Original Article

ACTIVE CYCLE OF BREATHING TECHNIQUE FOR AIRWAY CLEARANCE AND RESPIRATORY FUNCTION IN PULMONARY TUBERCULOSIS: A CASE STUDY

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ABSTRACT

Background: Pulmonary tuberculosis (TB) remains a major public health challenge in Indonesia, often leading to ineffective airway clearance due to excessive secretions. Non-pharmacological interventions, such as chest physiotherapy and deep breathing, are widely used; however, their effectiveness can be further enhanced through the Active Cycle of Breathing Technique (ACBT).

Objectives: This study aimed to describe the nursing care process using ACBT and evaluate its effectiveness in improving airway clearance and respiratory function in a patient with pulmonary TB.

Methods: A single-case descriptive study using an evidence-based nursing approach was conducted with an 82-year-old female patient diagnosed with pulmonary TB and ineffective airway clearance. ACBT was administered once daily for four consecutive days, each session lasting 15 minutes. Data were collected through observation, clinical documentation, and semi-structured interviews, and analyzed descriptively by comparing pre- and post-intervention respiratory parameters (respiratory rate, oxygen saturation, sputum characteristics, and lung sounds).

Results: Clinical indicators showed progressive improvement. Respiratory rate decreased from 24 to 20 breaths/min, oxygen saturation increased to 97% on room air, and auscultation revealed reduced wheezing and rhonchi. The patient reported easier sputum expectoration and reduced dyspnea after four days of intervention.

Conclusion: ACBT effectively enhanced airway clearance and respiratory function in a pulmonary TB patient. It is recommended as an evidence-based, non-pharmacological intervention for respiratory nursing practice.

Keywords: Pulmonary Tuberculosis, Airway Clearance, Active Cycle of Breathing Technique, Evidence-Based Nursing, Case Study.

INTRODUCTION

Pulmonary tuberculosis (TB) continues to be a leading infectious disease worldwide, particularly in Indonesia (Rachmawati & Sholihah, 2023). Despite widespread implementation of the Directly Observed Treatment Short Course (DOTS) program, the disease remains a major cause of morbidity and mortality (Semitala et al., 2024). A common complication in patients with pulmonary TB is a decline in oxygen saturation caused by hypoxia, which often

results from impaired airway clearance due to infection-related processes in the lungs (Sikora et al., 2024). Current management strategies typically involve pharmacological interventions such as mucolytic therapy, alongside nursing interventions including education on effective coughing techniques. However, these measures have not proven fully effective, as many patients remain dependent on healthcare providers for their implementation.

According to the World Health Organization (WHO, 2025), an estimated 10.8 million people worldwide are affected by pulmonary TB, comprising 6 million men, 3.6 million women, and 1.3 million children. In Indonesia, pulmonary TB continues to be one of the most prevalent diseases. Data from the Indonesian Tuberculosis Eradication Association (PPTI, 2024) reported 969,000 cases, equivalent to one new case every 33 seconds. This figure represents a 17% increase compared with 2020, when 824,000 cases were recorded (Yayasan KNCV Indonesia, 2022). Observations conducted in the X Hospital, Surabaya, revealed that in March 2025, 25 patients were hospitalized with pulmonary TB. Ineffective airway clearance is a frequent complication in TB, often resulting from increased mucus production and bronchial inflammation. While pharmacological interventions such as mucolytics and bronchodilators are beneficial, complementary nursing interventions are required to optimize secretion clearance.

Patients with pulmonary TB typically present with chronic cough lasting more than two weeks, accompanied by weight loss, nocturnal fever, and fatigue, with sputum examination confirming the presence of Mycobacterium tuberculosis colonies (Gordhan et al., 2022). This infection stimulates excessive mucus production within the airways, leading to bronchial narrowing and impaired oxygen distribution to the alveoli (Gopalaswamy et al., 2020). Ineffective airway clearance in such cases may be attributed to several factors, including excessive sputum production due to chronic inflammation, weakened cough reflex caused by fatigue or respiratory muscle weakness, anxiety that hinders effective coughing, supine positioning that obstructs mucus drainage, and limited knowledge or skill in performing effective coughing and breathing techniques (Aufa et al., 2024). Initial management often involves pharmacological therapy (e.g., mucolytics, bronchodilators) combined with nursing interventions such as education on effective coughing and breathing exercises. Nonetheless, these interventions remain suboptimal, as many patients are unable to perform them independently (Astuti et al., 2024). The Active Cycle of Breathing Technique (ACBT) integrates breathing control, thoracic expansion exercises, and forced expiration (huffing) to promote sputum mobilization from peripheral to central airways.

