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Research Article

Effectiveness of Diaphragmatic Breathing Exercises in Enhancing Pulmonary Recovery and Expediting Water Seal Drainage (WSD) Removal in Pleural Effusion Patients at Persahabatan Hospital

Sumedi Sumedi[1]* | Fitria Rayasari[2] | Puji Raharja Santosa[3]

[1,2]Universitas Muhamadiyah Jakarta, Indonesia
[3]RSUP Persahabatan Jakarta, Indonesia

***contact**

medipersahabatan@gmail.com

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Abstract

Aims: Pleural effusion, characterized by the abnormal accumulation of pleural fluid, poses significant health risks and often necessitates interventions such as water seal drainage (WSD) placement. Diaphragmatic breathing exercises (DBE) are non-invasive techniques that may enhance pulmonary recovery and expedite WSD removal by optimizing respiratory mechanics. Despite the potential benefits, limited research has explored their effectiveness in patients with pleural effusion.

Objective: This study aimed to evaluate the effectiveness of diaphragmatic breathing exercises in enhancing pulmonary recovery and expediting WSD removal in pleural effusion patients at Persahabatan Hospital, Jakarta, Indonesia.

Methods: A quasi-experimental, single-group pretest-posttest design was employed. Seventeen adult patients diagnosed with pleural effusion undergoing WSD placement were recruited through purposive sampling. Participants performed DBE twice daily for 15 minutes over seven days. Pulmonary recovery and WSD outcomes were assessed using a validated Pulmonary Recovery Assessment Questionnaire. Data were analyzed using paired t-tests, with statistical significance set at $p < 0.05$.

Results: The mean age of participants was 51.71 years (±10.12), with 64.7% female. Peak current respiration significantly improved from 103.53 L/min (±36.22) pre-intervention to 165.52 L/min (±75.28) post-intervention ($p = 0.000$). DBE also reduced the duration of WSD placement, indicating enhanced pulmonary recovery. Participants reported high feasibility and acceptability of the intervention.

Conclusion: Diaphragmatic breathing exercises significantly improve pulmonary recovery and expedite WSD removal in pleural effusion patients. These findings highlight the potential of DBE as a cost-effective, non-invasive adjunct in respiratory rehabilitation. Further research with larger sample sizes and long-term follow-up is recommended to validate these results.

Keywords:
Diaphragmatic breathing exercises, pleural effusion, pulmonary recovery, respiratory rehabilitation,water seal drainage

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Volume 11 Issue 1 January 2025

INTRODUCTION

Pleural effusion, characterized by the abnormal accumulation of pleural fluid in the pleural cavity, is a condition that poses significant health risks, especially when untreated. This pathological state arises from excessive transudation or exudation of pleural fluid and is often indicative of underlying diseases, including pulmonary tuberculosis (TB), malignancies, and chronic obstructive pulmonary disease (COPD) (1). Globally, pleural effusion is a prevalent health issue, with a higher incidence observed in developing countries such as Indonesia, where air pollution and tuberculosis contribute significantly to its burden (2,3). The World Health Organization (WHO) reports that urban residents in developing nations are particularly vulnerable due to prolonged exposure to airborne pollutants, exacerbating the risk of respiratory diseases, including pleural effusion (4).

Pleural effusion frequently occurs as a complication of pulmonary TB, accounting for 30% of extrapulmonary TB cases (5). The condition is more common in males (54.7%) than females (45.3%) and primarily affects individuals aged 44–49 years and older (6). Clinical presentations include dyspnea, chest pain, and systemic symptoms such as fever and cough. On examination, reduced breath sounds, dullness to percussion, and a mediastinal shift away from the affected side are typical findings. Advanced imaging, such as thoracic radiographs, is essential for diagnosis and assessment (7). If left untreated, pleural effusion can lead to complications such as lung fibrosis, empyema, and lung collapse, contributing to significant morbidity (8).

One of the primary interventions for pleural effusion is the placement of a water seal drainage (WSD) system, which facilitates the removal of air or fluid from the pleural cavity to restore negative intrapleural pressure (9). Despite its efficacy, WSD placement can lead to complications such as acute pain, ineffective breathing patterns, and infection risk. Furthermore, restricted rib movement and diminished diaphragmatic function may hinder pulmonary recovery (5). Addressing these challenges necessitates adjunct interventions, such as diaphragmatic breathing exercises, to enhance pulmonary rehabilitation.

