Management of Pulmonary Tuberculosis in a Military Healthcare Setting Within a Confined Training Environment, a Case Study

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DOI: https://doi.org/10.47772/IJRISS.2026.100300393

Received: 24 March 2026; Accepted: 30 March 2026; Published: 10 April 2026

ABSTRACT

Tuberculosis (TB) remains a persistent global health challenge, particularly in countries with moderate to high disease burden such as Malaysia. Despite continuous national and international efforts, TB continues to present significant challenges related to delayed diagnosis, ongoing transmission, and treatment adherence. These challenges are further intensified in military healthcare settings, especially within confined training environments where individuals live, train, and interact in close proximity for prolonged periods. Such conditions create an ideal environment for the transmission of airborne infectious diseases, including pulmonary tuberculosis (PTB). This study presents a case of PTB involving a young adult male who developed symptoms while participating in a physically demanding training course conducted in a confined environment. The study aims to examine the clinical management of the patient, the diagnostic challenges encountered, and the public health interventions implemented to prevent further transmission. Additionally, it evaluates the screening and management of close contacts within the same course setting, highlighting the risks associated with confined group environments. A case study methodology was adopted, incorporating patient medical records, laboratory findings, radiological imaging, and follow-up outcomes. A comprehensive screening programme was conducted among course participants to identify latent TB infections and prevent progression to active disease. The findings revealed delays in early detection, gaps in pre-course medical screening, and procedural inefficiencies that contributed to increased transmission risk. This study underscores the importance of early identification, systematic screening, and proactive infection control strategies in confined environments. It contributes to the broader understanding of TB management in military healthcare settings and provides practical recommendations for strengthening disease surveillance, improving screening protocols, and preventing outbreaks in high-risk environments.

Keywords: Pulmonary tuberculosis, military healthcare setting, confined environment, infection control, latent tuberculosis

INTRODUCTION

Tuberculosis (TB) remains one of the most enduring infectious diseases worldwide, despite significant advancements in diagnosis, treatment, and global control initiatives. Caused by *Mycobacterium tuberculosis*, the disease primarily affects the lungs but may also involve other organ systems. Transmission occurs through

airborne droplets, making TB particularly dangerous in environments where individuals are in close proximity for extended periods (Wani et al., 2025).

In Malaysia, tuberculosis continues to be endemic and represents a major public health concern. Although the country has achieved gradual reductions in TB incidence, the decline has not been sufficient to meet international targets set under the End TB Strategy. The persistence of TB is influenced by multiple factors, including delayed diagnosis, inadequate screening, limited awareness, and environmental conditions that facilitate disease transmission (Mohidem et al., 2021).

One of the critical risk factors for TB transmission is the presence of confined environments, where ventilation may be limited and individuals share common spaces. Military healthcare settings, particularly those associated with training courses, present unique challenges in this regard. Personnel undergoing training are often required to live in shared accommodations, participate in group activities, and maintain close interpersonal contact. These conditions significantly increase the risk of airborne disease transmission (Manzoor et al., 2026).

Furthermore, physically demanding training activities may compromise immune function, making individuals more susceptible to infection. Fatigue, stress, and nutritional challenges can further exacerbate vulnerability to infectious diseases. In such environments, a single undetected case of tuberculosis has the potential to expose a large number of individuals, leading to widespread transmission (Hatch-McChesney & Smith, 2023).

This study explores a case of pulmonary tuberculosis that occurred within a confined training environment and examines the clinical management, contact screening, and infection control measures implemented. It also highlights gaps in existing healthcare practices and provides recommendations for improving TB prevention and management in similar high-risk settings.

Objective

The primary objective of this study is to describe the comprehensive clinical management of a patient diagnosed with pulmonary tuberculosis within a military healthcare setting. This includes examining the patient's clinical presentation, diagnostic pathway, treatment regimen, and follow-up outcomes in the context of a confined training environment. A secondary objective is to evaluate the effectiveness of contact tracing and screening measures among individuals participating in the same training course. Given the confined nature of the environment, close and prolonged interactions significantly increase the risk of transmission, making contact screening a critical component of disease control.

In addition, the study aims to identify gaps and delays in the management process, including issues related to early detection, pre-course health screening, and response time. These gaps may contribute to increased transmission risk and highlight the need for improved healthcare protocols. Ultimately, this study seeks to provide evidence-based recommendations to strengthen tuberculosis prevention, enhance infection control strategies, and improve overall healthcare preparedness in confined and high-density environments.

