CASE REPORT

# Conservative Management of Chest Tube and Ambulatory Water Sealed Drainage in Persistent Pneumothorax due to Tuberculosis

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**ABSTRACT**

**Introduction:** Pneumothorax is characterized by the presence of air in the pleural cavity, which can result from various pulmonary conditions, including tuberculosis (TB). Conservative management, including the use of chest tubes with ambulatory water-sealed drainage (WSD), offers a viable alternative for patients who are ineligible for surgery or decline surgical intervention. This case report aimed to highlight that all treatment options should be discussed with the patient to determine their primary priority, with consideration for the least invasive option.
**Case:** A 22-year-old woman with secondary spontaneous pneumothorax due to TB presented with shortness of breath following a cough and was found to have a >2cm lucent area on chest X-ray. Initial management included chest tube insertion and WSD. A persistent pneumothorax was identified after 13 days of admission, and surgery was advised, but the patient declined. Conservative management was continued with ambulatory drainage for a total of 34 days, and management of TB as an underlying disease, and adequate nutritional support. Over the course of a month, clinical symptoms improved, and subsequent evaluations confirmed resolution of the pneumothorax. The chest tube was removed. The patient completed 12 months of anti-TB therapy, was declared cured, and experienced no recurrence of pneumothorax. Conservative management, including ambulatory WSD, effectively manages persistent air leak (PAL) for patients unsuitable for surgery. Ambulatory WSD facilitates mobility, reduces hospital stay, and minimizes complications. Proper patient education, nutritional support, and management of underlying conditions are essential for favorable outcomes.
**Conclusion:** The management of persistent pneumothorax should be guided by the patient's clinical condition. Conservative management can yield favorable results, followed by best supportive management.

## INTRODUCTION

A pneumothorax is an abnormal collection of air in the pleural cavity. It occurs when air accumulates between the parietal and visceral pleura inside the chest. Pneumothorax results from the entry of air through the bronchial or alveolar passages into the pleural cavity and is often accompanied by an air leak. Air leakage is the leakage of air from an air-containing cavity into a space that does not contain air, such as the pleural cavity. It may be caused by a fistula at the periphery of the lung (alveolar-pleural fistula), at the central airway (bronchopleural fistula), or by entry of atmospheric air.[1]

Secondary spontaneous pneumothorax occurs in the presence of underlying pulmonary disease, such as a pulmonary infection or granulomatous pulmonary disease. The incidence of secondary pneumothorax is 6.3 per 100,000 in males and 2.0 per 100,000 in females annually.[2] Pneumothorax is one of the pulmonary complications of pulmonary tuberculosis (TB), occurring in approximately 1.5% of TB patients, with high mortality and requires complex management, one

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of which is chest tube insertion.[3]

A persistent air leak (PAL) in a pneumothorax patient is defined as an air leak lasting beyond 5-7 days after chest tube insertion with water-sealed drainage (WSD).[2] Risk factors for PAL include female sex, history of infection, and chronic obstructive pulmonary disease (COPD).[4] The likelihood of PAL in secondary spontaneous pneumothorax increases on day 7, day 14, and thereafter.[5] And if, on day 7, there is only a 50% chance of PAL resolution until day 14.[5] The incidence of PAL is reported as 39 cases per 1,700 pneumothorax patients, with an overall mortality rate ranging from 67% to 92%, mainly if not adequately managed.[4]

Fistula, especially alveolar pleural fistula, are the most frequent cause of PAL and is associated with prolonged hospitalization time and increased morbidity. Persistent air leak management options include conservative non-operative strategies, such as chest tube insertion with WSD or ambulatory WSD, as well as surgical management, including thoracotomy or video-assisted thoracoscopy (VATS). Surgical management remains the gold standard for PAL, particularly when chest tube insertion with active suction fails.[4] However, recent studies suggest that other conservative approaches, such as ambulatory WSD with a 1-valve system, can be a modality for managing persistent pneumothorax.[5] This modality is preferred because many patients are considered not to meet criteria for surgery, such as elderly patients with decreased pulmonary function compared to young adults, or patients who refuse surgery.[5]

This case report describes a patient with PAL managed conservatively. The patient was diagnosed with bone TB (navicular bone) from postoperative tissue. The patient was also diagnosed with pulmonary TB from a rapid molecular test (RMT) of sputum. A computed tomography (CT) scan of the thorax with contrast was performed, revealing a pneumothorax with a subpleural bleb. An air leak due to the fistula was suspected, and the patient was planned for VATS. The patient and his family refused surgery and were discharged with a chest tube connected to the ambulatory dry seal drainage.

