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Physiotherapy Following Water Seal Drainage in Left Pneumothorax: A Case Report

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Abstract

Background: Pneumothorax is a respiratory emergency characterized by air accumulation within the pleural cavity, leading to impaired lung expansion and gas exchange. Elderly patients with chronic obstructive pulmonary disease (COPD) and cardiopulmonary comorbidities frequently experience persistent respiratory dysfunction following water seal drainage (WSD).

Objective: This case report aimed to describe the short-term clinical outcomes of physiotherapy interventions in an elderly patient with left pneumothorax following WSD placement.

Methods: A single-patient case report was conducted in a 68-year-old male with left pneumothorax, COPD, and pulmonary heart disease on the fourth day after WSD insertion. The patient received oxygen therapy via nasal cannula at 5 L/min. Physiotherapy interventions included diaphragmatic breathing, pursed-lip breathing, and gentle chest physiotherapy administered over three sessions during a three-week observation period. Outcomes included oxygen saturation (SpO_2), respiratory rate, Borg Scale, Numeric Rating Scale (NRS), thoracic expansion, and Barthel Index.

Results: SpO_2 increased from 92% to 95%, while respiratory rate decreased from 28 to 24 breaths/minute. Dyspnea decreased from Borg Scale 5/10 to 4/10, and chest pain decreased from NRS 5/10 to 4/10. Thoracic expansion improved minimally, whereas the Barthel Index remained 25/100, indicating severe dependence. No adverse events were observed.

Conclusion: Physiotherapy interventions were associated with short-term respiratory improvement following WSD placement in an elderly patient with left pneumothorax. However, functional improvement was not observed during the short observation period.

Keywords
Pneumothorax; Physical Therapy Modalities; Breathing Exercises; Thoracic Drainage; Pulmonary Rehabilitation

Introduction

Pneumothorax is a potentially life-threatening respiratory condition characterized by the accumulation of air within the pleural cavity, resulting in partial or complete lung collapse and impaired ventilation.[1] The disruption of intrapleural pressure reduces lung expansion and compromises gas exchange, potentially leading to hypoxemia, respiratory distress, and hemodynamic instability in severe cases.[2] Clinical manifestations commonly include acute chest pain, dyspnea, tachypnea, and decreased breath sounds on the affected side.[3] Elderly patients and individuals with chronic respiratory disorders are at greater risk of prolonged hospitalization, respiratory dysfunction, and delayed functional recovery following pneumothorax.[4]

Pneumothorax is generally classified as spontaneous or traumatic. Secondary spontaneous pneumothorax frequently occurs in patients with underlying pulmonary diseases such as chronic obstructive pulmonary disease (COPD), pulmonary fibrosis, tuberculosis, and lung malignancy.[5] Among these conditions, COPD is one of the most common risk factors because emphysematous alveolar destruction increases susceptibility to pleural rupture and recurrent pneumothorax.[6] In addition, patients with pulmonary heart disease often demonstrate impaired cardiopulmonary reserve, reduced exercise tolerance, and increased respiratory workload, thereby complicating the recovery process following chest drainage procedures.[7]

The global incidence of pneumothorax ranges from 6 to 66 cases per 100,000 population annually, with recurrence rates approaching 30% within the first year after the initial episode.[8] Management strategies depend on pneumothorax severity, respiratory stability, and the presence of persistent air leakage. Current approaches include conservative observation, needle aspiration, chest tube insertion, surgical intervention, and water seal drainage (WSD).[9] WSD is widely used to evacuate pleural air and restore negative intrapleural pressure, thereby facilitating lung re-expansion and improving respiratory mechanics.[7] However, despite successful chest drainage, many patients continue to experience dyspnea, chest pain, ineffective breathing patterns, respiratory muscle dysfunction, and reduced functional capacity during the recovery phase.[10]