METHODOLOGY

This study utilised a case study design to provide an in-depth analysis of pulmonary tuberculosis management within a military healthcare setting. The case study approach is particularly suitable for examining complex clinical and operational scenarios, allowing for a comprehensive understanding of the interplay between patient factors, environmental conditions, and healthcare interventions.

Data were collected from multiple sources, including patient medical records, laboratory investigations, radiological findings, and follow-up reports. These data provided a detailed account of the patient's clinical progression, diagnostic challenges, and response to treatment. In addition to patient-specific data, a systematic screening programme was conducted among individuals who had close contact with the patient during the

training course. The confined nature of the environment placed these individuals at higher risk of infection, necessitating thorough screening procedures.

Screening methods included clinical assessment, Mantoux testing, and chest radiography for individuals with positive or suspicious findings. The purpose of this screening was to identify both active and latent tuberculosis cases and to implement appropriate preventive measures. The study was conducted over a six-month period, allowing sufficient time to observe treatment outcomes and evaluate the effectiveness of screening interventions. Ethical considerations were strictly adhered to, including maintaining patient confidentiality and ensuring responsible use of clinical data.

Case Description

The patient was a 22-year-old male who was actively participating in a physically demanding training course conducted within a confined environment. The course involved close living arrangements, shared facilities, and prolonged interaction among participants. These conditions created a high-risk environment for the transmission of airborne diseases such as tuberculosis. The patient initially presented with a persistent dry cough lasting approximately two months. This was accompanied by haemoptysis, significant weight loss, and night sweats. These symptoms are characteristic of pulmonary tuberculosis; however, they may be overlooked or misattributed to fatigue or minor illness in high-intensity training environments.

The patient reported a noticeable decline in body weight over a short period, indicating systemic involvement of the disease. Despite these symptoms, he denied any known contact with individuals diagnosed with tuberculosis. This suggests the possibility of undetected exposure within the community or within the confined training environment itself. Initial investigations included sputum testing for Acid Fast Bacilli (AFB), inflammatory markers, and chest radiography. The initial sputum tests returned negative results, which can occur in early stages of TB or due to sampling limitations. However, chest radiography revealed abnormalities consistent with pulmonary tuberculosis, prompting further investigation.

Following specialist consultation, the patient was admitted for further evaluation and management. Repeat sputum testing conducted during admission returned positive results, confirming the diagnosis of pulmonary tuberculosis. This highlights the importance of repeated diagnostic testing in cases with high clinical suspicion, particularly in high-risk environments. The patient was initiated on standard anti-tuberculosis therapy, consisting of isoniazid, rifampicin, pyrazinamide, and ethambutol. These medications are administered in combination to effectively eliminate the bacteria and prevent the development of drug resistance.

During hospitalisation, the patient developed a low-grade fever, and further imaging using computed tomography (CT) revealed miliary tuberculosis, indicating widespread dissemination of the infection. Fibrotic changes were also observed in the lungs, suggesting ongoing inflammatory processes. Despite the severity of the condition, the patient responded well to treatment. He demonstrated gradual improvement in clinical symptoms, including weight gain and improved appetite. He was subsequently discharged and continued treatment under a directly observed therapy (DOTS) programme to ensure adherence and monitor progress.

Table 1: Timeline of Symptom Onset, Diagnosis and Treatment

Stage	Event
Week 0	Onset of symptoms (cough)
Week 4–8	Progressive symptoms (weight loss, haemoptysis)
Week 8	Initial medical evaluation (negative sputum)
Week 9	Abnormal chest X-ray
Week 10	Repeat sputum positive (Diagnosis confirmed)
Week 10+	Treatment initiated (HRZE + DOTS)

Contact Screening In A Confined Course Environment

The confined nature of the training course significantly increased the risk of tuberculosis transmission among participants. Individuals were exposed to shared living spaces, close interpersonal interactions, and prolonged contact durations, all of which facilitate the spread of airborne pathogens.

In response to the confirmed case, a comprehensive screening programme was conducted among 188 course participants. These individuals were considered high-risk contacts due to their prolonged exposure to the patient in a confined environment. Screening procedures included clinical assessment, Mantoux testing, and chest radiography for individuals with positive or suspicious findings. The Mantoux test is widely used to detect latent TB infection by measuring the immune response to tuberculin.

The screening results revealed that 16 individuals (8.5%) tested positive on the Mantoux test. Although these individuals did not exhibit symptoms or radiological evidence of active disease, they were classified as having latent tuberculosis infection (LTBI). Latent TB infection represents a state in which the bacteria remain dormant within the body without causing symptoms. However, individuals with LTBI are at risk of developing active tuberculosis, particularly if their immune system becomes compromised.