Current nursing approaches include pharmacological collaboration through mucolytic agents and anti-tuberculosis treatment (ATT) to restore lung function and minimize airway obstruction (Salari et al., 2023). Additionally, chest physiotherapy, effective coughing, and deep breathing exercises are applied as non-pharmacological interventions (Hartati & Rindiani, 2023). To optimize these interventions outlined in the Indonesian Nursing Intervention Standards, such as effective coughing exercises, airway management, and respiratory monitoring, ACBT can be integrated as a complementary nursing intervention. This method aims to enhance patient autonomy, enabling individuals with pulmonary TB to conduct therapy independently (Wahyudi et al., 2021).

ACBT is a non-pharmacological technique proven effective in managing ineffective airway clearance in patients with respiratory conditions, including pulmonary TB (Endria et

al., 2022). It consists of controlled breathing exercises designed to mobilize sputum from the smaller lower airways towards the larger upper airways, from where it can be expelled more easily through coughing (Wahyudi et al., 2021). The technique involves three main components: breathing control, thoracic expansion exercises, and forced expiration (Belli et al., 2021).

Previous studies have demonstrated ACBT's role in enhancing oxygenation, reducing dyspnea, and improving pulmonary ventilation. However, evidence in TB patients, especially among older adults, remains limited (Phillips et al., 2023). Similarly, a four-day ACBT program in pulmonary TB patients was associated with improved oxygen saturation and reduced dyspnea (Kushariyadi et al., 2024).

Overall, patients with pulmonary TB often experience ineffective airway clearance, evidenced by sputum retention, reduced oxygen saturation, and disordered breathing patterns. While existing nursing interventions, such as chest physiotherapy, effective coughing, and breathing exercises, have been beneficial, their outcomes can be enhanced through the integration of ACBT. This combined approach not only optimizes therapy but also fosters patient independence in managing airway clearance.

Therefore, this study aims to explore the application of ACBT in an elderly patient with pulmonary tuberculosis and analyze its effectiveness in improving airway clearance.

METHODS

Study Design

This research employed a single-case descriptive design within an evidence-based nursing framework. Data collection was carried out directly using the nursing process approach, which included assessment, diagnosis, intervention, implementation, and evaluation.

Settings

The study was conducted in the Pulmonary Tuberculosis Isolation Ward of a hospital in Surabaya. Interaction and data collection were carried out over four days during the patient's hospitalization, specifically from April 18 to April 21, 2025.

Research Subject

An 82-year-old female patient with pulmonary tuberculosis was purposively selected for this study. She experienced persistent shortness of breath, worsened with activity and slightly relieved at rest, which did not improve despite home oxygen therapy. Additional complaints included decreased appetite for the past week and a productive cough with difficulty expectorating sputum. This case was chosen for its clinical relevance to ineffective airway clearance in pulmonary tuberculosis. The clinical instructor and ward supervisor approved study eligibility.

Instruments

Data were recorded using observation sheets aligned with the Indonesian Nursing Outcome Standards (SLKI), assessing respiratory rate (RR), oxygen saturation (SpO_2), breath sounds, and sputum characteristics. The SLKI indicators for airway clearance were used as evaluation criteria.

Data Collection

The intervention combined airway management with ACBT, administered once daily for four consecutive days (April 18–21, 2025). Each session lasted 15 minutes and followed

standard ACBT phases: breathing control, thoracic expansion, and forced expiration. Patient and family education were provided through demonstration and leaflet guidance.

Data Analysis

Data collection involved reviewing clinical records, obtaining patient history, performing a physical examination with a stethoscope to assess lung sounds, and conducting semi-structured interviews with both the patient and her caregiver. At the initial encounter, the researcher warmly introduced herself, explained the patient's current health concerns in clear and simple terms, and described the goals and procedures of the study. The patient and caregiver listened attentively and gave their verbal consent to participate. During the conversation, they shared personal experiences regarding the patient's shortness of breath, loss of appetite, persistent productive cough, and previous attempts at self-care, such as using home oxygen therapy. The nurse researcher guided the interview with empathy, reading each question aloud and providing clarification when needed to ensure understanding. The entire process was carried out in a supportive manner, with the interview lasting approximately 15 minutes at the patient's bedside, just before the nursing intervention was implemented.

