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Application of Active Cycle of Breathing Technique in Post-Tuberculosis Obstruction Syndrome Patients

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Pasien dengan sindrom obstruksi pasca tuberkulosis (SOPT) sering mengalami gangguan bersihan jalan napas akibat sisa kerusakan jaringan paru yang menetap. Penelitian ini bertujuan mengevaluasi penerapan *Active Cycle of Breathing Technique* (ACBT) pada dua pasien SOPT dengan masalah bersihan jalan napas tidak efektif, serta mengamati dampaknya terhadap peningkatan pengeluaran sputum dan penurunan gejala sesak napas. Desain yang digunakan adalah studi kasus kualitatif di ruang perawatan paru pada Januari 2025. Penelitian ini telah memperoleh informed consent tertulis dari pasien. Data dikumpulkan melalui wawancara semi-terstruktur, observasi harian langsung, pemeriksaan fisik, dan telaah dokumentasi medis. Parameter yang diamati meliputi frekuensi napas, saturasi oksigen, suara napas, efektivitas batuk, jumlah sputum, dan keluhan sesak. ACBT diberikan selama tiga hari berturut-turut, 3–4 kali per hari. Hasil menunjukkan penurunan RR pada Pasien 1 dari 26 menjadi 20 x/menit dan peningkatan SpO_2 dari 95% menjadi 98%. Pada Pasien 2, RR stabil 22 x/menit dengan peningkatan SpO_2 dari 97% menjadi 98%. Keduanya mengalami peningkatan jumlah sputum, perbaikan batuk, dan penurunan gejala sesak. ACBT terbukti efektif sebagai intervensi keperawatan pada pasien SOPT dengan masalah bersihan jalan napas tidak efektif. Disarankan pengembangan SOP untuk praktik klinis serta studi lanjutan dengan desain kuantitatif jangka panjang dan jumlah sampel lebih besar.

Application of Active Cycle of Breathing Technique in Post-Tuberculosis Obstruction Syndrome Patients

Patients with post-tuberculosis obstructive syndrome (PTOS) often experience ineffective airway clearance due to residual lung tissue damage. This study aimed to evaluate the application of the Active Cycle of Breathing Technique (ACBT) in two PTOS patients with ineffective airway clearance and to observe its impact on sputum production and dyspnea reduction. A qualitative case study design was conducted in a pulmonary ward in January 2025. Informed consent was obtained from both patients prior to participation. Data were collected through semi-structured interviews, direct daily observation, physical examination, and medical record review. Observed parameters included respiratory rate, oxygen saturation, breath sounds, cough effectiveness, sputum volume, and perceived dyspnea. ACBT was performed for three consecutive days, 3–4 sessions per day. Results showed a decrease in respiratory rate in Patient 1 from 26 to 20 breaths/min and an increase in SpO_2 from 95% to 98%. Patient 2 maintained a stable rate of 22 breaths/min with SpO_2 increasing from 97% to 98%. Both patients demonstrated increased sputum expectoration, improved cough effectiveness, and reduced dyspnea symptoms. ACBT proved to be an effective nursing intervention for managing airway clearance in PTOS patients. The development of standard operating procedures (SOPs) and further quantitative research with larger samples and long-term follow-up is recommended.

Introduction

Tuberculosis (TB) is an infectious disease that is still a global health problem. Based on *Global Tuberculosis Report 2024* from WHO, in 2023 there are around 10.8 million new cases of TB and 1.25 million deaths, making TB the second highest cause of death after COVID-19. Indonesia ranks second in the world with 1.09 million new cases and 130 thousand deaths, which reflects the high burden of the disease nationally (WHO, 2024). Although TB control programs have reached a large portion of the population, The success rate of TB treatment in Indonesia in 2022 only reached 85%, still below the WHO's global target of 90% (Ministry of Health of the Republic of Indonesia, 2023). Completion of treatment does not always guarantee a full recovery, as many TB patients remain with structural and functional impairment of the lungs after therapy has been declared complete. Around 42,7% post-TB patients experience *Post-Tuberculosis Lung Disease* (PTLD), which is a structural and functional disorder of the lungs that persists after active TB infection. These disorders include abnormalities of pulmonary function (46.7%), chronic respiratory symptoms (41.0%), and radiological abnormalities (64.6%) (Maleche-Obimbo et al., 2022). Even in the case of drug-resistant TB (MDR-TB), the prevalence of PTLD can reach 70% (Allwood et al., 2021).