To prevent progression to active disease, all individuals with latent infection were prescribed preventive therapy with isoniazid for six months. This approach is consistent with international guidelines and is effective in reducing the risk of reactivation. The screening programme highlights the importance of early identification and preventive treatment in controlling TB transmission, particularly in confined environments where the risk of exposure is high.

Table 2: Summary of Contact Screening Outcomes

Category	**Number (%)**
Total participants screened	188
Mantoux positive (LTBI)	16 (8.5%)
Active TB detected	0
Preventive therapy initiated	16

DISCUSSION

The findings from this case highlight not only the clinical management of pulmonary tuberculosis but also reveal important systemic and procedural gaps that contributed to delayed diagnosis and increased transmission risk. Although the patient presented with classical symptoms such as prolonged cough, haemoptysis, weight loss, and night sweats, there was a delay of approximately two months before definitive diagnosis was established. This delay is consistent with findings by Santos et al. (2021), who reported a median diagnostic delay of 62 days with most cases exceeding one month, suggesting that prolonged symptomatic periods are common and clinically significant. In high-risk settings such as confined military training environments, such delays are particularly critical because they prolong infectious periods and increase the likelihood of transmission among close contacts, as similarly observed in outbreak settings described by Labuda et al. (2022).

From a clinical decision-making perspective, the initial negative sputum results in this case may have contributed to diagnostic uncertainty and delayed escalation of care. While false-negative sputum results are recognised in early or paucibacillary tuberculosis, reliance on a single negative result without prompt repeat testing may reflect a gap in clinical suspicion or diagnostic protocol. Divala et al. (2022) reported that a substantial proportion of symptomatic patients, ranging from 33% to 96%, were not adequately investigated despite presenting with TB-related symptoms, highlighting missed opportunities for early diagnosis. In the present case, earlier repeat sputum analysis or use of more sensitive diagnostic approaches could have reduced the delay, reinforcing the need for heightened clinical vigilance in high-risk environments.

The delay in diagnosis can also be examined from a broader systemic and operational perspective. Training environments often prioritise physical endurance and course completion, which may discourage early reporting of symptoms among participants. Additionally, limited access to immediate healthcare assessment or absence of structured symptom surveillance may contribute to delayed detection. Although Sence et al. (2025) reported no significant difference in diagnostic delay between military and civilian populations, the present case suggests that environmental and behavioural factors specific to confined training settings may still play a role in delaying diagnosis. These findings indicate that the issue is not solely clinical but also organisational, requiring improvements in health monitoring systems within training environments.

The confined and high-density nature of the training environment in this case further amplified the risk of tuberculosis transmission. Aulia et al. (2024) demonstrated that population density and poor ventilation significantly increase TB transmission risk, which directly reflects the shared accommodation and close-contact conditions observed in this course. Similarly, Manzoor et al. (2026) identified prolonged exposure and environmental factors as key determinants of transmission in healthcare and institutional settings. The present case illustrates how these known risk factors operate in real-world military training environments, reinforcing the need for proactive environmental and infection control measures.

The contact screening outcomes in this study further demonstrate the implications of delayed diagnosis. The identification of 16 individuals (8.5%) with latent tuberculosis infection among 188 participants indicates substantial exposure within the cohort. This finding aligns with outbreak investigations reported by Fang et al. (2021), where individuals with latent infection progressed to active disease when preventive therapy was not administered. Similarly, Du et al. (2023) showed that even individuals initially testing negative may later develop active TB, particularly in high-exposure settings. The implementation of isoniazid preventive therapy in this case is supported by Jonas et al. (2023), who demonstrated that treatment of latent TB significantly reduces progression to active disease, highlighting the importance of early screening and intervention.

The discussion on pre-course medical screening also warrants further critical evaluation. Although this study identified gaps in screening, these gaps likely include the absence of structured baseline symptom assessment, limited risk stratification, and lack of routine pre-course investigations such as chest radiography or Mantoux testing. Evidence from Huerte et al. (2023) shows that comprehensive pre-employment medical screening is effective in identifying health risks in high-density occupational settings. Similarly, Apriani et al. (2022) reported that a significant proportion of individuals in training environments were already infected at baseline, with additional conversions occurring during training. However, current literature, including Suhr et al. (2024), highlights a lack of direct evidence on the effectiveness of pre-course screening in preventing infectious disease transmission, indicating a critical research and policy gap that is also reflected in this case.

