Inhalation of Water Vapor and Eucautious Oil to Improve the Clearance of the Airways of Pulmonary Tuberculosis Patients

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Pulmonary tuberculosis remains a major health problem and is often accompanied by ineffective airway clearance due to excessive sputum production. This case study aimed to describe the effectiveness of warm steam inhalation combined with eucalyptus oil in improving airway clearance among patients with pulmonary tuberculosis. The study involved three patients treated in the Mawar Ward of Dr. Adhyatma, MPH Regional General Hospital using a nursing process approach based on SDKI, SLKI, and SIKI standards. Nursing interventions included warm steam inhalation with eucalyptus oil, semi-Fowler positioning, effective coughing techniques, and adequate fluid intake. The results showed consistent clinical improvement in all patients, indicated by increased oxygen saturation, decreased respiratory rate, reduced dyspnea, and more effective sputum expectoration. These findings suggest that warm steam inhalation combined with eucalyptus oil is an effective non-pharmacological nursing intervention to support airway clearance in patients with pulmonary tuberculosis.
Keywords: Pulmonary tuberculosis, Ineffective airway clearance, Steam inhalation, Eucalyptus oil, Nursing care

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1. Introduction

Tuberculosis (TB) is an infectious disease that remains one of the leading causes of death and a major source of morbidity worldwide. Prior to the COVID-19 pandemic, TB had surpassed HIV/AIDS as the leading cause of death from infectious diseases. *Mycobacterium tuberculosis*, the bacterium responsible for TB, is transmitted through the air when infected individuals sneeze or cough [1].

Mycobacterium tuberculosis is the pathogenic agent that causes tuberculosis (TB). Although it primarily affects the lungs, TB bacteria can also infect other organs such as the kidneys, spine, and brain. Not all individuals infected with TB bacteria develop symptoms. Therefore, two related conditions exist: latent TB infection (LTBI) and active TB disease. TB infection can be fatal if not properly treated. When a person develops active TB, the bacteria multiply and attack the lungs as well as other organs, including the skin, brain, spine, lymph nodes, bones, and kidneys. TB bacteria can spread through the bloodstream or lymphatic system from the lungs to other parts of the body.Tuberculosis is the leading cause of death from infectious agents and ranks among the top ten causes of death globally. Regionally, the lowest TB incidence rates are found in the Eastern Mediterranean (8.1%), the Americas (2.9%), and Europe (2.2%). In contrast, Southeast Asia (45.6%), Africa (23.3%), and countries in the Western Pacific region (17.8%) report the highest TB case numbers. Approximately two-thirds of all global TB cases originate from ten countries: Bangladesh (3.6%), Nigeria (4.4%), the Philippines (7.0%), Pakistan (5.8%), India (27.9%), Indonesia (9.2%), China (7.4%), the Democratic Republic of the Congo (2.9%), South Africa (2.9%), and Myanmar (1.8%) [2].

Data indicate that TB-related mortality declined between 2005 and 2019. However, from 2019 to 2021, mortality rates increased again. In 2021, an estimated 1.6 million deaths were caused by TB, including 1.4 million among HIV-negative individuals (95% UI: 1.3– 1.5 million) and 158,000–218,000 among HIV-positive individuals. This number increased compared to 2020 (1.5 million deaths) and 2019 (1.4 million deaths). The cumulative reduction in TB mortality from 2015 to 2021 reached only 5.9%, which is approximately one-sixth of the first target set by the WHO End TB Strategy [3].

In Indonesia, an estimated 969,000 new TB cases occur annually. In 2022, a total of 724,309 cases (75%) were successfully confirmed, while the remaining 25% were undetected or unreported. Cases of drug-resistant TB (MDR/RR-TB) in 2021 were estimated at 28,000 cases, or approximately 10 cases per 100,000 population an increase of 17% from 24,000 cases in the previous year. Additionally, 12,531 cases of more complex drug-resistant TB (DR-TB) were identified, with a treatment coverage rate of 51% [4].