Ethical Considerations

Ethical approval was granted by the Institutional Review Board of the Faculty of Nursing and Midwifery, Universitas Nahdlatul Ulama Surabaya. Written informed consent was obtained from the patient for participation in the study and for the publication of anonymized results. Throughout the intervention, assurances were provided regarding privacy, confidentiality, and the participant's right to withdraw at any stage.

RESULTS

Case description

An 82-year-old female, hereafter referred to as Mrs. M, was admitted with a primary diagnosis of pulmonary tuberculosis. She reported persistent shortness of breath experienced from morning until evening, described as labored and breathless, which worsened during physical activity and slightly improved with rest. Previous self-management attempts, including the use of home oxygen therapy, did not alleviate her symptoms. Her medical history revealed loss of appetite over the past week, accompanied by a productive cough with difficulty expectorating sputum. Notably, she had been hospitalized one month earlier with the same diagnosis.

Family history indicated hypertension, while she denied any allergies to food or medication. Mrs. M had no history of smoking, coffee consumption, or alcohol use. She was currently undergoing anti-tuberculosis treatment and regularly consumed Isoniazid 300 mg once daily, Cefixime 100 mg twice daily, and Symbicort inhalation twice daily.

On physical examination, her general condition appeared weak, but she was fully conscious (GCS E4 V5 M6). Vital signs were as follows: blood pressure 140/81 mmHg, heart rate 121 bpm (strong and regular), respiratory rate 24 breaths per minute, body temperature 36.8°C, and oxygen saturation 97% with 10 L/min oxygen via mask.

Respiratory assessment revealed symmetrical chest expansion, use of accessory muscles, and additional breath sounds of wheezing and bilateral rhonchi on auscultation. Cardiovascular assessment showed a visible and palpable ictus cordis with warm extremities and capillary refill <2 seconds. Heart sounds S1 and S2 were present without murmur or gallop.

Neurological examination showed no complaints of pain, intact sensory and motor function, and normal sleep patterns.

Urinary function was within normal limits, with urine output balanced against fluid intake. Gastrointestinal assessment indicated a low body weight (42 kg, BMI 15.4) with recent weight loss of 2 kg due to decreased appetite. The abdomen was normal with active bowel sounds, and the patient reported one soft stool per day with assistance. Electrolyte testing showed hypokalemia (K^+ 3.0 mmol/L).

Musculoskeletal assessment revealed an adequate range of motion and muscle strength, though she required partial to total assistance with most activities of daily living, particularly toileting, walking, and stair climbing. Skin turgor was normal, with no edema or lesions observed. Endocrine and genital examinations showed no abnormalities.

Laboratory results revealed leukocytosis (18.49×10^3/μL), anemia (Hb 11.20 g/dL), and increased RDW-CV (18.6%). Liver function test showed elevated SGOT (82.2 U/L). Thoracic X-ray demonstrated fibro-infiltrates in the right suprahilar region, consistent with relatively stable pulmonary tuberculosis.

During hospitalization, Mrs. M received several medications, including Acetylcysteine, Salbutamol, Valutine nebulization, Ondansetron, Ceftriaxone, Ranitidine, Santagesik, Pulmicort nebulization, Curcuma Force, potassium chloride supplementation, Methylprednisolone, and Norepinephrine infusion.

Nursing diagnosis

The priority nursing diagnosis for Mrs. M was identified as ineffective airway clearance related to the infectious process. This was evidenced by the presence of dyspnea, difficulty in expectorating sputum, oxygen saturation of 97% with a 10 L/min mask, audible wheezing, rhonchi, respiratory rate of 24 breaths per minute, intercostal chest retraction, and an elevated leukocyte count of 18.49×10^3/μL.

Intervention

Nursing interventions to address the problem of ineffective airway clearance in Mrs. M were carried out in accordance with the Indonesian Nursing Intervention Standards (SIKI), specifically through airway management combined with the Active Cycle of Breathing Technique (ACBT). These included close observation of the patient's breathing pattern, lung sounds, and sputum characteristics to monitor respiratory status. The therapy was performed with the patient positioned in semi-Fowler's to facilitate breathing, accompanied by the provision of warm fluids to help liquefy sputum, and the application of ACBT to aid airway clearance. Mrs. M was also taught effective coughing techniques to support sputum expectoration. Collaboration with the medical team involved the administration of bronchodilators, expectorants, and mucolytics to optimize airway recovery.