One form of PTLD that is often found is post-tuberculosis obstruction syndrome (SOPT). This condition is characterized by airway obstruction due to permanent structural damage to the lungs, such as fibrosis, bronchiectasis, and mucus hypersecretion. One of the main manifestations that emerged was Airway clearance is ineffective, i.e., the patient's inability to eliminate secretions from the airways, which can lead to hypoxia, reinfection, and decreased quality of life (Faradita et al., 2025; Mahesti & Fatmarizka, 2023). This condition demands the implementation of respiratory therapy strategies that have been proven effective in improving airway clearance. In the context of nursing interventions, a non-pharmacological approach based on respiratory rehabilitation becomes important to restore ventilation function and prevent further decline in lung capacity. One of the models that can be used as a reference is *Pulmonary Rehabilitation Model*, which combines education, physical exercise, position management and breathing techniques to improve the functional capacity and quality of life of patients with chronic lung disease (Raghu et al., 2018; Wells, 2013; Jamiyanti et al. 2022)**.** Technique *Active*

Cycle of Breathing Technique (ACBT) is an effective respiratory physiotherapy approach in aiding secretion mobilization and improving lung ventilation.

ACBT consists of three main stages, namely respiratory control (*breathing control*), thoracic expansion exercises, and techniques *forced expiratory* (huffing). Previous research has shown that ACBT is able to increase sputum excretion, improve breathing frequency, and reduce shortness of breath in patients with obstructive pulmonary disorder (Lewis, Williams, & Olds, 2012; Zisi, Chryssanthopoulos, Nanas, & Philippou, 2022). Case studies report that ACBT as part of routine physiotherapy in post-TB patients can improve breathing patterns, but without measuring specific effects separately (Mahesti & Fatmarizka, 2023). The implementation of ACBT techniques in the context of post-tuberculosis patient nursing is still very limited, both in clinical practice and in the research literature. This shows that there is a gap in theory and practice, where attention to post-TB residual disorders has not been optimally associated with respiratory rehabilitation-based nursing interventions. In addition, there have not been many studies that link nursing interventions such as ACBT to long-term clinical outcomes, such as increased functional capacity, decreased symptoms, and patient independence in *respiratory self-management*.

This review aimed to evaluate the application of *Active Cycle of Breathing Technique* (ACBT) in patients with *Post-Tuberculosis Obstruction Syndrome* (SOPT) who experienced ineffective airway clearance problems. Specifically, this study not only assessed the clinical effects of ACBT interventions on increased sputum excretion and decreased symptoms of shortness of breath, but also explored patients' subjective responses during the implementation of this technique. Thus, the results of the study are expected to provide a comprehensive picture of the benefits of ACBT, both in terms of clinical objectives and the perception of comfort, involvement, and ease of implementation from the patient's perspective. This approach is also expected to strengthen the scientific evidence regarding the effectiveness of ACBT as an applicative and measurable nursing intervention in respiratory rehabilitation in post-tuberculosis patients.