The productive age group of 25–34 years bears the highest burden of TB disease, with a prevalence of 753 cases per 100,000 population. Results from the 2013–2014 Indonesian Tuberculosis Prevalence Survey (SPTB) indicate that men are at a higher risk of developing TB than women (1,083 per 100,000 vs. 461 per 100,000 population). TB cases are also more prevalent in urban areas (846 per 100,000 population) compared to rural areas (674 per 100,000 population), and higher among elderly individuals aged over 65 years (1,582 per 100,000 population) [5].

According to the 2018 Basic Health Research (Riskesdas) data, Central Java Province ranked third in terms of pulmonary TB prevalence in Indonesia. In 2019, the city of Semarang recorded 4,307 TB cases. A study conducted in 2021 at Dr. Adhyatma, MPH Regional General Hospital in Semarang identified 125 TB cases. One of the most common nursing problems encountered in patients with tuberculosis is ineffective airway clearance. This condition occurs when secretions or obstructions cannot be effectively expelled from the airway, thereby impairing airway patency [6].

When a person coughs or clears their throat, bronchial secretions are expelled. However, excessive accumulation of secretions may indicate the presence of foreign bodies or obstructions within the respiratory system that hinder airflow. These secretions are produced as a result of irritation of the mucous membranes caused by physical, chemical, or infectious factors. This condition reduces the effectiveness of airway clearance mechanisms, leading to further mucus accumulation. Airway clearance is classified as ineffective when a patient experiences or is at risk of experiencing respiratory dysfunction due to an inability to expectorate sputum effectively [7]. Impaired airway clearance can lead to the accumulation of sputum, disrupting the breathing process and reducing gas exchange in the lungs. Consequently, patients may experience symptoms such as shortness of breath, cyanosis, fatigue, lethargy, and weakness (Nugroho & Kristiani, 2018). If this condition persists, it may result in airway narrowing, obstruction, or even adhesion. Therefore, nursing interventions are essential to assist in mucus clearance and restore optimal airway function [8].

Warm steam inhalation therapy combined with eucalyptus oil is a non- pharmacological nursing intervention that has been shown to be effective in helping patients clear respiratory secretions. The combination of warm steam and eucalyptus oil works by thinning secretions, reducing excessive sputum production, and maintaining airway patency. Steam inhalation containing eucalyptus oil helps relieve nasal congestion, liquefy mucus to facilitate expectoration, and maintain moisture in the respiratory mucosa. These effects occur because steam acts as a decongestant, helping to open the airways and reduce respiratory obstruction [9]. Eucalyptus oil, which contains the compound cineole (eucalyptol), has various therapeutic benefits, including anti-inflammatory, mucolytic (mucus-thinning), and bronchodilator properties that help dilate the airways and calm the respiratory system. These

pharmacological effects have also been shown to reduce exacerbation rates in patients with chronic obstructive pulmonary disease (COPD) and to assist individuals with rhinosinusitis and asthma [10].

The results of a study by [11] demonstrated a significant effect of steam inhalation combined with eucalyptus oil on sputum expulsion in children with acute respiratory infections (ARI), with a chi-square test result of p = 0.038 (< 0.05). Meanwhile, research by [7] reported that hot steam therapy combined with eucalyptus oil aroma effectively reduced symptoms associated with ineffective airway clearance. Following therapy, patients experienced decreased sputum production, reduced wheezing, disappearance of rhonchi and dyspnea, absence of pain during speech, and lower anxiety levels [12].

2. Literature Review

Pulmonary tuberculosis remains a complex global health problem, not only because of its high incidence but also due to its impact on respiratory function and patients' quality of life. The [1] reports that more than 10 million new TB cases occur annually, with the highest burden in developing countries. Pathophysiologically, infection with *Mycobacterium tuberculosis* induces a chronic inflammatory response in lung tissue, leading to mucus hypersecretion, alveolar damage, and impairment of mucociliary clearance. Chronic inflammation stimulates goblet cell hyperplasia and increases mucus viscosity, contributing to sputum retention and ineffective airway clearance. According to the Indonesian Nursing Diagnosis Standards [13], [14], ineffective airway clearance is characterized by ineffective cough, adventitious breath sounds, dyspnea, and altered respiratory patterns conditions frequently observed in patients with pulmonary TB.