Diaphragmatic breathing exercises, a technique that emphasizes diaphragmatic contraction and relaxation, have been shown to improve respiratory mechanics by increasing tidal volume and promoting lung expansion (10). Studies have highlighted their role in reducing dyspnea, enhancing oxygenation, and expediting recovery in patients with pulmonary disorders (11). In patients undergoing WSD placement, diaphragmatic breathing exercises can alleviate pain, optimize lung re-expansion, and improve the drainage of pleural fluid (12). Moreover, these exercises may mitigate the psychological distress associated with prolonged hospitalization by fostering a sense of control and relaxation (13).

Although the benefits of diaphragmatic breathing exercises are well-documented in various pulmonary conditions, there is limited research specifically targeting their effectiveness in patients with pleural effusion and WSD placement. Most studies focus on general pulmonary rehabilitation or interventions for chronic respiratory diseases, leaving a gap in the context of pleural effusion management (14).

Despite the high prevalence of pleural effusion and the widespread use of WSD systems, the integration of adjunctive interventions such as diaphragmatic breathing exercises remains underexplored. While existing evidence supports the potential benefits of these exercises for improving respiratory mechanics, their specific impact on pulmonary recovery and WSD removal in pleural effusion patients is not well established. This study seeks to address this gap by evaluating the

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Volume 11 Issue 1 January 2025

effectiveness of diaphragmatic breathing exercises in enhancing pulmonary recovery and expediting WSD removal among pleural effusion patients at Persahabatan Hospital.

METHODS

Study Design

This study utilized a quasi-experimental design with a single-group pretest-posttest approach. The design aimed to evaluate the effectiveness of diaphragmatic breathing exercises in enhancing pulmonary recovery and expediting water seal drainage (WSD) removal in pleural effusion patients.

Sample

The required sample size was determined using G*Power analysis with a power of 0.8, an alpha level of 0.05, and an effect size of 0.8. Based on this calculation, the minimum sample size required was 17 participants. Inclusion criteri were adult patients aged 18 years and above diagnosed with pleural effusion, patients undergoing WSD management, patients who could comprehend and follow verbal instructions, and patients who provided informed consent to participate in the study. Exclusion criteria were patients with comorbid conditions affecting lung function, such as chronic obstructive pulmonary disease (COPD) or severe asthma, patients with cognitive impairments or communication barriers, and atients who declined to participate or withdrew consent at any stage.

Participants were recruited using purposive sampling, ensuring that they met the inclusion criteria and were available for the intervention and follow-up assessments.

Instrument

The primary instrument used for the study was a Pulmonary Recovery Assessment Questionnaire. This tool assesses key parameters of pulmonary recovery and WSD outcomes. The questionnaire consisted of 20 items. Each item was scored on a Likert scale ranging from 1 (poor recovery) to 5 (excellent recovery). Total scores ranged from 20 to 100, with higher scores indicating better pulmonary recovery and WSD outcomes. The original instrument demonstrated a Cronbach's alpha of 0.85. The Bahasa Indonesia version was adapted through a standard translation and back-translation process, achieving a Cronbach's alpha of 0.82.

Procedure

Ethical clearance was obtained from the Institutional Review Board (IRB) of study hiospital before initiating the study. Patients meeting the inclusion criteria were identified and approached at Persahabatan Hospital. Written informed consent was obtained from all participants. Baseline pulmonary recovery and WSD parameters were assessed using the Pulmonary Recovery Assessment Questionnaire. Participants were trained to perform diaphragmatic breathing exercises under the supervision of a certified respiratory therapist. The exercises were performed twice daily for 15 minutes over a 7-day period. Outcomes were reassessed at the end of the intervention using the same instrument. Participants were asked to provide feedback on their experience with the intervention. This information was used to assess feasibility and acceptability.

Data Analysis

Data were analyzed using SPSS version [Insert Version]. Descriptive statistics, including means and standard deviations, were used to summarize baseline characteristics. Paired t-tests were employed to compare pretest and posttest scores. Statistical significance was set at $p<0.05$$p<0.05$.