Method

This study uses a qualitative approach with a case study design to explore in depth the application of *Active Cycle of Breathing Technique* (ACBT) in patients with post-tuberculosis obstruction syndrome (SOPT) who experience ineffective airway clearance problems. The study was conducted on two patients (two cases) who were treated in the Upper Carnation Room, Majalaya Regional General Hospital, Bandung Regency. The design of this qualitative case study is based on a research objective that not only wants to assess the clinical impact of ACBT, but also explore subjective responses and individual dynamics during the intervention process. This approach is considered most appropriate for understanding the intervention process in a real-world context and capturing variations in patient responses in depth, which cannot be obtained from quantitative designs such as experiments. Data collection was carried out through semi-structured interviews, direct observations, physical examinations (IPPA: inspection, palpation, percussion, and auscultation), as well as the review of patient medical data such as thoracic photographs and laboratory examinations. This study was carried out on January 8–11, 2025 for two patients in turn. The study was conducted on 2 patients to allow an in-depth exploration of each case, both from physiological and subjective aspects. The selection of two cases also considered variations in clinical conditions to compare responses to interventions contextually. The study subjects were selected based on inclusion criteria, namely adult patients (age ≥18 years) with a history of tuberculosis who had completed treatment, experienced symptoms of airway clearance disorders (productive cough, snorting, shortness of breath), and were cooperative and able to follow ACBT technical instructions. The exclusion criteria include patients with other active lung diseases such as active TB or severe COPD, cognitive impairments, respiratory conditions, and physical limitations that hinder the optimal implementation of ACBT. Written consent has been obtained from both patients. ACBT intervention was applied to each patient for 3 consecutive days, with a frequency of 3–4 times per day according to the patient's ability and tolerance. Observations were made by the researcher during the ACBT session, by recording parameters such as breathing frequency, oxygen saturation, effective coughing ability, amount and characteristics of sputum, and subjective complaints of patients. The observation instruments were compiled in a daily monitoring sheet based on nursing intervention standards. The data obtained were analyzed

descriptively through daily recording and narrative tracing of changes in clinical responses, changes in symptoms, and achievement of nursing outcome criteria, such as increased sputum excretion, decreased breathing frequency, and additional improvement in breathing sound. Information from observations, interviews, and medical documentation was compared to obtain a complete picture. Efforts to maintain objectivity are carried out through triangulation of data between instruments (observations, interviews, and medical documentation), validation with the clinical team, and discussions with the research team.

Research Results

An initial assessment was carried out on two patients with a history of tuberculosis who experienced symptoms of respiratory system disorders. Patient 1 (Mrs. A), 54 years old, complained of coughing with phlegm for more than a month, shortness of breath especially during activities, and wheezing breath with an additional diagnosis of iron deficiency anemia. The results of the examination showed a breathing rate of 26 times per minute, SpO_2 95% with the help of the nasal cannula, and additional breathing sounds in the form of ronking and wheezing in both lung chambers. The patient's breathing is shallow and irregular, with respiratory support muscle retraction. Meanwhile, Patient 2 (Mr. U), 59 years old, complained of shortness of breath and coughing up phlegm for the past two weeks. Breathing rate is 24 times per minute, SpO_2 97% without the help of oxygen, and additional breathing sounds are light and wheezing. The breathing pattern is regular but the chest expansion decreases. Based on the results of the study, both patients met the criteria for ineffective airway cleaning nursing diagnosis.

Table 1. Results of ACBT Intervention in Patients 1 and Patient 2

Parameter	Patient 1	Patient 2
Initial conditions	Severe shortness of breath during activity, cough with phlegm >1 month, anemia	Mild tightness, cough with phlegm in the last 2 weeks
Frequency of initial breaths	26 x/min (with nasal cannula, SpO_2 95%)	24 x/min (without oxygen, SpO_2 97%)
Sound of early breathing	Ronki and wheezing in both lungs	Light and wheezing ronki
Day 1 of ACBT	Ineffective, sputum difficult to come out, weak cough, RR: 24 x/min, SpO_2: 95%	Already able to follow ACBT, sputum discharges after 2 cycles, RR: 23 x/min, SpO_2: 98%