Supportive respiratory interventions are essential in nursing management to improve airway clearance. Steam inhalation therapy combined with eucalyptus oil (containing 1,8-cineole/eucalyptol) has been reported to exert mucolytic, mild bronchodilatory, and anti-inflammatory effects. Pharmacological reviews by the [15]indicate that cineole reduces mucus viscosity and enhances ciliary activity in the respiratory epithelium. Experimental evidence cited by [15]demonstrates that 1,8-cineole decreases mucus production in goblet cells. Clinical findings from [7] and [6] also report improvements in sputum expectoration and breathing comfort following steam inhalation therapy. However, despite these findings, literature specifically discussing the integration of steam inhalation therapy with eucalyptus oil into structured nursing care for pulmonary TB patients with ineffective airway clearance remains limited. Most studies focus on general respiratory disorders rather than TB-specific nursing diagnoses, indicating a need for deeper exploration within a nursing care context. Based on the identified research gap, the problem in this study is formulated as follows: "How is the implementation of steam inhalation therapy with eucalyptus oil in improving ineffective airway clearance in patients with pulmonary tuberculosis within the nursing care framework?". This problem formulation emphasizes exploration and clinical description rather than hypothesis testing, aligning with a non-quantitative research design. The study aims to analyze and describe the nursing process, patient responses, and changes in airway clearance status following the intervention, thereby contributing to evidence-based supportive nursing care in pulmonary tuberculosis management.

3. Methods

This study employed a case study method using a nursing process approach based on the standards of SDKI, SLKI, and SIKI. This approach was selected to enable an in-depth assessment of the patient's condition, the formulation of nursing diagnoses in accordance with national standards, the determination of measurable outcomes, and the implementation of relevant nursing interventions. The primary intervention examined in

this case study was warm steam inhalation combined with eucalyptus oil as a non- pharmacological nursing intervention to improve airway clearance in patients with pulmonary tuberculosis. The case study was conducted on pulmonary TB patients hospitalized in the Mawar Ward of Dr. Adhyatma, MPH Regional General Hospital, Central Java Province, involving three patients selected based on predetermined inclusion and exclusion criteria.

The main focus of this case study was to comprehensively describe the application of the nursing process in patients with pulmonary tuberculosis experiencing Ineffective Airway Clearance, covering all stages from assessment, nursing diagnosis, outcome planning, intervention implementation, to evaluation. The study emphasized not only the clinical condition of the patients but also the effectiveness of warm steam inhalation combined with eucalyptus oil in thinning secretions, facilitating sputum expectoration, improving breathing patterns, and reducing adventitious breath sounds. Data were collected through interviews, direct observation, physical examination of the respiratory system, and medical and nursing documentation. The collected data were then analyzed and presented narratively and systematically following the nursing process framework.

The research instruments included nursing assessment forms and an airway clearance observation sheet based on SDKI indicators, encompassing respiratory rate, adventitious breath sounds, cough effectiveness, sputum quantity and characteristics, and oxygen saturation. The case study was conducted in the Mawar Ward of Dr. Adhyatma, MPH Regional General Hospital during the clinical practice period from March 24, 2025 to November 8, 2025. Ethical considerations were addressed in accordance with the principles of beneficence, respect for human dignity, and justice, including ethical approval from the hospital ethics committee and informed consent from all respondents, while ensuring confidentiality and equal treatment for all participants.