Conservative management continued with ambulatory drainage for a total of 34 days and management of TB as an underlying disease, and adequate nutritional support. A follow-up chest X-ray was obtained one month before the completion of anti-TB drug (ATD) treatment, and it revealed no avascular lucent area, indicating no pneumothorax. The patient completed 12 months of anti-TB therapy. There were no respiratory complaints, the physical examination was within normal limits, and the sputum evaluation was negative for TB. This case report aimed to emphasize the importance of engaging patients in shared decision-making, particularly by presenting all available management options and aligning the choice with the patient's main priority. In this context, we emphasize the importance of considering the least invasive yet clinically effective approach as an integral part of individualized care.

## CASE

A 22-year-old woman presented with a chief complaint of severe shortness of breath for one day before hospital admission after coughing. The patient also coughed up white sputum, which worsened over three days and was accompanied by a decrease in appetite and weight loss for the last six months (initial weight: 60 kg, current weight: 36 kg). The patient was diagnosed with bone TB (navicular bone) from a postoperative tissue biopsy two months earlier. Subsequently, pulmonary TB was diagnosed using an RMT of sputum, which was performed after the diagnosis of bone TB. Upon arrival, the patient was being treated for TB with four fixed-dose combinations (FDC) of ATD for 43 days.

Upon arrival, the physical examination revealed tachycardia and tachypnea, with an oxygen saturation of 99% using a nasal cannula at 3 liters per minute. Eye examination revealed icterus on both sclera. The patient realized her eyes had become icteric before the onset of tachypnea. Then, liver function and bilirubin laboratory tests were performed. Bilirubin values increased (total bilirubin 6.20, direct bilirubin 4.41, and indirect bilirubin 1.79). The patient experienced drug-induced liver injury (DILI). Hence, four FDCs of ATD were stopped. A special regimen was administered, which included streptomycin 500 mg every 24 hours intramuscularly (IM), levofloxacin 750 mg every 24 hours intravenously (IV), and ethambutol 750 mg every 24 hours orally (PO). After ten days, bilirubin levels decreased (total bilirubin 1.5, direct bilirubin 0.84, and indirect bilirubin 0.66). Rifampicin (RIF) was initiated at a dose of 75 mg/day, increasing to 300 mg after 6±7 days. Then, isoniazid (INH) was initially introduced at 50 mg/day, growing sequentially to 150 mg/day after 6±7 days, and then continued without complaint from the patient. A specific ATD regimen consisted of INH 150 mg administered orally every 24 hours, rifampicin 300 mg administered orally every 24 hours, and ethambutol 750 mg administered orally every 24 hours for 9 months.

Chest examinations revealed asymmetry, decreased tactile fremitus with hypersonic percussion, and diminished breath sounds on the left lung. A chest radiograph showed an avascular area on the left hemithorax with a positive pleural visceral line, suggestive of pneumothorax (Figure 1A). Calculation of the distance according to the British Thoracic Society (BTS) was more than 2 cm. We decided to perform an insertion of the chest tube and connect it to a WSD system.

By the thirteenth day of admission, the physical examination still revealed a decrease in breath sounds in the left hemithorax and continued to show air bubbles on the WSD. The patient was evaluated for a chest X-ray, which later revealed an avascular lucent area on the left hemithorax with a persistent positive pleural visceral line (Figure 1B). It was concluded that the pneumothorax became persistent. The patient was referred to a thoracic and cardiovascular surgeon for evaluation of surgery.

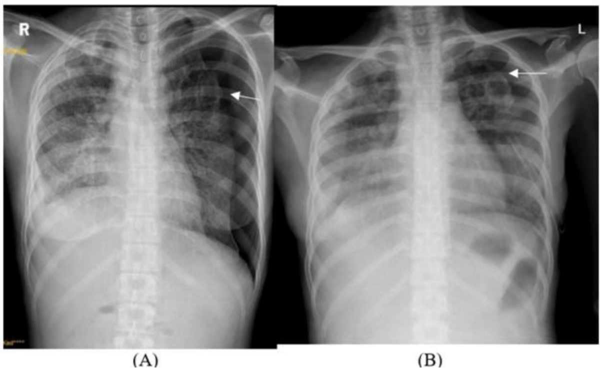


**Figure 1.** Anteroposterior thoracic photograph. A) Before chest tube insertion with water-sealed drainage (WSD), showing pneumothorax (arrow) and evaluation thoracic photograph; B) After chest tube insertion with WSD, still showing pneumothorax with reduced impression (arrow).