Respiratory physiotherapy has an important role in supporting pulmonary recovery following thoracic conditions and chest drainage procedures. Previous studies have demonstrated that breathing exercises and chest physiotherapy may improve ventilatory efficiency, optimize respiratory muscle recruitment, reduce dyspnea, and improve thoracic mobility in patients with respiratory dysfunction.[11] Diaphragmatic breathing exercise is intended to facilitate diaphragmatic activation and reduce excessive accessory muscle activity, thereby improving tidal volume distribution and breathing efficiency.[12] Meanwhile, pursed-lip breathing exercise may prolong expiratory time and maintain positive airway pressure during expiration, which can help reduce airway collapse and improve alveolar ventilation, particularly in patients with obstructive pulmonary disease.[13] Gentle chest physiotherapy may also contribute to pain reduction and breathing comfort by decreasing muscular tension surrounding the thoracic region.[12]

Despite the recognized role of respiratory physiotherapy in pulmonary rehabilitation, evidence specifically addressing physiotherapy management following WSD in elderly patients with secondary pneumothorax remains limited. Existing literature predominantly focuses on surgical management, chest drainage techniques, or pulmonary rehabilitation in COPD populations, while evidence regarding short-term physiotherapy outcomes following pneumothorax is still scarce.[13] Furthermore, elderly patients with

multiple comorbidities are frequently underrepresented in respiratory rehabilitation studies despite having a higher risk of respiratory deconditioning, frailty, and functional decline during hospitalization.[14] Therefore, clinically detailed case reports remain important to describe rehabilitation strategies, patient responses, and practical considerations in complex cardiopulmonary conditions.[19]

This case was clinically relevant because the patient presented with several high-risk characteristics, including advanced age, COPD, pulmonary heart disease, recurrent hospitalization, oxygen dependency, and severe functional limitation following WSD placement. These conditions created substantial challenges for respiratory rehabilitation and functional recovery.

Therefore, this case report aimed to describe the short-term clinical outcomes of physiotherapy interventions consisting of diaphragmatic breathing, pursed-lip breathing, and gentle chest physiotherapy in an elderly patient with left pneumothorax following WSD placement.

Methods

This study was designed as a single-patient case report following the CARE (CAse REport) guideline for clinical case reporting.[19] The patient was a 68-year-old male hospitalized at Ario Wirawan Pulmonary Hospital, Salatiga, Indonesia, with a diagnosis of left pneumothorax following water seal drainage (WSD) insertion**.** The patient had a previous history of chronic obstructive pulmonary disease (COPD), pulmonary heart disease, recurrent hospitalization, and previous smoking exposure. The current hospitalization represented the third inpatient admission associated with respiratory complications.

The patient reported dyspnea at rest accompanied by left-sided chest pain around the incision area, productive cough, wheezing, and sleep disturbance approximately one week before physiotherapy assessment. The patient received oxygen therapy via nasal cannula at 5 L/min during hospitalization. Previous pulmonary rehabilitation history was not identified from medical documentation. Information regarding body mass index (BMI), detailed nutritional status, pulmonary function testing, and medication history was unavailable during the acute care phase.

At the initial physiotherapy examination, the patient was observed in a semi-Fowler position with oxygen supplementation delivered through a nasal cannula and a left hemithorax WSD system installed during hospitalization. Clinical observation demonstrated an ineffective breathing pattern characterized by tachypnea, shallow breathing, accessory respiratory muscle activation, forward head posture, barrel chest configuration, and productive cough.

Palpation assessment revealed tenderness surrounding the left thoracic incision area. Percussion examination demonstrated hyperresonance at the second and fourth intercostal spaces bilaterally, while auscultation revealed inspiratory crackles at the second and fourth intercostal spaces on both hemithoraces. All clinical examinations and outcome measurements were performed by the attending physiotherapist responsible for patient management during hospitalization.