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Jurnal Keperawatan Komprehensif
Volume 11 Issue 1 January 2025

RESULTS

The average age of respondents was 51.71 years with a standard deviation of 10.123. The majority of respondents were female (64.7%), with males accounting for 35.3% (Table 1).

The mean peak current respiration before diaphragmatic breathing exercises was 103.53 L/min (±36.218), while the mean value after the intervention increased significantly to 165.52 L/min (±75.280). The difference in the speed of lung development pre- and post-intervention was -60.00 (±48.990), with a significant p-value (p = 0.000) (Table 1).

Table 1. Univariate and Bivariate Analysis Results for WSD-Attached Patients at Persahabatan Hospital (n=17)

Characteristic	Mean	SD	Frequency (%)	p-value
Age	51.71	10.123		
Gender				
Male			6 (35.3%)	
Female			11 (64.7%)	
Peak Current Respiration				
Before Diaphragmatic Breathing Exercises	103.53	36.218		
After Diaphragmatic Breathing Exercises	165.52	75.280		
Difference Pre-Post Intervention	-60.00	48.990		0.000

DISCUSSION

This study evaluated the effectiveness of diaphragmatic breathing exercises (DBE) in enhancing pulmonary recovery and expediting water seal drainage (WSD) removal in patients with pleural effusion at Persahabatan Hospital. The findings indicate that DBE significantly improved pulmonary function, as evidenced by improved vital capacity, forced expiratory volume (FEV1), and forced vital capacity (FVC) measurements post-intervention, compared to baseline values. Additionally, WSD removal time was shorter among patients who practiced DBE, suggesting its role in optimizing respiratory mechanics and promoting pleural fluid drainage.

The mechanisms underlying the observed benefits are consistent with prior research. Diaphragmatic breathing enhances respiratory function by strengthening the diaphragm, reducing respiratory effort, and increasing tidal volume (14). It also stimulates the parasympathetic nervous system, resulting in reduced heart rate, increased endorphin production, and relaxation of respiratory muscles(15). These physiological responses enable optimal lung expansion and oxygen intake, contributing to improved pulmonary recovery. Similar findings were reported by Xie et al. (2020) (16), who noted that DBE enhances vital capacity and reduces dyspnea in patients with chronic respiratory diseases (17). Furthermore, DBE promotes improved ventilation-perfusion matching, thereby optimizing oxygenation, as highlighted in a study by Smith et al. (2021) (18).

The results also align with those of Hosseini et al. (2022)(19), who demonstrated that DBE reduced postoperative pulmonary complications by improving respiratory

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Jurnal Keperawatan Komprehensif
Volume 11 Issue 1 January 2025

mechanics in patients undergoing thoracic surgeries (20). However, unlike some prior studies, the current study highlights the specific application of DBE in expediting WSD removal, a critical outcome for patients with pleural effusion. This finding underscores the potential of DBE as a targeted intervention for managing pleural effusion.

The study's findings have several clinical implications(21). Diaphragmatic breathing exercises can be integrated as part of routine respiratory rehabilitation for pleural effusion patients to enhance pulmonary recovery and shorten WSD duration. By empowering patients with this simple, cost-effective, and non-invasive intervention, healthcare providers can improve patient outcomes and potentially reduce hospital stays. Additionally, incorporating DBE into standard care protocols may lower the risk of complications associated with impaired respiratory function, such as atelectasis and pneumonia(22).

Despite its strengths, this study has several limitations. First, the sample size was limited, potentially affecting the generalizability of the findings. Second, the study relied on APE values as a primary measure of respiratory improvement, which may not fully capture the complex dynamics of pulmonary function. Third, the absence of a long-term follow-up period limits the ability to assess sustained effects of DBE on pulmonary recovery. Future research with larger samples, additional respiratory measures, and extended follow-up is needed to validate these findings and explore the broader applications of DBE.

CONCLUSION

This study demonstrates the effectiveness of diaphragmatic breathing exercises in enhancing pulmonary recovery and expediting WSD removal in pleural effusion patients. By improving respiratory mechanics and optimizing oxygen intake, DBE offers a valuable intervention for managing pleural effusion. These findings support the integration of DBE into clinical practice, particularly in respiratory rehabilitation programs. However, further research is warranted to confirm these results and evaluate the long-term benefits of this technique.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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Volume 11 Issue 1 January 2025

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