4. Results And Discussion

Case Study Result

Case Patient 1

During the initial assessment conducted on August 14, 2025, the patient presented with the main complaints of worsening shortness of breath, productive cough with difficulty expectorating sputum, and a sensation of chest fullness for the past five days. The patient reported having taken medication but experienced no improvement. Physical examination revealed elevated blood pressure of 146/89 mmHg, pulse rate 111 beats/minute, body temperature 37.1°C, oxygen saturation (SpO_2) 93%, and respiratory rate 26 breaths/minute, with fine crackles (rhonchi) heard in the upper left lung field. The patient had a history of asthma and smoking.

The nursing diagnosis established was Ineffective Airway Clearance, related to airway hypersecretion and pulmonary infection. The goal of care was to improve airway clearance through nursing interventions, including encouraging fluid intake of at least 2000 mL/day if no contraindications were present, positioning the patient in a semi- Fowler position to facilitate breathing, teaching effective coughing techniques, and administering warm steam inhalation therapy combined with eucalyptus oil to help thin secretions and reduce airway irritation. Warm beverages were also recommended to support hydration and reduce coughing discomfort.

On the first day of therapy (August 15, 2025), vital signs and breathing patterns were monitored. The patient was positioned in semi-Fowler and instructed in effective coughing techniques. Warm steam inhalation with eucalyptus oil was administered, and the patient was able to follow the inhalation procedure

well, although shortness of breath was still reported during light activity. The respiratory rate remained 26 breaths/minute and SpO_2 93%. Warm beverages were given several times to assist sputum liquefaction. On the second day (August 16, 2025), inhalation therapy was repeated and warm beverage intake continued. The patient reported more effective expectoration of thick yellow sputum and a reduction in shortness of breath. The respiratory rate decreased to 25 breaths/minute and SpO_2 increased to 94%. Fine crackles were still present, but the patient appeared more comfortable. Education on independent inhalation therapy was provided to promote self-management.

On the third day (August 17, 2025), inhalation therapy was continued. The patient reported a significant reduction in dyspnea and improved ability to cough effectively, although sputum remained thick and yellow. The respiratory rate decreased to 22 breaths/minute and SpO_2 increased to 95%. Fine crackles were still slightly audible. The patient demonstrated a good response to therapy and education, performing inhalation correctly without full supervision. Adequate fluid intake was continuously encouraged to support optimal hydration and recovery.

Progress notes over the three-day period indicated clear improvement, including better breathing patterns, increased oxygen saturation, reduced shortness of breath, and more effective coughing. Warm steam inhalation combined with eucalyptus oil proved effective as a supportive therapy in managing pulmonary TB symptoms, particularly ineffective airway clearance.

Case Patient 2

The initial assessment was conducted on August 14, 2025, in the Mawar Ward of Dr. Adhyatma, MPH Regional General Hospital. The patient complained of progressively worsening shortness of breath and productive cough with sputum released gradually, accompanied by chest pain for one week. Physical examination showed blood pressure 126/73 mmHg, pulse 104 beats/minute, temperature 36.8°C, oxygen saturation (SpO_2) 95%, and respiratory rate 25 breaths/minute. The patient had a history of tuberculosis with multiple hospitalizations and a history of heavy smoking for 15 years. Auscultation revealed moist crackles in the upper left lung field.

Based on these findings, the nursing diagnosis was Ineffective Airway Clearance related to airway hypersecretion. The goal of care was to improve airway clearance, with expected outcomes including regular breathing patterns, improved depth of respiration, reduced dyspnea, decreased sputum production, and reduced or absent crackles. Standard Operating Procedures (SOPs) implemented included encouraging fluid intake of at least 2000 mL/day if not contraindicated, positioning the patient in semi-Fowler or Fowler positions to facilitate breathing, teaching effective coughing techniques, and administering warm steam inhalation combined with eucalyptus oil. Warm beverages were also recommended to help thin sputum.