As outcome measures, the nurse referred to the Indonesian Nursing Outcomes Standards (SLKI), with the intended goals and expected results including an improvement in effective coughing, reduction in wheezing and rhonchi, alleviation of dyspnea, decreased chest retraction, and stabilization of respiratory rate.

Implementation

The nursing implementation was carried out over four days, with the intervention consisting of airway management combined with the Active Cycle of Breathing Technique (ACBT), performed once daily for 15 minutes. The program was implemented from 18 April

2025 to 21 April 2025. At the outset, the nurse provided the patient with information about the therapeutic steps to be undertaken. The nurse then explained both the purpose and procedure of ACBT, emphasizing how the technique could help clear the airways and improve breathing. To enhance understanding, an educational leaflet was given as a visual aid. Once the patient had understood and agreed, the nurse proceeded to teach the step-by-step application of ACBT, ensuring that the patient was able to perform the technique correctly and effectively.

Evaluation

Following the nursing intervention using the Active Cycle of Breathing Technique (ACBT) over four consecutive days, the patient demonstrated marked improvement in respiratory function. Subjectively, the patient reported that the shortness of breath previously experienced had resolved, and sputum expectoration was more effective, with the mucus described as thick and white. The patient also expressed greater comfort after being given warm fluids, which helped to ease throat discomfort. In addition, nebulization provided a sense of relief, with the patient reporting smoother and easier breathing. Objectively, the patient's respiratory rate returned to normal at 20 breaths per minute, with oxygen saturation (SpO_2) recorded at 97% on room air, without supplemental oxygen. Auscultation revealed a reduction in both rhonchi and wheezing across the lung fields, alongside diminished chest retraction. These clinical indicators collectively reflected a significant improvement in the patient's respiratory condition.

Considering these findings, the respiratory problem was considered resolved. The patient demonstrated the ability to expectorate sputum effectively, experienced reduced dyspnea, and presented with decreased adventitious lung sounds. Oxygen saturation remained stable without additional support. Given the overall clinical improvement, the therapeutic intervention was subsequently discontinued.

DISCUSSION

Based on the anamnesis, Mrs. M presented to the hospital with complaints of shortness of breath, experienced from morning until late afternoon. The breathing pattern was described as labored and gasping, aggravated by physical activity and slightly relieved during rest. In her health history, the patient reported a reduced appetite for the past week, accompanied by a productive cough with sputum that was difficult to expectorate. Independent efforts, such as home oxygen therapy, had been attempted, yet symptoms did not improve. At present, the patient is undergoing treatment for pulmonary tuberculosis (TB). Clinical examination revealed a blood pressure of 140/81 mmHg, pulse rate of 121 beats per minute, respiratory rate of 24 breaths per minute, body temperature of 36.8°C, and oxygen saturation of 97% with a mask delivering 10 L/min. Intercostal chest retractions were also observed.

Findings from the assessment align with established literature indicating that pulmonary tuberculosis is an infectious disease caused by Mycobacterium tuberculosis, primarily affecting the lungs (WHO, 2024). Pulmonary TB is characteristically marked by symptoms such as a productive cough lasting more than two weeks, weight loss, and night sweats (KemenKes, RI, 2022). Typical respiratory manifestations include hemoptysis, chest pain, and dyspnea, while systemic features often comprise fever, nocturnal sweating, fatigue or malaise, anorexia, and weight loss (Sari et al., 2022).

The clinical presentation in Mrs. M demonstrates hallmark manifestations of active pulmonary tuberculosis that remain sub-optimally managed, evidenced by persistent breathlessness, difficult sputum expectoration, appetite loss, and signs of increased respiratory effort such as intercostal retractions and tachycardia. Although the patient has been receiving TB therapy and attempted self-management with oxygen supplementation, the absence of improvement highlights the necessity for more comprehensive professional interventions, including respiratory management and nutritional support. This underscores the principle that pulmonary TB care cannot rely solely on pharmacological treatment but must also integrate a holistic approach involving patient education, close monitoring, and family engagement, so that both respiratory and systemic symptoms are adequately addressed and the patient's quality of life is enhanced.