An evaluation of the chest CT scan with contrast was performed and revealed pneumothorax with a subpleural bleb (Figure 2). Air leakage due to the fistula was suspected, and the patient was planned for VATS to close the fistula. However, the patient and her family refused surgery, and she was discharged with a chest tube connected to the ambulatory dry seal drainage. The patient also continued the ATD regimen.

At the pulmonary outpatient clinic, one month after chest tube insertion with ambulatory dry seal drainage, respiratory symptoms and breath sounds had improved. Liver function tests and bilirubin were within normal limits.

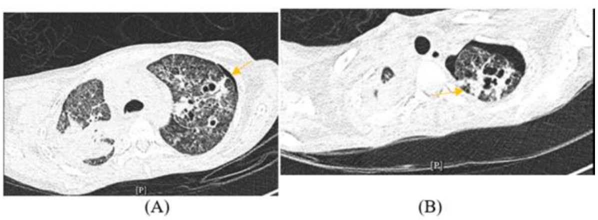


**Figure 2.** Contrast-enhanced thoracic computed tomography scan showing pneumothorax. A) Persistent pneumothorax (yellow arrow); B) Subpleural bleb (yellow arrow).

Two weeks later, the chest tube was removed. The patient had no respiratory or gastrointestinal complaints. The last ATD regimen was continued for a total of 12 months. The patient routinely visited the pulmonary outpatient clinic with improved conditions at every visit. A re-evaluation chest X-ray was taken one month after the patient completed ATD treatment, and it revealed no avascular lucent area, indicating no pneumothorax. The patient completed 12 months of ATD treatment. There were no respiratory complaints; the physical examination was within normal limits, liver function did not increase, and the sputum evaluation was negative for TB.

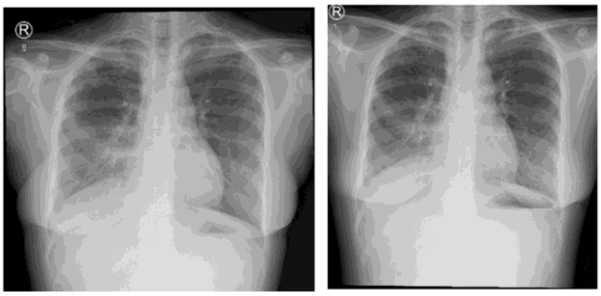


**Figure 3.** Chest X-ray re-evaluation showed no pneumothorax. A) Anteroposterior chest X-ray at the 9$^{th}$ month of anti-tuberculosis drug (ATD) treatment; B) Anteroposterior chest X-ray at the 11$^{th}$ month of ATD treatment.

## DISCUSSION

A 22-year-old woman was referred from another hospital with secondary spontaneous pneumothorax and bone TB. After 13 days of WSD, the patient still complained of dyspnea, and from the X-ray, the pneumothorax was persistent. Video-assisted thoracoscopy surgery was advised to close the fistula, but the patient refused and preferred conservative management with WSD. After 34 days on a chest tube and adequate TB treatment, the condition improved, and then the chest tube was removed. Pneumothorax in this patient occurred due to the large extent of the lesion in the patient's lung. Based on the obtained CT scan results, a subpleural bleb was left on the super-anterior aspect.

Pneumothorax is defined as the presence of air within the pleural cavity, which occurs when air from the atmosphere, airway, or lung enters the pleural cavity.[2] It is divided into spontaneous, post-traumatic, or iatrogenic. Spontaneous pneumothorax can be primary or secondary, depending on the presence or absence of underlying pulmonary diseases, such as lung TB, COPD, or other conditions.[6] In this case, the patient was diagnosed with pulmonary TB from RMT results. A CT scan revealed multiple cavities with surrounding consolidation in the superior lobe of the left lung. A reticulonodular pattern was seen in the superior, medial, and inferior lobes of the right lung, accompanied by consolidation in the superior and inferior lobes of the right lung, suggestive of pulmonary TB. The patient was therefore diagnosed with secondary spontaneous pneumothorax due to the underlying pulmonary disease of TB.