On the first day of care (August 15, 2025), the patient's breathing pattern, rate, depth, and respiratory effort were closely monitored. The patient agreed to learn effective coughing techniques and was positioned in semi-Fowler. The patient reported mild dyspnea, particularly during light activity. The respiratory rate was 25 breaths/minute and SpO_2 95%. Warm steam inhalation with eucalyptus oil was initiated at 08:00 AM, and the patient followed the procedure well, showing early signs of effective coughing. On the second day (August 16, 2025), the intervention was repeated, including warm beverages and inhalation therapy. The patient reported coughing up thick yellow sputum, slight improvement in dyspnea, and fine crackles were still present. The respiratory rate decreased slightly to 24 breaths/minute, with SpO_2 remaining at 95%. The patient was able to perform effective coughing independently and appeared more comfortable. On the third day (August 17, 2025), inhalation therapy was continued under close

supervision. The patient reported further reduction in shortness of breath and easier expectoration. Sputum production decreased. The respiratory rate was 22 breaths/minute, and SpO_2 increased to 97%. Fine crackles were still slightly audible. The patient was educated on independent inhalation therapy and encouraged to maintain adequate fluid intake and warm beverage consumption. Warm steam inhalation combined with eucalyptus oil contributed to thinning sputum and reducing airway irritation. Progress notes over three days showed gradual improvement in respiratory status, including reduced dyspnea, improved effective coughing, and increased oxygen saturation. Although crackles had not completely resolved, continued interventions and self-care education were expected to further optimize airway clearance.

Case Patient 3

During the initial assessment conducted on August 14, 2025, in the Mawar Ward of Dr. Adhyatma, MPH Regional General Hospital, the patient complained of worsening shortness of breath, especially at night, accompanied by productive cough with difficulty expectorating sputum and mild chest pain over the past two days. The patient had previously been hospitalized once for asthma and had a smoking history of ten years prior to admission. Vital signs upon admission showed blood pressure 161/98 mmHg, pulse

112 beats/minute, body temperature 37.3°C, oxygen saturation (SpO_2) 91%, and respiratory rate 28 breaths/minute. Auscultation revealed fine crackles in the lower right lung field, along with intercostal retractions and mild cyanosis of the lips. The nursing diagnosis for this case was Ineffective Airway Clearance related to airway hypersecretion due to pulmonary infection. The goals of care were to improve airway clearance, reduce dyspnea, enhance effective coughing, decrease respiratory rate, and increase oxygen saturation.

On the first day of therapy (August 15, 2025), the patient received warm steam inhalation combined with eucalyptus oil in the semi-Fowler position. The nurse taught effective coughing techniques and instructed the patient to consume at least 2000 mL/day of fluids and warm beverages to help thin sputum. Monitoring of vital signs and breathing patterns showed a respiratory rate of 26 breaths/minute and SpO_2 95%. The patient reported persistent dyspnea, ineffective coughing, and continued presence of crackles. Use of accessory muscles and shallow, irregular breathing were observed. On the second day (August 16, 2025), inhalation therapy and warm beverage administration were continued. The patient reported more effective coughing with expectoration of thick yellow sputum and reduced dyspnea. The respiratory rate remained 28 breaths/minute, with SpO_2 94–95%. Crackles became finer. The patient appeared more comfortable and was taught to perform inhalation therapy independently under nurse supervision. Nebulizer therapy was also administered. Ongoing education focused on maintaining adequate fluid intake and proper coughing techniques.

On the third day (August 17, 2025), the patient showed significant improvement. The respiratory rate decreased to 22–25 breaths/minute, and oxygen saturation increased to 95–97%. Coughing became more effective, sputum production decreased, and crackles diminished, although still slightly present. The patient was able to perform warm steam inhalation with eucalyptus oil independently and was encouraged to maintain a semi- Fowler position and consume warm fluids as instructed.

The SOPs implemented in this case included positioning in semi-Fowler to facilitate breathing, administering warm steam inhalation with eucalyptus oil to thin sputum and relieve airway irritation, teaching effective coughing techniques, encouraging fluid intake of at least 2000 mL/day, providing warm beverages, monitoring vital signs and breathing patterns, and administering oxygen therapy when necessary. Education on independent inhalation therapy played a key role in enhancing patient self-management. Progress notes over the three-day therapy period demonstrated a significant reduction in

respiratory rate, improved oxygen saturation, and decreased complaints of dyspnea and coughing. The patient's positive response indicates that warm steam inhalation combined with eucalyptus oil, as part of nursing interventions, is effective in managing pulmonary TB symptoms and improving patient comfort and airway clearance.