Dyspnea severity was evaluated using the Borg Rating of Perceived Exertion Scale, while pain intensity was assessed using the Numeric Rating Scale (NRS). Functional ability was assessed using the Barthel Index to evaluate activities of daily living and dependency level in hospitalized geriatric patients.[16]

Vital sign assessment demonstrated blood pressure of 144/91 mmHg, heart rate of 113 beats/minute, respiratory rate of 28 breaths/minute, body temperature of 36.1°C, and oxygen saturation (SpO_2) of 92%. Thoracic expansion was assessed using circumferential chest expansion measurements with a standard measuring tape during maximal inspiration and expiration in a semi-Fowler position. Measurements were performed at the axillary level, fourth-to-fifth intercostal space, and xiphoid process level. The physiotherapy intervention program consisted of diaphragmatic breathing exercise, pursed-lip breathing exercise, and gentle chest physiotherapy administered during three treatment sessions over a three-week observation period.

Before intervention, baseline vital signs and subjective tolerance were evaluated to ensure patient safety. Physiotherapy sessions were postponed or modified if excessive fatigue, severe dyspnea, oxygen desaturation, or hemodynamic instability were observed. No intervention termination due to adverse symptoms occurred during the observation period.

Diaphragmatic breathing exercise was performed in a semi-Fowler position. The patient was instructed to inhale slowly through the nose while emphasizing abdominal expansion and to exhale in a controlled manner through the mouth. The exercise was performed for approximately 5–10 minutes with repeated breathing cycles adjusted according to patient tolerance.

Pursed-lip breathing exercise was administered in a comfortable semi-Fowler position. The patient was instructed to inhale slowly through the nose for approximately two seconds and exhale gently through partially closed lips for approximately four seconds to prolong expiratory time and improve breathing control.[13]

Gentle chest physiotherapy consisted of light soft tissue relaxation techniques applied around the thoracic and peri-incisional chest wall musculature while avoiding direct pressure over the WSD insertion area. The intervention aimed to reduce muscular tension and improve breathing comfort. Clinical outcomes were evaluated before intervention (T1) and after completion of the intervention period (T2). Outcome measures included oxygen saturation (SpO_2), respiratory rate, Borg Scale, Numeric Rating Scale, thoracic expansion, and Barthel Index.

Because this study involved a single-patient case report, data analysis was performed descriptively by comparing clinical findings before and after intervention without inferential statistical analysis. To provide a clearer overview of the chronological progression of the patient's condition, intervention period, and post-intervention reassessment, Figure 1 presents the clinical timeline according to CARE guideline recommendations.[19] The flowchart summarizes the sequence of hospitalization, water seal drainage (WSD) insertion, physiotherapy intervention, and clinical reassessment during the observation period.

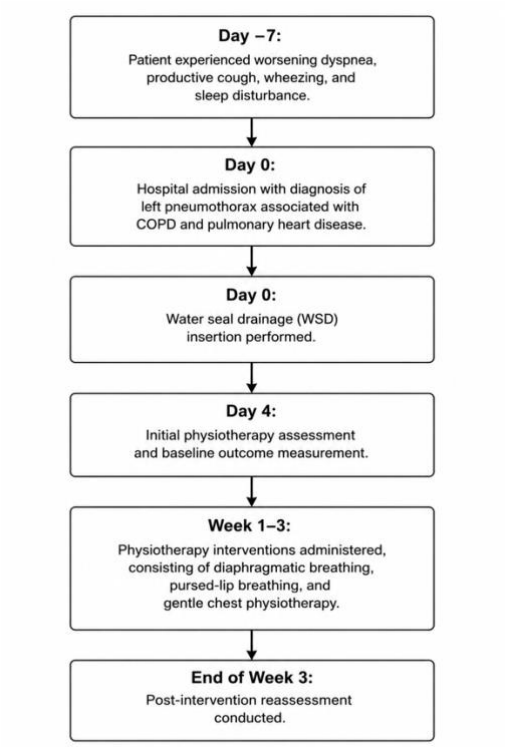

Figure 1. Clinical Timeline of Physiotherapy Intervention Following Water Seal Drainage in a Patient with Left Pneumothorax

Written informed consent for publication of clinical information was obtained from the patient and family prior to manuscript preparation. Patient confidentiality and anonymity were maintained throughout the reporting process.