Air leakage is defined as airflow into the pleural cavity, typically due to a fistula in the peripheral pulmonary (alveolar-pleural fistula), in the central airway (bronchopleural fistula), or via communication with the atmosphere. It can be persistent or known as a PAL.[1] It occurs through three primary routes: rupture of the alveolus, trauma, and the presence of gas-producing bacteria.[3] Persistent air leakage is characterized by air bubbles that persist after 5-7 days of chest tube placement.[2] Fistula, as the leading cause of PAL, is challenging to identify, even by radiologic examination.[7] The diagnosis of PAL can be made by bronchoscopy, chest radiograph, or thoracic CT scans, among other techniques.[8,9] Computed tomography scans and radiologic examinations are widely used. It is the gold standard for radiologic examination of pneumothorax, persistent pneumothorax, and fistula.[6]

The incidence of PAL is approximately 39 cases out of 1,700 pneumothorax patients, with an overall mortality rate of 67%-92%.[4] Persistent air leak is more frequent in patients with underlying lung disease or those undergoing surgery in the thoracic cavity area, where, in patients who undergo lobectomy, the incidence of PAL can reach 26%.[4] In this case, air bubbles were still present on the 13$^{th}$ day of admission, and an evaluation radiology examination was performed to confirm the PAL even though it had been treated with chest tube insertion and WSD with active suction.

In this patient, the pneumothorax persisted despite the insertion of a chest tube for 13 days. Chest tube insertion improves 63%-93% cases of pneumothorax, but in some cases, it may persist for several days.[2] Persistent pneumothorax is common in lungs with underlying disease (secondary spontaneous pneumothorax). Other causes of PAL include poorly controlled pulmonary infections, complications from ventilator use, incidence of thoracic trauma, or after lung surgery.[4]

Management of PAL remains challenging. Some guidelines recommend initial conservative management with chest tube drainage. However, if this management is unsuccessful, the primary option is surgery.[4,9] Conservative approaches aim to reduce flow through the fistula, promote healing while minimizing loss of pleural space. Non-operative, conservative management of PAL, which includes chest tube insertion connected to WSD with active suction, outpatient management with ambulatory one-way valve dry seal drainage, or a combination of these approaches, is beneficial in the treatment of PAL. In this patient, conservative management led to a significant improvement in the condition and symptoms. However, in some cases, when these conservative strategies are not successful, surgical management is required.[2,4]

There are notable differences between the American College of Chest Physicians (ACCP) and the BTS guidelines. According to the BTS, a thoracic surgeon should be consulted for surgery if the air leak persists for more than two days or if the lung does not expand.[10] The ACCP recommends waiting up to four days in cases of initial spontaneous pneumothorax and up to five days in cases of secondary pneumothorax before considering surgery.[11] The European Respiratory Society (ERS) outlines five indications for definitive management of primary spontaneous pneumothorax: hemopneumothorax, bilateral pneumothorax, persistent air leak for 3-5 days, second-attack pneumothorax, and special occupations (pilots and divers).[12] From a theoretical perspective, the appropriate timing for surgical intervention is if a persistent air leak occurs 5-7 days after chest tube insertion.[2] Air leaks that persist beyond 2-5 days are often considered candidates for surgical intervention. Nevertheless, given the patient's stable condition, conservative ambulatory drainage was deemed appropriate and successfully maintaned.[2]

Operative management is the primary option for patients with PAL who fail to improve with conservative management. In this case, PAL was suspected due to a fistula and did not improve within thirteen days after chest tube insertion. The success rate of operative management of PAL is as high as 80-95%.[13] Operative management is also the gold standard management in secondary pneumothorax, as it can include excision of blebs, bullae, or other abnormalities that appear on the visceral pleura during surgery. Both VATS and thoracotomy show similar efficacy, though thoracotomy carries a lower recurrence rate than VATS, and it has higher morbidity.[1,4]

The role of suction in chest tube management remains a topic of controversy. Some experts argue that the use of negative pressure on the lung may delay the healing of alveolar-pleural fistulas as suction continues to draw air through the pleural defect, preventing the defect from healing. Meanwhile, others argue that the use of negative pressure may expel air more quickly than air entering through the leak, thereby increasing adhesion to the leak area and aiding the healing process.[2] There are no definite criteria for determining whether patients need suction or not. However, based on a study by Duchman, *et al*. (2024), it is said that the decision to use suction or ambulatory dry seal drainage is due to the patient's clinical condition.[2]

Cerfolio, *et al*., as cited by Lazarus, *et al*. (2017), showed that among 33 patients with air leaks, those managed with standard WSD without negative pressure resulted in faster leak closure than in patients who were given negative pressure through suction.[1] Brunelli, *et al*., as quoted by Lazarus, *et al*. (2017), showed no difference between the speed of healing in patients who were given negative pressure compared to patients who were not.[1] According to Duchman, *et al*. (2024), management using ambulatory dry seal drainage using one valve on an outpatient basis has a success rate of 72-85.4%.[2] It reduces the need for surgical management, reduces the length of hospitalization, and reduces expenditure on hospitalization.[2] Therefore, based on these recommendations, the patient was discharged with ambulatory dry seal drainage using a one-way valve of the Scheffler valve type, observation, and continued ATD management.