Discussion

This discussion integrates the analysis of three cases of patients with pulmonary tuberculosis (pulmonary TB) who received nursing care with the intervention of warm steam inhalation therapy combined with eucalyptus oil. All three cases demonstrated a primary nursing problem of Ineffective Airway Clearance, which was associated with airway hypersecretion and manifested by dyspnea, thick productive cough, and impaired breathing patterns.

The assessments conducted across the three cases revealed compromised respiratory conditions, with initial respiratory rates ranging from 26 to 28 breaths per minute and low oxygen saturation (SpO_2) levels between 91% and 93%. These findings indicate hypoventilation and the accumulation of sputum that was difficult to expectorate. Moist crackles were auscultated, reflecting excessive mucus in the airways. These clinical manifestations are consistent with the pathophysiology of pulmonary TB, in which inflammation and lung tissue damage impair airway clearance mechanisms.

The intervention of warm steam inhalation combined with eucalyptus oil demonstrated significant positive effects in all three cases. On the first day, this therapy began to improve patients' respiratory comfort, as evidenced by gradual reductions in respiratory rate and slight improvements in oxygenation, although dyspnea remained prominent. The semi-Fowler position facilitated lung expansion and optimized ventilation. Effective coughing techniques were taught as an essential modality to promote efficient sputum clearance, while the administration of warm beverages assisted in thinning airway secretions.

By the second day, patients showed improved responses to the intervention, characterized by more effective coughing with increased expectoration of thick yellow sputum, reduced respiratory rates, and improved oxygen saturation. Fine crackles began to diminish, indicating successful secretion thinning and reduced airway obstruction. Patients also started to perform inhalation therapy independently, which is important for maintaining treatment consistency and continuity beyond direct healthcare supervision.

On the third day, notable clinical improvement was observed, with respiratory rates approaching normal ranges (22–25 breaths per minute) and oxygen saturation increasing to 95–97%. Patients demonstrated more effective terminal coughing, producing less but thinner sputum, and adventitious breath sounds became minimal or nearly absent. These outcomes indicate that inhalation therapy as a complementary intervention can significantly improve airway clearance in patients with pulmonary TB.

The Standard Operating Procedures (SOPs) consistently applied included semi- Fowler positioning, warm steam inhalation with eucalyptus oil, effective coughing techniques, recommendations for fluid intake of 2000 mL per day, warm beverage consumption, and intensive monitoring of breathing patterns and oxygen saturation. This integrated approach highlights the importance of holistic nursing care that incorporates non-pharmacological therapies alongside medical treatment.

During the assessment phase, vital sign data consistently reflected increased respiratory workload, aligning with impaired airway clearance. Oxygen saturation levels in all three patients ranged from low to lower-normal values, indicating ventilation– perfusion disturbances. Productive but ineffective coughing suggested the presence of abundant, thick secretions that required specific interventions to facilitate clearance. Medical histories of asthma, tuberculosis, and smoking further confirmed that all patients belonged to a high-risk group for airway clearance impairment.

The nursing diagnoses established in all three cases were consistent with clinical findings, namely Ineffective Airway Clearance related to airway hypersecretion due to pulmonary infection. Following diagnosis, nursing care plans were developed based on SLKI and SIKI standards, with primary goals to enhance patients' ability to clear their airways, reduce dyspnea, improve breathing patterns, increase cough effectiveness, and improve oxygen saturation.