Results

Clinical outcomes were evaluated before intervention (T1) and after completion of the physiotherapy program (T2) during the three-week observation period. Baseline clinical assessment demonstrated impaired respiratory status characterized by tachypnea, reduced oxygen saturation, dyspnea, productive cough, limited thoracic expansion, and severe functional dependence. Following the intervention period, improvements were observed in several respiratory-related parameters, although functional independence remained unchanged.

To facilitate comparison of clinical progression before and after intervention, the overall findings are summarized in Table 1.

Table 1. Comparison of Clinical Outcomes Before and After Physiotherapy Intervention

Outcome Measure	T1 (Pre-intervention)	T2 (Post-intervention)
Oxygen saturation (SpO_2)	92%	95%
Respiratory rate	28 breaths/minute	24 breaths/minute
Borg Dyspnea Scale	5/10	4/10
Numeric Rating Scale (NRS)	5/10	4/10
Thoracic expansion – axillary level	1 cm	1.5 cm
Thoracic expansion – ICS 4–5	2 cm	2.5 cm
Thoracic expansion – xiphoid level	1 cm	1.5 cm
Barthel Index	25/100	25/100

Abbreviations: ICS, intercostal space; NRS, Numeric Rating Scale; SpO_2, peripheral oxygen saturation.

An improvement in oxygenation status was observed following the intervention period, with oxygen saturation increasing from 92% to 95%. Respiratory rate also decreased from 28 breaths/minute at baseline to 24 breaths/minute after intervention.

Dyspnea severity assessed using the Borg Scale decreased from 5/10 to 4/10, while chest pain intensity assessed using the Numeric Rating Scale decreased from 5/10 to 4/10. During the intervention sessions, the patient demonstrated adequate tolerance to breathing exercises and chest physiotherapy without signs of worsening respiratory distress or oxygen desaturation.

Thoracic expansion measurements demonstrated minimal improvement at all measurement levels. At the axillary level, thoracic expansion increased from 1 cm to 1.5 cm. At the fourth-to-fifth intercostal space, thoracic expansion increased from 2 cm to 2.5 cm. At the xiphoid process level, thoracic expansion increased from 1 cm to 1.5 cm.

Functional ability assessed using the Barthel Index remained unchanged at 25/100, indicating persistent severe dependence in activities of daily living throughout the observation period.

To illustrate the changes in clinical outcomes before and after the physiotherapy intervention period, Figure 2 presents the comparison of baseline and post-intervention assessments. The flowchart summarizes the progression of oxygen saturation, respiratory rate, dyspnea severity, pain intensity, thoracic expansion, and functional ability during the three-week observation period.

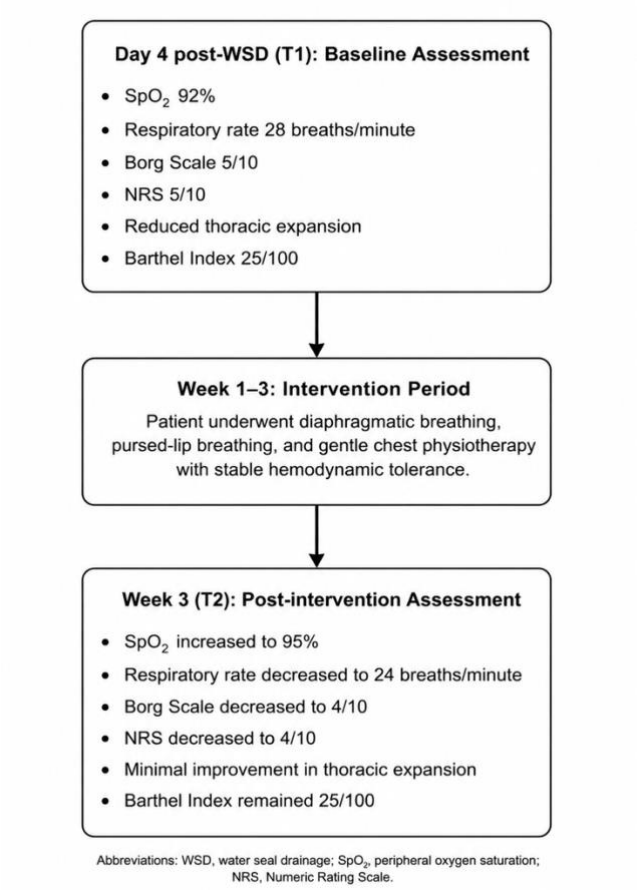

Figure 2. Clinical Outcome Progression Before and After Physiotherapy Intervention

No adverse events, intervention intolerance, or worsening respiratory symptoms were observed during the intervention period. No follow-up chest imaging, spirometry, respiratory muscle strength testing, or peak expiratory flow measurements were available during the inpatient observation period.

