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Heimlich Valve as Ambulatory Treatment for Persistent Pneumothorax in a Patient with Pulmonary Tuberculosis: A Case Report and Literature Review

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ABSTRACT

Tuberculosis (TB) is still a significant medical and social problem in developing nations like Indonesia, with high morbidity and mortality rates. Tuberculosis infection are mostly found in the lungs, but they can affect other organs as well. Secondary spontaneous pneumothorax (SSP) is one of the most serious complications of tuberculosis, requiring the insertion of a chest tube in the majority of cases. The Heimlich valve can be used in complicated and persistent pneumothorax. The Heimlich valve may be outdated, but it is a very efficient one-way valve that provides safe air evacuation from the thoracic cavity. A 53-year-old man was hospitalized after complaining of left-sided chest discomfort and shortness of breath. The patient confirmed receiving tuberculosis treatment four years ago. During a physical examination, hyperresonance to percussion and decreased vesicular breath sounds was found on left side, wheezing on the right, and SaO2 of 92% in room air. An x-ray of the chest revealed a left side pneumothorax and fibrosis at the right lung's apex. Emergency drainage was done and an X-ray evaluation of the collapsed lung aeration was observed. However, even though drainage has been done for 19 days, an examination revealed persistent pneumothorax, requiring extended drainage. Due to a lack of resources and to prevent prolonged hospitalization, we began using a Heimlich valve to treat pneumothorax. The chest tube and Heimlich valve were detached successfully after two months. In conclusion, the Heimlich valve provides a practical and affordable treatment for ambulatory care of persistent pneumothorax.

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Introduction

Tuberculosis (TB) caused by infection of Mycobacterium tuberculosis (M. Tuberculosis), remains a global public health challenge (1). According to WHO, in 2020, 10 million people worldwide will suffer from TB and cause 1.2 million deaths. Meanwhile, Indonesia reached 845,000 estimated cases with a death rate of 96,700, or equivalent to 11 deaths/hour (2).

Despite the development of medical TB treatment in the twentieth century, TB remains the top cause of death among curable infections. Serious complications can occur following tuberculosis including secondary spontaneous pneumothorax (SSP). Most of these patients required chest tube insertion, which is the preferred treatment for complete drainage and resolution (1). The lungs expand, and air leakage ceases within three days in primary spontaneous pneumothorax (PSP), while in SSP, the meantime for the lung to expand is five days. In approximately 20% of patients, the lung remains collapsed, or an air leak persists after seven days. It requires a longer hospital stay, more invasive procedures, and limiting the patient's ambulation (3).

The Heimlich valve was first introduced in 1965 as a one-way portable device. It is designed to be used as a drainage procedure for pneumothorax so that it does not require suction for pneumothorax management. Heimlich valve is used for patients who no longer require hospitalization but still need thoracic drainage. Patients can be discharged with a Heimlich valve that is carefully treated (4).

In this case report, a male, 53 years old, with tuberculosis and persistent SSP despite being in a chest drainage for 19 days, used the Heimlich valve and showed a good clinical response. The Heimlich valve is a less expensive option for managing ambulatory persistent pneumothorax.

Case Report

A 53-year-old male has come to the emergency room with acute shortness of breath and left-sided chest pain two days before hospitalization. He was a heavy smoker with Brinkman index 320 and had previously completed TB treatment four years ago. He was afebrile, blood pressure was 150/90 mmHg, heart rate was 130 beats/minute, respiratory rate was 36 times/minute, and oxygen saturation was 92% on room air. He was unable to lie flat or sit in a reclined position. Physical examination revealed a patent airway and tracheal deviation to the right. Hyperresonance to percussion and decreased vesicular breath sounds was found on left side whereas wheezing was found on the right side. Pneumothorax on the left side and fibrosis at the apex of the right lung were found in chest X-rays (Figure 1A). Laboratory findings were significant for leukocytosis 11.700/ul, increased SGOT 68 U/l, and a 110 mm/hour sedimentation rate. Acid-Fast Bacilli (AFB) smear-negative. An urgent chest tube insertion was performed (Figure. 1B). After three days of pleural drainage and treatment with a bronchodilator and antibiotic, the patient's respiratory status improved, and oxygen supply could be decreased. Evaluation chest X-rays showed left lung fully expanded on the 4th day of chest tube insertion (Figure 1C).