From the anamnesis conducted with Mrs. M, the primary nursing diagnosis identified in this case study was ineffective airway clearance, associated with the infectious process. This was evidenced by complaints of shortness of breath, difficulty in expectorating sputum, oxygen saturation at 97% with 10 L/min via mask, the presence of wheezing (+), rhonchi (+), a respiratory rate of 24 breaths per minute, intercostal chest retraction (+), and a leukocyte count of $18.49 \times 10^3/\mu L$.

According to the Indonesian Nursing Diagnosis Standards (SDKI) outlined by (PPNI, 2018a), ineffective airway clearance is defined as the inability to clear secretions or obstructions from the airway to maintain a patent airway. This nursing problem is commonly encountered among patients with pulmonary tuberculosis, largely due to the infectious process, which triggers excessive sputum production and subsequently compromises airway patency (Endria et al., 2022). If left unaddressed, ineffective airway clearance can lead to further complications such as ineffective breathing patterns and impaired gas exchange, which may exacerbate the patient's clinical condition (Kushariyadi et al., 2024).

Based on this explanation, ineffective airway clearance was established as the primary nursing diagnosis due to the clinical manifestations of dyspnea, intercostal muscle retraction, rhonchi, wheezing, and tachypnoea, all of which indicate airflow obstruction caused by sputum accumulation. Although oxygen saturation was within the normal range under oxygen therapy, this finding highlights the patient's dependence on supplemental oxygen. Furthermore, the laboratory data indicating leukocytosis reinforce the presence of an active infectious process as the underlying cause of airway clearance disturbance, particularly relevant in patients with a history of pulmonary tuberculosis, who are more susceptible to excessive sputum production. If not managed promptly, this condition poses a significant risk of progressing to ineffective breathing patterns and impaired gas exchange.

The implementation of the primary nursing interventions for Mrs. M was carried out in accordance with the Indonesian Nursing Intervention Standards (SIKI), focusing on airway management combined with the Active Cycle of Breathing Technique (ACBT), guided by Evidence-Based Nursing (EBN) principles. The interventions included monitoring the patient's respiratory rate, rhythm, and depth; auscultating lung sounds with a stethoscope; assessing sputum characteristics (color, volume, and consistency); positioning the patient in semi-Fowler's or Fowler's position to optimize lung expansion; and assisting the patient in performing effective coughing and deep breathing exercises. The integration of ACBT provided an evidence-based approach proven to facilitate sputum clearance and enhance

alveolar ventilation, thereby supporting recovery and reducing the risk of further complications in patients with ineffective airway clearance, such as those with pulmonary tuberculosis.

Airway management involves training patients who are unable to cough effectively to clear the larynx, trachea, and bronchioles of secretions or foreign matter (PPNI, 2018b). In this case, the intervention was combined with ACBT, which encompasses three phases: breathing control, thoracic expansion exercises, and the forced expiration technique (huffing). During the thoracic expansion phase, chest expansion promotes greater lung tissue stretch and improves pulmonary capacity. Meanwhile, huffing is designed to accelerate expiratory flow and open secondary airways, thereby enabling more effective clearance of sputum (Horison, 2023). Applying this evidence-based nursing approach has been shown to effectively address the problem of ineffective airway clearance in patients with pulmonary tuberculosis (Kushariyadi et al., 2024).

The integration of SIKI-based airway management with ACBT offers a distinct advantage in empowering patients with pulmonary tuberculosis to manage ineffective airway clearance more independently. This intervention not only facilitates the effective expulsion of sputum but also equips patients with simple breathing techniques that are easy to learn and practice on their own. The active involvement of family members in supervising, reminding, and facilitating regular breathing exercises further accelerates patient adaptation to the therapy. By fostering both patient independence and family support, this approach strengthens the patient's role in their recovery journey and reduces reliance on healthcare professionals.

The nursing implementation was carried out in line with the primary interventions previously outlined. The intervention for Mrs. M was conducted in the X Hospital, Surabaya, over four days, with each therapeutic session lasting 15 minutes, from 18 to 21 April 2025. During this period, close monitoring was undertaken of the patient's respiratory rate, rhythm, depth, and overall response to the Active Cycle of Breathing Techniques (ACBT). Each session commenced with the patient being positioned in semi-Fowler, followed by training in breathing control, thoracic expansion, and huffing. The patient was also guided to recognize signs of sputum retention and was taught to perform the techniques independently with minimal supervision from a family member.