Discussion

This case report described the short-term clinical outcomes of respiratory physiotherapy interventions in an elderly patient with left pneumothorax following water seal drainage (WSD). The intervention program consisting of diaphragmatic breathing, pursed-lip breathing, and gentle chest physiotherapy was associated with improvement in oxygen saturation, respiratory rate, dyspnea, chest pain, and thoracic expansion during the observation period. However, no measurable improvement was identified in functional independence, as indicated by the unchanged Barthel Index score. These findings suggest that respiratory physiotherapy may contribute to short-term respiratory stabilization following WSD placement, although functional recovery in medically complex geriatric patients may remain limited during short-term hospitalization.[15]

The improvement in oxygen saturation from 92% to 95% may reflect enhanced ventilatory efficiency and gradual restoration of breathing mechanics following respiratory exercise intervention.[16] Pneumothorax disrupts intrapleural pressure dynamics and impairs lung expansion, resulting in ineffective ventilation and reduced oxygenation.[5] Although WSD facilitates pleural air evacuation and lung re-expansion, residual respiratory dysfunction often persists because of pain, respiratory muscle inhibition, ineffective breathing patterns, and prolonged immobilization.[8] In the present case, the patient demonstrated tachypnea, shallow breathing, accessory muscle overuse, and reduced thoracic expansion during baseline assessment, indicating persistent respiratory mechanical impairment despite WSD insertion.

Diaphragmatic breathing exercise may have contributed to respiratory improvement by facilitating diaphragmatic excursion and reducing excessive accessory muscle activity.[12] Previous studies have demonstrated that diaphragmatic breathing may improve tidal volume distribution and breathing efficiency in patients with pulmonary dysfunction.[17] In elderly individuals, reduced chest wall compliance and diminished respiratory muscle strength may further compromise ventilatory reserve, thereby increasing the importance of efficient breathing pattern control during recovery.[18]

Pursed-lip breathing exercise may also have contributed to the reduction in dyspnea and respiratory rate observed in this patient. This intervention prolongs expiratory time and helps maintain positive airway pressure during expiration, thereby reducing dynamic airway collapse and improving ventilatory control, particularly in patients with chronic obstructive pulmonary disease (COPD).[13] The reduction in Borg Scale score from 5/10 to 4/10 and respiratory rate from 28 to 24 breaths/minute may indicate improved breathing comfort and reduced ventilatory distress during resting conditions. Nevertheless, these findings should be interpreted cautiously because this report involved only a single patient without objective pulmonary function testing.

The reduction in chest pain observed following intervention may also have indirectly contributed to improved breathing tolerance. Pain associated with chest tube insertion frequently limits deep inspiration and promotes shallow breathing patterns that impair pulmonary ventilation.[19] Gentle chest physiotherapy and soft tissue relaxation techniques may reduce muscular tension surrounding the thoracic region and facilitate breathing comfort during rehabilitation sessions.[20]

Thoracic expansion demonstrated only minimal improvement throughout the observation period. This finding may reflect persistent restrictive breathing characteristics associated with pneumothorax recovery, chronic pulmonary disease, pain, respiratory muscle deconditioning, and prolonged hospitalization.[21] In elderly patients with COPD and recurrent hospitalization, thoracic mobility recovery may occur gradually because of reduced chest wall flexibility and impaired respiratory muscle performance.[22]

