring systems, longer follow-up, and stratification by pneumonia severity and comorbidities that influence secretion clearance and hypoxemia risk (5,16,17).

## CONCLUSION

Postural drainage, with or without Active Cycle of Breathing Technique, improved oxygen saturation, radiographic severity score, and CASA-Q outcomes over 4 weeks in adults with pneumonia; however, the addition of ACBT produced larger and clinically consistent between-group benefits, supporting combined airway clearance therapy as a more effective adjunct strategy for improving oxygenation and reducing cough/sputum impact in this population.

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