The four-day application of ACBT is consistent with previous research, which demonstrated that such an intervention can reduce respiratory rate, improve oxygen saturation, and clear airway obstructions caused by sputum (Kushariyadi et al., 2024). Each phase of ACBT plays a crucial role: breathing control optimizes oxygen transport, ventilation–perfusion balance, mucociliary clearance, and reduces the work of breathing; thoracic expansion enhances ventilation distribution and thoracic mobility; and forced expiration (huffing) facilitates the mobilizations of sputum to the upper airways through changes in thoracic pressure and airway dynamics, stimulating the cough reflex to maximize airway clearance (Agustiana et al., 2024). The application of these techniques was effective in improving transpulmonary pressure, expanding lung tissue, mobilizing bronchial secretions, enhancing arterial oxygenation, and lowering $PaCO_2$ levels. ACBT stimulates airflow through pulmonary secretions, facilitates mucus clearance, and supports improved ventilation (Pratama, 2021).

Overall, this intervention proved effective in improving breathing patterns, increasing oxygen saturation, and significantly aiding airway clearance. Positive changes were observed in the form of a reduced respiratory rate, more regular breathing rhythm, and improved ability

to expectorate sputum independently. Furthermore, as the technique can be performed under light supervision by family members, it is highly practical and easily applicable in daily care. These findings reinforce the evidence that ACBT is a supportive, cost-effective intervention within airway management, enhancing both patient comfort and confidence in managing respiratory difficulties.

Following the provision of nursing care over a period of four consecutive days, a marked improvement was observed in the client's respiratory condition. Complaints of breathlessness had significantly reduced, sputum was able to be expectorated, and the client reported a soothing sensation in the throat after consuming warm fluids. Furthermore, the client expressed that breathing felt lighter and no longer labored.

An overall improvement in respiratory status was evident, as reflected in a respiratory rate within the normal range of 20 breaths per minute and an oxygen saturation of 97% despite the absence of supplemental oxygen. Pulmonary auscultation revealed a reduction in both rhonchi and wheezing across both lung fields, while the decreased use of accessory respiratory muscles indicated enhanced pulmonary ventilation. These findings are consistent with previous research (Kushariyadi et al., 2024), which reported that the application of Active Cycle of Breathing Techniques (ACBT) over four days can effectively address airway clearance problems in patients with pulmonary tuberculosis. ACBT has also been shown to improve transpulmonary pressure, expand ventilated lung areas, facilitate the mobilization of bronchial secretions, enhance arterial oxygenation, and reduce $PaCO_2$ levels (Pratama, 2021).

The outcomes achieved in this case also correspond with the expected results for Mrs. M, namely an improvement in effective coughing, a reduction in sputum production, diminished wheezing, and a return of respiratory frequency to within normal limits.

CONCLUSION

The Active Cycle of Breathing Technique (ACBT) effectively improved airway clearance and respiratory function in an elderly patient with pulmonary tuberculosis. The intervention normalized respiratory rate, increased oxygen saturation, and reduced wheezing and rhonchi within four days. ACBT is recommended as an evidence-based, practical nursing intervention that can be incorporated into standard respiratory care protocols and nursing education.

SUGGESTION

This study suggests that ACBT is a safe, simple, and effective non-pharmacological intervention that should be incorporated into standard care for patients with pulmonary disorders, particularly tuberculosis. It also highlights the need for its inclusion in nursing curricula as a core clinical skill. Further experimental research with larger samples and longer intervention periods is required to strengthen the evidence and assess its impact on quality of life. At the managerial level, healthcare institutions should consider developing SOPs and providing nurse training to ensure effective implementation. However, the limited sample size and short intervention period warrant cautious interpretation of these findings.

LIMITATIONS

This study was limited by its single-case design, short observation period, and potential researcher bias during data collection. Future studies with quasi-experimental designs and larger samples are recommended to validate the findings and explore long-term outcomes.