However, the patient's clinical status deteriorated within several days, and evaluation imaging revealed persistent pneumothorax (Figure 1D). After 19 days of hospitalization, we discussed the possibility of prolonged pleural drainage and hospitalization with the patient and family. Due to a resource-limited setting and surgery disapproval, we started a Heimlich valve insertion for treatment of the pneumothorax with, so the patient would be able to recover at home. Considering the clinical evidence supporting pulmonary tuberculosis, the patient was prescribed oral TB drugs and continued treatment in the Primary Health Center. The patient regularly visited our hospital's outpatient clinic for medical examination and chest X-rays. He was informed that he should go to the hospital immediately in case of abrupt chest discomfort or breathlessness .

After two months of pharmacological treatment and a chest tube with a Heimlich valve, the patient's lungs were completely re-expanded , and the Heimlich valve was successfully removed (Figure 2). He was able to live at home and resume his normal activities while the Heimlich valve was

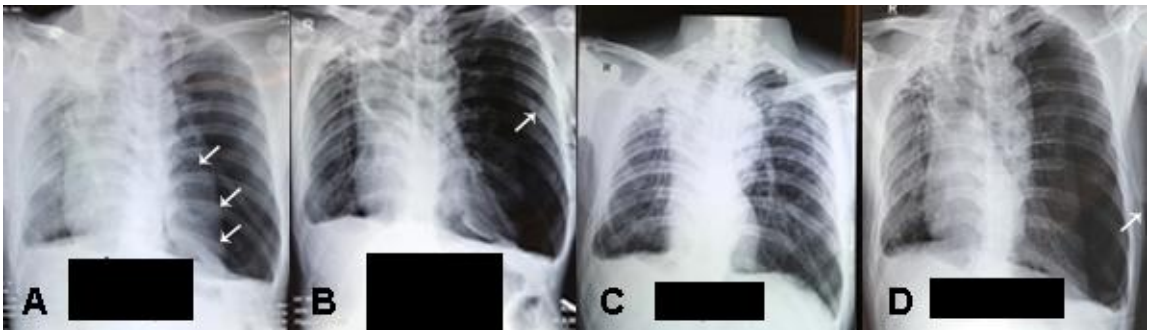

Figure 1. A. Chest X-ray when admitted to hospital, left-side pneumothorax; **B.** Chest X-ray after chest tube insertion procedure; **C**. Chest X-ray 4th days after chest tube insertion, left lung fully expanded; **D.** Clinical status patient deteriorated, and repeat Chest X-ray (19th day) revealed persistent left pneumothorax, Heimlich valve performed (indicated by arrow).

placed. Finally, after six months of therapy for pulmonary TB, the patient had clinically improved.

Discussion

Approximately 1.5% of patients with pulmonary and pleural tuberculosis have pneumothorax as a complication (5). Unlike primary spontaneous pneumothorax, pneumothorax caused by an infection such as tuberculosis (TB) can be fatal due to the patient's underlying respiratory disease and the compromised cardiopulmonary reserve. In active tuberculosis patients, the incidence of spontaneous pneumothorax is approximated to be around 1% (6). Globally, the prevalence of SSP is 6.3/100,000 (males) and 2.0/100,000 (females) per year (7). A study at a hospital centre in Indonesia showed that SSP was more common than other types of pneumothoraxes, and it mostly affects men. Tuberculosis is a common underlying condition in individuals with secondary spontaneous pneumothorax, with a death rate of roughly 83.8 percent (8).

The goal of treatment for spontaneous pneumothorax is to alleviate symptoms and prevent recurrences. Management depends on the underlying disease, severity of symptoms, past occurrences, and the patient's occupation. Observation, aspiration, tube drainage, pleurodesis, and surgery are some options available (7). A guideline by The American College of Chest Physicians recommends inserting a chest tube connected to either a water seal device or a Heimlich valve to treat large or symptomatic pneumothoraxes (9).

The Heimlich valve, a portable single-way device designed for pneumothorax drainage procedures was introduced in 1965 to eliminate the need for suctioning in pneumothorax management. Henry Heimlich, an American thoracic surgeon who is widely recognized for his Heimlich maneuver, invented the valve. This tool quickly gained popularity for treating outpatients with a pneumothorax who had a persistent air leak. (10-11).