Ambulatory dry seal chest drains with a manual valve of the Scheffler type, which provides low pressure within a closed system, accelerate patient mobility. As the patient mobilizes, the lungs expand faster. The mechanical Scheffler valve enables the effective evacuation of fluid or air, features a one-way valve, includes a bubble to detect intrapleural pressure, and utilizes a continuous suction mode driven by spring pressure. It is recommended for the ambulatory management of dry seal drainage, as administered to the patient in this case report.[14,15] This ambulatory dry seal drainage management system, featuring a single valve, was chosen because it accelerates mobility and reduces hospital stay time. This modality was particularly selected for patients who did not undergo surgery. Dugan, *et al*. (2017) found ambulatory dry seal drainage minimized side effects, such as subcutaneous emphysema, and shortened the duration of hospitalization by 46% with a low readmission rate of 4%.[4]

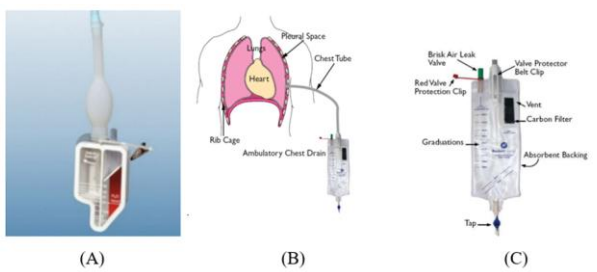


**Figure 4.** Example of ambulatory water-sealed drainage (A) and its parts (B, C)[14]

Ambulatory dry seal drainage using a single valve is beneficial for PAL management. This management is provided in the absence of subcuticular emphysema. Observation and evaluation of PAL encompass the duration of lung development, the process of lung development, and the patient's clinical condition. A chest X-ray has to be performed to evaluate the patient's condition.[4]

In this patient, the chest tube was removed within one month after insertion, following clinical improvement and a subsequent evaluation of the chest X-ray. The duration of PAL healing remains a topic of debate. However, some studies suggest that it will improve within 14 days. However, the duration of chest tube removal varies between patients.[2] Multivariate analysis showed that age, smoking history, and TB were related to longer duration of pleural drainage, whereas smoking history, pulmonary emphysema, and TB were related to longer duration of Heimlich valve.[16] Criteria for chest tube removal include: no more air leakage, serosanguineous fluid discharge without blood, production of less than 150 to 400cc in 24 hours, and absence of pneumothorax on thoracic photographs.[17] Complications of PAL, if not adequately managed, are pneumonia, empyema, hypoxemia, inadequate lung expansion, increased length of stay, and mortality.[2,18]

Drug-induced liver injury is a well-recognized adverse drug reaction of TB treatment. It complicates TB treatment in 5-33% of patients.[19] First-line ATD associated with hepatotoxicity are INH, RIF, and pyrazinamide (PZA). Treatment of DILI includes, if liver function is normal, a sequential reintroduction of the original dosage, starting with INH, RIF, and PZA, with daily monitoring of the patient's clinical condition and liver function. Isoniazid is initially introduced at 50 mg/day. If no reaction occurs, it should be increased sequentially to 300 mg/day after 2±3 days and then continued. After a further 2±3 days without response, RIF at a dose of 75 mg/day can be added, increasing to 300 mg after 2±3 days, and then to 450 mg (<50 kg) or 600 mg (>50 kg) as appropriate for the patient's weight after a further 2±3 days without reaction, and then continued. Finally, PZA is added at 250 mg/day, increasing to 1.0 g after 2±3 days and then to 1.5 g (<50 kg) or 2 g (>50 kg).[20]

## CONCLUSION

This case report highlights that the management of persistent pneumothorax remains decided based on the clinical condition of the patient. The management of PAL remains challenging due to the lack of updated research on a treatment algorithm or guidelines. Variability in management among published cases has resulted from the absence of current guidelines for treating these cases. Persistent air leaks occur in individuals with complex underlying pulmonary disease, as in this case. Conservative management, combined with prolonged WSD, can yield good results, followed by supportive management.

### Consent
Written informed consent was obtained from the patient.

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### Conflict of Interest
The authors declared there is no conflict of interest.

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### Authors' Contributions
Preparation, data gathering: NWC. Analysis: NWC, FS. Drafting: FS, IS. All authors contributed and approved the final version of the manuscript.

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