REFERENCES

Agustiana, M., Widayati, C. N., Fatchulloah, F., & Nisa, A. (2024). EFEK ACTIVE CYCLE OF BREATHING TECHNIQUE TERHADAP SESAK NAFAS PADA PENDERITA TUBERKULOSIS DI WILAYAH KERJA PUSKESMAS PURWODADI 1. *The Shine Cahaya Dunia Ners*, *9*(02), 55. https://doi.org/10.35720/tscners.v9i02.601

Astuti, W., Ningrum, C., Prasasti, R., & Mustabela, I. (2024). Penerapan Pursed Lips Breathing Terhadap Pola Napas Tidak efektif Pada Pasien Tuberkulosis. *Jurnal Masker Medika*, *12*(2), 478–483.

Aty, Y. M., Betrice Amelia Benu, Yustinus Rindu, & Trivonia Sri Nurwela. (2024). Penerapan Teknik Active Cycle of Breathing Technique (ACBT) dalam Mengatasi Penumpukan Sekret pada Penderita Tuberculosis Paru. *Sehat Rakyat: Jurnal Kesehatan Masyarakat*, *3*(4), 248–254. https://doi.org/10.54259/sehatrakyat.v3i4.3309

Aufa, S. W., Putri, A. S. E., & Kasra, K. (2024). Analysis of Risk Factors Affecting Survival in Tuberculosis Patients: Systematic Review. *Jurnal Ilmiah Kesehatan Masyarakat: Media Komunikasi Komunitas Kesehatan Masyarakat*, *16*(3), 162–173. https://doi.org/10.52022/jikm.v16i3.678

Belli, S., Prince, I., Savio, G., Paracchini, E., Cattaneo, D., Bianchi, M., Masocco, F., Bellanti, M. T., & Balbi, B. (2021). Airway Clearance Techniques: The Right Choice for the Right Patient. *Frontiers in Medicine*, *8*. https://doi.org/10.3389/fmed.2021.544826

Endria, V., Yona, S., & Waluyo, A. (2022). Penerapan Active Cycle of Breathing Technique untuk Mengatasi Masalah Bersihan Jalan Nafas pada Pasien Tuberkulosis Paru dengan Bronkiektasis: Studi Kasus. *Journal of Telenursing (JOTING)*, *4*(1), 144–152. https://doi.org/10.31539/joting.v4i1.3435

Gopalaswamy, R., Shanmugam, S., Mondal, R., & Subbian, S. (2020). Of tuberculosis and non-tuberculous mycobacterial infections—A comparative analysis of epidemiology, diagnosis and treatment. *Journal of Biomedical Science*, *27*(1), 1–17. https://doi.org/10.1186/s12929-020-00667-6

Gordhan, B. G., Sewcharran, A., Letsoalo, M., Chinappa, T., Yende-Zuma, N., Padayatchi, N., Naidoo, K., & Kana, B. D. (2022). Detection of differentially culturable tubercle bacteria in sputum from drug-resistant tuberculosis patients. *Frontiers in Cellular and Infection Microbiology*, *12*(September), 1–11. https://doi.org/10.3389/fcimb.2022.949370

Hartati, S., & Rindiani, N. A. (2023). Application of postural drainage and chest physiotherapy to increase airborne clearance in children with bronchopeneumonia. *The 3 Rd International Allied Health Students Conference (IAHSC) 2023*, *2022*, 6–11.

Horison, N. (2023). PENGARUH LATIHAN ACTIVE CYCLE OF BREATHING TECHNIQUES (ACBT) TERHADAP PERUBAHAN POLA NAFAS PADA PASIEN TUBERKULOSIS PARU DI RUMAH SAKIT SITI AISYAH KOTA LUBUKLINGGAU. *INJECTION: Nursing Journal*, *3*.

KemenKes, RI. (2022). Tuberkulosis. *Kementrian Kesehatan Republik Indonesia*. https://ayosehat.kemkes.go.id/topik-penyakit/pencegahan-infeksi-bagi-bayi-dan-balita/tuberkulosis#:~:text=Pengobatan%20TB-,Apa%20yang%20dimaksud%20Tuberkulosis%3F,kelenjar%20getah%20bening%2C%20dan%20jantung.