Parameter	Patient 1	Patient 2
Day 2 of ACBT	Sputum starts to come out slightly, tightness decreases slightly, RR: 22 x/min, SpO_2: 97%	Sputum comes out more smoothly, tightness begins to decrease, RR: 22 x/min, SpO_2: 98%
Day 3 of ACBT	More sputum, decreased ronki, lighter tightness, RR: 20 x/min, SpO_2: 98%	No tightness, normal breathing sound, minimal sputum, RR: 22 x/min, SpO_2: 98%
Response to ACBT	Slow, comorbid and severe obstruction	Fast, milder initial clinical conditions
Effectiveness of late cough	Improved but still needs to be guided	Effective and self-sufficient
Final airway cleaning	Improved, there is still residual secretion	Effective and clean

Active *Cycle of Breathing Technique* (ACBT) intervention was administered 3–4 times a day for three days in patient 1. On the first day, the patient showed difficulty in expelling sputum despite having been taught the ACBT technique. The patient appeared to be still tight and unable to cough effectively. On the second day, sputum starts to come out although it is still in small quantities and the patient starts to seem more comfortable after the exercise. On the third day, the expelled sputum increases, the sound of the ronki sounds lighter, and shortness of breath decreases. Although the response to the intervention was relatively slow, overall patients showed positive clinical progress and respiratory problems began to resolve gradually.

Patient 2 showed a faster response to the ACBT intervention. On the first day, the patient was already able to follow the ACBT technique well and was able to expel sputum after two cycles of exercise. The second day showed significant improvement, with sputum coming out more smoothly and shortness of breath starting to decrease. Auscultation examination showed a decrease in the sound of the ronki, and the patient stated that his breathing felt lighter. On the third day, the patient no longer experienced tightness, the sound of breathing returned to normal, and airway cleaning was declared effective. The difference in patient response is thought to be influenced by the severity of the initial symptoms and the history of previous lung conditions.

Discussion

Active Cycle of Breathing Technique (ACBT) is a non-pharmacological intervention that has been shown to be effective in helping to overcome ineffective airway clearance disorders in patients with post-tuberculosis obstruction syndrome (SOPT). The results showed that both patients experienced an increase in the ability to expel sputum and a decrease in symptoms of

shortness of breath after three days of ACBT. Quantitatively, there was a decrease in respiratory frequency (RR) in Patient 1 from 26 to 20 x/min, as well as an increase in oxygen saturation (SpO_2) from 95% to 98%. In Patient 2, RR was stable at 22 x/min with an increase in SpO_2 from 97% to 98%. In addition, the amount of sputum that was successfully expelled gradually increased from day to day, especially in Patient 1 who originally had an ineffective cough and difficulty in secretory mobilization. Additional breathing sounds such as ronki and wheezing were also clinically reduced, in line with the reduction in complaints of tightness reported by both patients. The effectiveness of coughing increased, especially in Patient 2 who showed the ability to cough independently from day two. Meanwhile, Patient 1 showed slower progress, likely due to comorbid factors such as anemia and a more severe degree of obstruction. ACBT works through three main components, namely breath control (*breathing control*), thoracic expansion, and forced expiratory techniques (*Huffing*). These three components synergistically increase intrathoracic pressure and strengthen the ability to cough without causing fatigue of the respiratory muscles (Jones, Pickering, Gough, & Mandrusiak, 2025). ACBT has been shown to be effective in increasing lung ventilation capacity, tidal volume, and secretion excretion, while lowering respiratory symptoms, improving oxygen saturation, and reducing the use of the respiratory support muscles in patients with obstructive pulmonary disease (Mckoy, Wilson, Saldanha, Odelola, & Robinson, 2016; Zisi et al., 2022). These findings support the results of the study showing that Mr. U's patients experienced a rapid response to ACBT, and his airway clearance problems were resolved from day two.