An important finding in this case was the absence of functional improvement despite partial respiratory stabilization. The Barthel Index remained unchanged at 25/100, indicating persistent severe dependence in activities of daily living. Functional recovery in hospitalized geriatric patients is multifactorial and may be influenced by frailty, sarcopenia, prolonged bed rest, cardiovascular limitation, nutritional deficiency, and generalized deconditioning.[18] The patient in this report demonstrated several indicators suggestive of frailty and reduced physiological reserve, including recurrent hospitalization, oxygen dependency, tachycardia, and reduced activity tolerance, which may have contributed to persistent functional limitation during the short observation period.[23]

The findings of this report are generally consistent with previous respiratory rehabilitation literature demonstrating that breathing exercises may improve dyspnea and respiratory efficiency in patients with pulmonary dysfunction.[13] However, most previous evidence has focused on COPD rehabilitation or postoperative thoracic conditions, while evidence specifically addressing physiotherapy following pneumothorax and WSD placement remains limited, particularly in elderly patients with multiple cardiopulmonary comorbidities.[24]

Several factors should be considered when interpreting the outcomes of this case. Natural recovery following WSD placement may have contributed to improvement in oxygenation and respiratory symptoms independently of physiotherapy intervention.[25] In addition, concurrent medical management such as oxygen therapy, bronchodilator administration, analgesic treatment, and inpatient monitoring may also have influenced clinical recovery.[26] Therefore, the present findings should not be interpreted as definitive evidence of therapeutic effectiveness but rather as a description of short-term clinical responses associated with physiotherapy intervention during hospitalization.[27]

From a clinical perspective, this case highlights the importance of individualized respiratory rehabilitation in medically complex geriatric patients following pneumothorax and WSD placement.[28] Early physiotherapy intervention may assist in symptom management, breathing pattern optimization, and maintenance of respiratory function during hospitalization when performed with careful monitoring of symptom tolerance and hemodynamic stability.[28]

Several limitations of this case report should be acknowledged. This report involved a single patient and therefore has limited generalizability. Objective pulmonary assessments such as spirometry, respiratory muscle strength testing, peak expiratory flow measurement, and follow-up chest imaging were unavailable during the observation period. In addition, the short follow-up duration limited evaluation of long-term respiratory and functional outcomes. Potential confounding factors related to medical treatment and spontaneous physiological recovery could not be fully controlled.

Further prospective studies with larger sample sizes, objective pulmonary function assessment, imaging follow-up, and longer observation periods are required to clarify the long-term effectiveness of respiratory physiotherapy interventions following pneumothorax management.

Conclusion

This case report demonstrated that respiratory physiotherapy interventions consisting of diaphragmatic breathing, pursed-lip breathing, and gentle chest physiotherapy were associated with short-term improvement in oxygenation, dyspnea, respiratory rate, chest pain, and thoracic expansion in an elderly patient with left pneumothorax following water seal drainage placement. However, these physiological improvements were not accompanied by measurable improvement in functional independence during the observation period, as the patient remained severely dependent in activities of daily living.

The findings suggest that early respiratory physiotherapy may provide supportive benefits during the post-WSD recovery phase, particularly in optimizing breathing patterns and improving respiratory comfort in patients with complex cardiopulmonary comorbidities. Nevertheless, the results should be interpreted cautiously because this report involved a single patient with a short follow-up duration and without objective pulmonary function assessment.

From a practical perspective, rehabilitation management in geriatric pneumothorax should not focus solely on respiratory symptoms but also address broader functional limitations through comprehensive multidisciplinary rehabilitation strategies. Further prospective studies with larger sample sizes, objective pulmonary evaluation, and longer follow-up periods are needed to clarify the effectiveness and long-term impact of respiratory physiotherapy interventions following pneumothorax management.

Author Contribution

Erika Miftahurrizqia: Conceptualization, methodology, investigation, data curation, formal analysis, writing original draft.
Isna Herawati: Conceptualization, methodology, formal analysis, writing review and editing, supervision.
Ririt Ika Lestari: Investigation, writing review and editing.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This case report was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent for publication of clinical information was obtained from the patient and family prior to manuscript preparation. Patient confidentiality and anonymity were maintained throughout the reporting process.

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