The core intervention applied across all cases was warm steam inhalation combined with eucalyptus oil. This non-pharmacological therapy was used to thin sputum, increase airway humidity, reduce irritation, and facilitate expectoration. Eucalyptus oil was selected for its warming effect and therapeutic aroma, which enhanced patient comfort and eased breathing. This intervention was combined with instruction in effective coughing techniques, which are critical for removing thick secretions adherent to airway walls. Additionally, semi-Fowler positioning and encouragement of fluid intake of at least 2000 mL per day were consistently implemented, as they were shown to improve ventilation and accelerate sputum thinning. Warm beverages were provided as an adjunct therapy to support hydration and airway comfort.

The implementation process revealed variations in patient responses; however, all cases demonstrated progressive improvement. On the first day, all patients continued to experience notable dyspnea and ineffective coughing, despite being able to follow inhalation therapy procedures. Secretions remained difficult to expel, and crackles were still prominent. Improvement became evident on the second day, marked by increased sputum expectoration, reduced dyspnea, improved oxygen saturation, and more effective coughing. Patients who initially appeared weak and dyspneic showed greater comfort, particularly with consistent inhalation therapy and warm beverage intake. By the third day, improvements were more pronounced, including significantly enhanced cough effectiveness, reduced crackles, respiratory rates approaching normal values, and oxygen saturation nearing or reaching normal levels. All three patients were able to perform inhalation therapy independently, indicating improved autonomy and understanding of the intervention.

Comparative analysis of the three cases showed that the first patient responded relatively quickly to therapy. The second patient demonstrated slower improvement, likely due to a history of recurrent TB and heavy smoking. The third patient, despite presenting with the most severe initial condition, showed a favorable response following intensive interventions, including inhalation therapy, adequate fluid intake, and nebulizer administration. These differences suggest that baseline physical condition, prior disease history, and lifestyle habits significantly influence recovery speed.

Overall, the analysis of these three cases underscores that warm steam inhalation combined with eucalyptus oil, as part of nursing care, is a safe and effective strategy for supporting recovery in patients with pulmonary tuberculosis, particularly in addressing ineffective airway clearance. This finding reinforces the need for integrated interventions that combine pharmacological treatment with complementary therapies to achieve optimal patient outcomes.

5. Conclusion

Based on the results of the case study involving the administration of warm steam inhalation combined with eucalyptus oil in three patients with pulmonary tuberculosis at the Mawar Ward of Dr. Adhyatma, MPH Regional General Hospital, it can be concluded that this intervention had a positive effect on improving airway clearance. In the first patient, inhalation therapy led to an improvement in oxygen saturation from 93% to 95% and a reduction in respiratory rate from 26 breaths per minute to 22 breaths per minute, accompanied by more effective coughing and decreased shortness of breath. In the second patient, warm steam inhalation combined with eucalyptus oil helped to thin sputum and improve ventilation, as indicated

by an increase in oxygen saturation from 95% to 97% and a decrease in respiratory rate from 25 breaths per minute to 22 breaths per minute, resulting in more comfortable breathing.

In the third patient, the combination of warm steam inhalation with eucalyptus oil and effective coughing techniques significantly improved respiratory function. This improvement was reflected in an increase in oxygen saturation from 91% to 95–97% and a reduction in respiratory rate from 28 breaths per minute to 22–25 breaths per minute, along with more effective coughing and reduced dyspnea. Overall, in all three cases, warm steam inhalation combined with eucalyptus oil was proven effective in improving airway clearance through increased oxygen saturation, decreased respiratory rate, and enhanced cough effectiveness, facilitating easier sputum expectoration.

Based on these findings, warm steam inhalation combined with eucalyptus oil can be recommended as an independent nursing intervention for managing ineffective airway clearance, particularly in pulmonary tuberculosis patients with thick sputum. Hospitals are advised to develop standard operating procedures for the application of eucalyptus oil inhalation therapy as a complementary treatment for pulmonary tuberculosis patients. Future researchers are encouraged to conduct studies with broader experimental designs and longer durations to evaluate the long-term effects of inhalation therapy on lung function and patients' quality of life. In addition, patients and their families are expected to continue inhalation therapy at home under nursing guidance, maintain environmental cleanliness, and adhere to anti-tuberculosis medication regimens as recommended by healthcare professionals.

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