The broader implications of delayed diagnosis are also supported by evidence from other infectious disease contexts. Ratnayake et al. (2020) demonstrated that delays in outbreak response significantly increase transmission and outbreak size, while Rong et al. (2020) showed that reducing diagnostic delays lowers transmission rates in COVID-19. These findings reinforce the importance of early detection across infectious diseases and are directly applicable to tuberculosis management in confined environments. In the present case, the prolonged delay before diagnosis likely contributed to increased exposure and the subsequent identification of multiple latent infections.

The effectiveness of Directly Observed Treatment Short-course (DOTS) in this case must also be interpreted within its specific context. While Elmuttalut (2024) identified DOTS as an important adherence strategy and Ali and Prins (2020) highlighted its role in improving treatment compliance, its effectiveness is not universally consistent. Pradipta et al. (2020) emphasised that DOT outcomes vary depending on implementation quality and setting, while Mussie et al. (2020) reported that rigid application may even contribute to drug resistance in certain contexts. Marahatta et al. (2021) further identified DOTS as both an enabler and barrier to adherence. In this case, the structured military healthcare system likely facilitated effective monitoring and adherence, suggesting that organisational support plays a critical role in determining treatment success.

Finally, this case must be interpreted within the broader global context of tuberculosis burden. Anderer (2025) reported that global TB cases have reached their highest levels in recent decades, while The Lancet Infectious

Diseases (2023) and Fukunaga et al. (2021) documented persistently high incidence and mortality rates. Chakaya et al. (2021) further emphasised TB as the leading infectious cause of death globally, with contributing factors such as poverty, malnutrition, and healthcare access disparities, as also highlighted by Kumar and Sharma (2025). These global trends underscore the continued relevance of tuberculosis as a major public health concern and reinforce the importance of strengthening early detection, screening, and infection control strategies in high-risk environments such as military training settings.

Limitations

This study has several limitations that should be acknowledged. First, the findings are based on a single case, which limits the generalisability of the results to broader populations or different operational settings. Second, the study did not include environmental assessments such as ventilation quality, air circulation, or crowd density measurements, which are important factors influencing airborne disease transmission. Third, reliance on self-reported symptoms from participants may introduce recall bias or underreporting, particularly in military training environments where individuals may minimise symptoms to avoid removal from training. Additionally, the absence of advanced diagnostic tools such as molecular testing may have influenced the timing of diagnosis. Despite these limitations, the study provides valuable insights into tuberculosis management within confined military environments.

CONCLUSION

This case study highlights the critical importance of early detection, prompt treatment, and comprehensive screening in managing pulmonary tuberculosis within a military healthcare setting. The confined nature of training environments significantly increases the risk of disease transmission, making proactive healthcare measures essential. Delays in diagnosis and inadequate pre-course screening can lead to increased exposure and potential outbreaks. Therefore, systematic screening protocols must be implemented to identify cases early and prevent transmission.

Preventive treatment for latent tuberculosis infection is a key strategy in reducing future disease burden, particularly in high-risk environments. Healthcare providers must remain vigilant and proactive in managing infectious diseases in confined settings. Strengthening infection control measures, improving screening processes, and enhancing awareness are essential steps toward achieving effective tuberculosis control and ensuring the safety of individuals in confined training environments.

RECOMMENDATIONS

Recommendations for Organisations

Organisations, particularly those operating in military healthcare settings and confined training environments, should prioritise comprehensive pre-participation health screening to detect infectious diseases at an early stage. This includes implementing mandatory medical evaluations, symptom surveillance, and risk assessment protocols before individuals are allowed to enter high-density or confined courses. In addition, organisations should strengthen infection control measures by ensuring proper ventilation, enforcing respiratory hygiene practices, and establishing rapid response mechanisms for suspected cases. Ultimately, a proactive and systematic approach to health monitoring and disease prevention will enhance operational readiness while minimising the risk of infectious disease transmission.

Recommendations for Future Research

Future research should focus on exploring the effectiveness of enhanced screening protocols and early detection strategies in reducing tuberculosis transmission within confined environments. Studies should also investigate the impact of environmental factors such as ventilation, crowd density, and duration of exposure on the spread of airborne infectious diseases in military and similar settings. In addition, longitudinal research is needed to assess the long-term outcomes of individuals with latent tuberculosis infection and the effectiveness of preventive therapy programmes. Further investigation into behavioural, organisational, and systemic factors

influencing delays in diagnosis and treatment would provide valuable insights for improving tuberculosis control strategies.

ACKNOWLEDGEMENT

The authors would like to thank Royal Medical and Dental Corp for supporting this study.

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