Kushariyadi, Sujarwanto, & Rosyida, A. Q. (2024). Active Cycle of Breathing Technique: The Right Choice for Ineffective Airway Clearance Nursing Problem. *Jurnal Kegawatdaruratan Medis Indonesia*, *3*(1), 90–103. https://doi.org/10.58545/jkmi.v3i1.229

Phillips, J., Hing, W., Pope, R., Canov, A., Harley, N., & Lee, A. L. (2023). Active cycle of breathing technique versus oscillating PEP therapy versus walking with huffing during an acute exacerbation of bronchiectasis: A randomised, controlled trial protocol. *BMC Pulmonary Medicine*, *23*(1), 36. https://doi.org/10.1186/s12890-023-02324-8

PPNI. (2018a). *Standar Diagnosa Keperawatan Indonesia: Definisi dan Indikator Diagnostik* (1st ed.). Persatuan Perawat Nasional Indonesia.

PPNI. (2018b). *Standar Intervensi Keperawatan Indonesia: Definisi dan Tindakan Keperawatan* (1st ed.). Persatuan Perawat Nasional Indonesia.

PPTI. (2024). *TB Kita Masih Nomor Dua di Dunia*. Perkumpulan Pemberantasan Tuberkulosis Indoneisa.

Pratama, A. D. (2021). Efektivitas Active Cycle Of Breathing Technique (Acbt) Terhadap Peningkatan Kapasitas Fungsional Pada Pasien Bronkiektasis Post Tuberkulosis Paru. *Jurnal Vokasi Indonesia*, *9*(1). https://doi.org/10.7454/jvi.v9i1.247

Rachmawati, A. S., & Sholihah, S. I. (2023). Pengaruh Penerapan Posisi Semi Fowler Terhadap Penurunan Sesak Napas Dalam Memenuhi Kebutuhan Oksigenasi Pada Penderita Tuberkulosis Paru. *Healthcare Nursing Journal (HNJ)*, *5*(1), 441–450.

Salari, N., Kanjoori, A. H., Hosseinian-Far, A., Hasheminezhad, R., Mansouri, K., & Mohammadi, M. (2023). Global prevalence of drug-resistant tuberculosis: A systematic review and meta-analysis. *Infectious Diseases of Poverty*, *12*(1), 1–12. https://doi.org/10.1186/s40249-023-01107-x

Sari, G. K., Sarifuddin, & Setyawati, T. (2022). Tuberkulosis Paru Post Wodec Pleural Efusion: Laporan Kasus Pulmonary Tuberculosis Post Wodec Pleural Effusion: Case Report. *Jurnal Medical Profession (MedPro)*, *4*(2). https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://jurnal.fk.untad.ac.id/index.php/medpro/article/download/761/420/2181&ved=2ahUKEwiEpq2RzquMAxWsS2cHHQXDKsIQFnoECDQQAQ&usg=AOvVaw1LbRJK2uPqnMnadnKYh_yM

Semitala, F. C., Kadota, J. L., Musinguzi, A., Welishe, F., Nakitende, A., Akello, L., Tinka, L. K., Nakimuli, J., Kasidi, J. R., Bishop, O., Nakasendwa, S., Baik, Y., Patel, D., Sammann, A., Nahid, P., Belknap, R., Kamya, M. R., Handley, M. A., Phillips, P. P. J., … Cattamanchi, A. (2024). Comparison of 3 optimized delivery strategies for completion of isoniazid-rifapentine (3HP) for tuberculosis prevention among people living with HIV in Uganda: A single-center randomized trial. *PLoS Medicine*, *21*(2), 1–16. https://doi.org/10.1371/journal.pmed.1004356

Sikora, M., Mikołajczyk, R., Łakomy, O., Karpiński, J., Żebrowska, A., Kostorz-Nosal, S., & Jastrzębski, D. (2024). Influence of the breathing pattern on the pulmonary function of endurance-trained athletes. *Scientific Reports*, *14*(1), 1–10. https://doi.org/10.1038/s41598-024-51758-5

Wahyudi, D. A., Xanda, A. N., Sukesi, N., Puspita, L., Wardani, P. K., Yurlina, E., Oktariyani, D., & Mukhlis, H. (2021). Active Cycle of Breathing to Respiratory Rate in Patients with Lung Tuberculosis. *International Journal of Pharmaceutical Research*, *13*(01). https://doi.org/10.31838/ijpr/2021.13.01.681

WHO. (2024). Tuberculosis. *World Health Organization*. https://www.who.int/news-room/fact-sheets/detail/tuberculosis

WHO. (2025). *Tuberculosis*. World Health Organization.

Yayasan KNCV Indoensia. (2022). *Laporan Kasus Tuberkulosis (TBC) Global Dan Indonesia 2022*. Yayasan KNCV Indoensia.