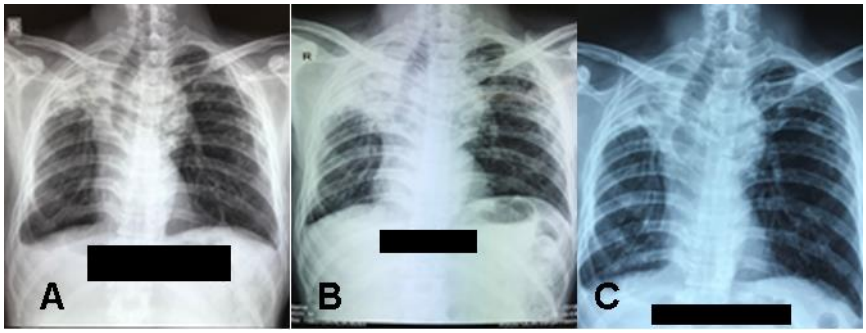

Figure 2. A. Follow-up Chest X-ray after chest tube with Heimlich valve in 22 days; **B.** Chest X-ray before removing Heimlich valve 60 days after chest tube insertion, left lung fully expanded; **C.** Chest X-ray after completing six months of therapy for pulmonary TB.

According to a systematic review by Brims et al., the Heimlich valve alone had an 85.8% success rate in managing spontaneous pneumothorax (12).

This device functions as a single-way valve to prevent the evacuated air from returning to the thoracic cavity. This valve is made from plastic and has two nozzles and a rubber arm within. The inlet nozzle permits air to pass through the valve through the chest tube, while the outlet nozzle lets the air moves out of the thoracic cavity during expiration. The rubber on the nozzle inlet had a closing function during inspiration that prevents air from entering (serves as a valve) (Figure 3) (10-11).

When air passes through the valve, a distinctive "flutter" noise is produced, as an indicator that the valve is working correctly. But if there is no movement of the rubber sleeve or sound during insertion, it is assumed that there is no air going out of the valve indicating that the pneumothorax has resolved or that the chest drainage is clogged. If this is the case, a thorough physical examination and a chest X-ray can help evaluate the pneumothorax's status. When compared to water seal drainage, the Heimlich valve has several advantages. The most important benefit is that it is portable and does not require clamping during the management of pneumothorax. Because it has two nozzles, it can also be connected to the WSD if negative pressure is needed or for pleural fluid evacuation (Figure 4) (10).

In this case, the Heimlich valve was placed on Mr. D on the 27th day of treatment. Installation of the Heimlich valve on Mr. D is beneficial because insertion of a Heimlich valve shortens his hospital stay and reduces complications from pneumothorax.

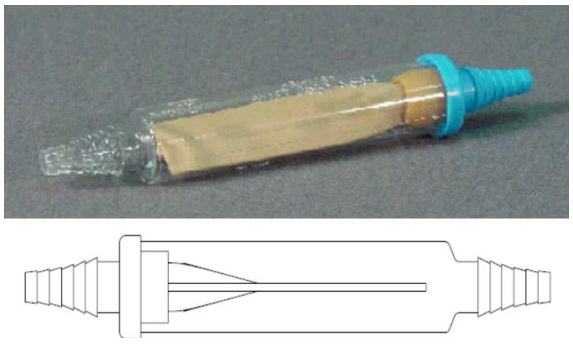

Figure 3. Heimlich valve (13).

Figure 4. On the left chest, a Heimlich valve is connected to a chest tube (10).

It is in line with a study published in Nairobi in 2016 by Makanga et al., which stated that the use of the Heimlich valve reduces treatment costs and duration of hospital stay when compared to the use of Water Seal Drainage (13).

Numerous studies have shown the safety of the Heimlich valve, even a study by Lee et al. concluded that the valve can be used in individuals above the age of 70 (14). Tension pneumothorax and empyema are complications that might arise during Heimlich valve placement. Tension pneumothorax can occur if the Heimlich valve is placed incorrectly, with the nozzle outlet connected to the chest tube, allowing outside air to enter the thorax (15). The duration chest tube attached to the thorax and the sterility of the technique used to insert it both contribute to empyema (10).

Hence, we concluded that in patients with SSP who do not qualify for surgery treatment, The Heimlich valve is a decent option since it allows for early patient mobilization and hospital discharge with minimal complications.

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