A slower response in Mrs. A than in Mr. U showed individual variation in the effectiveness of the ACBT intervention. One of the factors that affect this is the severity of airway obstruction. Mrs. A experienced respiratory support muscle retraction, shallow breathing, and low oxygen saturation (SpO_2 95%) despite using a nasal cannula, which indicates a heavier ventilation barrier than Mr. U. In addition, there were comorbidities in the form of anemia It can worsen oxygenation capacity and decrease energy reserves, so that patients experience fatigue faster when undergoing active breathing exercises. The ability to follow instructions is also an important determinant in the success of ACBT techniques. ACBT requires a good understanding of breathing rhythms, deep breathing coordination, and directed forced expiration. Patients who do not understand or are unable to follow each stage of this technique consistently will have

difficulty in eliminating sputum effectively. In this case, The role of nurses in providing repeated education, hands-on demonstrations, and motivational reinforcement is crucial, especially in patients like Mrs. A who show a slow response. Therefore, the implementation of ACBT needs to be adjusted individually, including the frequency of exercise and family support (Amanati, 2023).

Thus, the evidence from Shen et al. reinforces that ACBT can be adopted as supportive therapy that are safe and effective, both in acute and rehabilitative settings. This technique not only impacts the reduction of symptoms, but also has the potential to improve self-management patients against chronic diseases through structured breathing exercises that can be taught and repeated at home (Shen et al., 2021). In the context of health services in Indonesia, ACBT techniques are still not a routine part of the rehabilitation standards of post-TB patients, although this study shows great potential. This is a reflection of the importance of education for nurses and patients' families to be able to apply ACBT independently at home, as part of long-term rehabilitation to prevent recurrence and decline in lung function. Therefore, it is important for healthcare facilities to develop protocols or standard operating procedures (SP) for the implementation of evidence-based ACBT, especially in patients with SOPT. With structured guidance, ACBT can be integrated into nursing interventions in a systematic and continuous manner, both in inpatient and outpatient services. Although the study made a practical contribution, there were limitations in terms of the number of subjects with only two people, the relatively short duration of the intervention (three days), and the absence of objective measurements such as spirometry or blood gas analysis. Therefore, further research is needed with experimental designs, larger sample counts, and longer monitoring durations. Longitudinal studies are also highly recommended to observe the long-term impact of ACBT on lung function, quality of life and symptom recurrence rates in post-TB patients. Thus, ACBT can be assessed more holistically and potentially developed as part of the national respiratory rehabilitation protocol.

Conclusion

The results of this study show that *the Active Cycle of Breathing Technique* (ACBT) technique can help overcome the problem of ineffective airway clearance in patients with post-

tuberculosis obstruction syndrome, characterized by increased cough effectiveness, decreased breathing frequency, increased oxygen saturation, and reduced symptoms of congestion. These findings provide a practical basis for nurses to apply ACBT as a nursing intervention in respiratory rehabilitation, while encouraging its integration into evidence-based clinical services in post-TB patients. In conclusion, the Active Cycle of Breathing Technique (ACBT) has proven to be an effective non-pharmacological intervention for improving airway clearance and alleviating respiratory symptoms in patients with post-tuberculosis obstruction syndrome (SOPT). The study demonstrated significant improvements in sputum expulsion, oxygen saturation, and respiratory frequency among the patients, with Patient 1 and Patient 2 both showing notable progress after three days of ACBT. The intervention helped reduce additional breathing sounds, such as ronchi and wheezing, and improved the effectiveness of coughing, especially in Patient 2. However, individual variations in response to ACBT were observed, with Patient 2 showing faster progress than Patient 1, likely due to comorbid factors such as anemia and the severity of airway obstruction.

The study underscores the importance of tailored interventions, individualized frequency of exercises, and continuous education for patients and families to ensure successful implementation of ACBT. Despite its promising results, the study's limitations, such as the small sample size and short intervention period, highlight the need for further research with larger sample sizes, longer monitoring durations, and objective measurements to assess the long-term effectiveness of ACBT in post-TB rehabilitation. Ultimately, ACBT has the potential to be integrated into national respiratory rehabilitation protocols, benefiting post-TB patients and improving their self-management of chronic respiratory conditions.

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