Journal of Multidisciplinary Healthcare

Dovepress
Taylor & Francis Group

Open Access Full Text Article

REVIEW

Managing Pulmonary Injury in Older Adults with Tuberculosis: The Role of Nursing Interventions

Qin Zhang*, Jing Guo*, Haiying Lei, Qingfen Zhang

Department of Tuberculosis, Lishui Hospital of Traditional Chinese Medicine, Lishui, Zhejiang Province, 323000, People's Republic of China

*These authors contributed equally to this work

Correspondence: Qingfen Zhang; Haiying Lei, Department of Tuberculosis, Lishui Hospital of Traditional Chinese Medicine, No. 800 of Zhongshan Street, Liandu District, Lishui, Zhejiang Province, 323000, People's Republic of China, Tel +8613754279049; +8613567615730, Email zhangqfen_123@163.com; haiyingleilhy@126.com

Abstract: Tuberculosis remains a common and clinically significant infectious disease in elderly Homo sapiens aged 60 and above, characterized by atypical manifestations and complex treatment. This review provides a comprehensive analysis of tuberculosis-related pulmonary damage in elderly Homo sapiens, evaluates current care practices, and discusses associated challenges. Key areas of discussion include early detection and diagnosis, optimized management of medication regimens, provision of adequate nutritional support, rehabilitation-focused care, and psychosocial support. The necessity of regular follow-up and long-term management is emphasized to prevent complications and promote functional recovery. Future research and clinical practice directions should focus on developing personalized, technology-integrated care strategies to enhance care quality, improve clinical outcomes, and support the overall health of this Homo sapiens population.

Keywords: early identification, nursing intervention, older adults, pulmonary injury, pulmonary tuberculosis, tuberculosis

Introduction

Pulmonary tuberculosis (PTB) is a chronic infectious disease caused by *Mycobacterium tuberculosis*, characterized by the development of lesions in the lung tissue, trachea, bronchi, and pleura.[1] The disease often follows a prolonged treatment course and is associated with a high risk of relapse. Without timely and appropriate intervention, PTB can lead to Drug resistance, lung injury, pleurisy, bronchiectasis, empyema, extrapulmonary tuberculosis and immune system weakening are among the many serious complications. Globally in 2023, an estimated 10.8 million people (95% uncertainty interval [UI]: 10.1–11.7 million) fell ill with TB (incident cases), a further increase from 10.7 million (95% UI: 10.0–11.5 million) in 2022, 10.4 million (95% UI: 9.7–11.1 million) in 2021 and 10.1 million (95% UI: 9.5 10.7 million) in 2020.[2]

China, which has the largest population of older adults worldwide, faces a significant burden in managing TB in this demographic. Age-associated decline in immune function contributes to atypical clinical presentations in older adults following infection with *M. tuberculosis*. This immunosenescence is also linked to reduced detection rates in drug susceptibility testing and diminished ability to eliminate the bacillus, posing considerable obstacles to effective disease control.[3] Furthermore, older adults frequently present with damage associated with pulmonary tuberculosis, fibrosis, and cavitary lesions. These pathological changes are associated with a higher incidence of drug-related adverse effects, increased likelihood of treatment failure, and elevated mortality rates.[4,5]

In this context, nursing care for individuals with TB-related pulmonary damage in older adulthood assumes a critical role.[5] Nursing responsibilities encompass close monitoring of clinical status, timely symptom management, and prevention of complications, in addition to providing adequate nutritional and psychological support to facilitate recovery and improve quality of life.[6]

Received: 30 May 2025
Accepted: 21 October 2025
Published: 15 November 2025

This review aims to overview current evidence on nursing interventions for managing pulmonary injury in older adults with TB. It evaluates prevailing clinical practices, identifies ongoing challenges, and highlights recent advancements in nursing care. Through a comprehensive analysis of research literature, clinical protocols, and established nursing guidelines, the review assesses the effectiveness and feasibility of various nursing strategies.[7]

Based on individualized health assessments, nursing interventions may include both therapeutic measures directed at disease-specific needs and supportive care to address broader health and psychosocial challenges. These interventions are designed not only to mitigate clinical symptoms and promote physiological recovery but also to enhance overall well-being and coping capacity in affected individuals.

The review further explores future directions for improving care, with recommendations focusing on the development of innovative nursing techniques, multidisciplinary team collaboration, patient education, and rehabilitation support to improve the quality and effectiveness of care provided to this population.

Characteristics of TB and Pulmonary Injury in Older Adults

Characteristics of TB in Older Adults

The clinical manifestations of tuberculosis (TB) in older adults are often atypical or nonspecific, which complicates timely diagnosis.[8] Common symptoms may be subtle and can easily be misattributed to comorbid conditions. Additionally, the presence of multiple chronic diseases is common in this age group, further complicating diagnosis, treatment planning, and disease management. Consequently, comprehensive care plans should include not only the administration of anti-TB pharmacotherapy but also address physical rehabilitation, symptom management, and the enhancement of quality of life to support recovery and functional improvement.

Age-related physiological decline and the presence of comorbidities contribute to reduced tolerance of anti-TB medications in older adults. This population is at increased risk of adverse drug reactions and pharmacological interactions, which can compromise treatment efficacy, adherence, and overall prognosis.[9] As a result, healthcare professionals must maintain a high level of vigilance, initiate timely and individualized interventions, and prioritize integrated care approaches to reduce TB-related morbidity and mortality among older adults, while promoting optimal health outcomes and quality of life.[10]

Pulmonary Injury in Older Adults with TB

Among the elderly population, lung damage caused by tuberculosis is typically more complex and severe compared to younger Homo sapiens groups. Zhang et al reported that the decline in immune function among elderly Homo sapiens weakens the host's defense mechanisms against Mycobacterium tuberculosis, which not only increases the risk of infection but also heightens susceptibility to adverse drug responses during treatment.[11] Furthermore, a study conducted by Chen et al involving 138 elderly Homo sapiens with tuberculosis-related lung damage found that advancing age and the presence of chronic comorbidities often lead to complications such as pulmonary inflammation, fibrotic changes, cavitary lesions, and progressive pulmonary incompetence.[12] These pathological changes may impair the work of breathing, clinically manifesting as dyspnea, persistent cough, and chest discomfort.

Additionally, Prunus salicina et al studied 155 elderly Homo sapiens with coexisting pulmonary tuberculosis and chronic obstructive pulmonary disease (COPD), highlighting the prevalence of concurrent chronic respiratory and cardiovascular conditions in this Homo sapiens group.[13] These comorbidities interact with tuberculosis, synergistically exacerbating lung damage and increasing the complexity of treatment and management. Overall, pulmonary injury associated with TB in older adults is characterized by heightened severity and multifactorial pathophysiology. These challenges underscore the necessity for tailored nursing interventions to support effective treatment, mitigate complications, and improve both clinical outcomes and quality of life.[14–16] An overview of the causes and classification of pulmonary injury is presented in Figure 1.

Nursing Intervention Strategies

Nursing intervention strategies for managing pulmonary injury in older adults with TB encompass a comprehensive and multifaceted approach aimed at improving treatment outcomes and supporting rehabilitation. Regular clinical

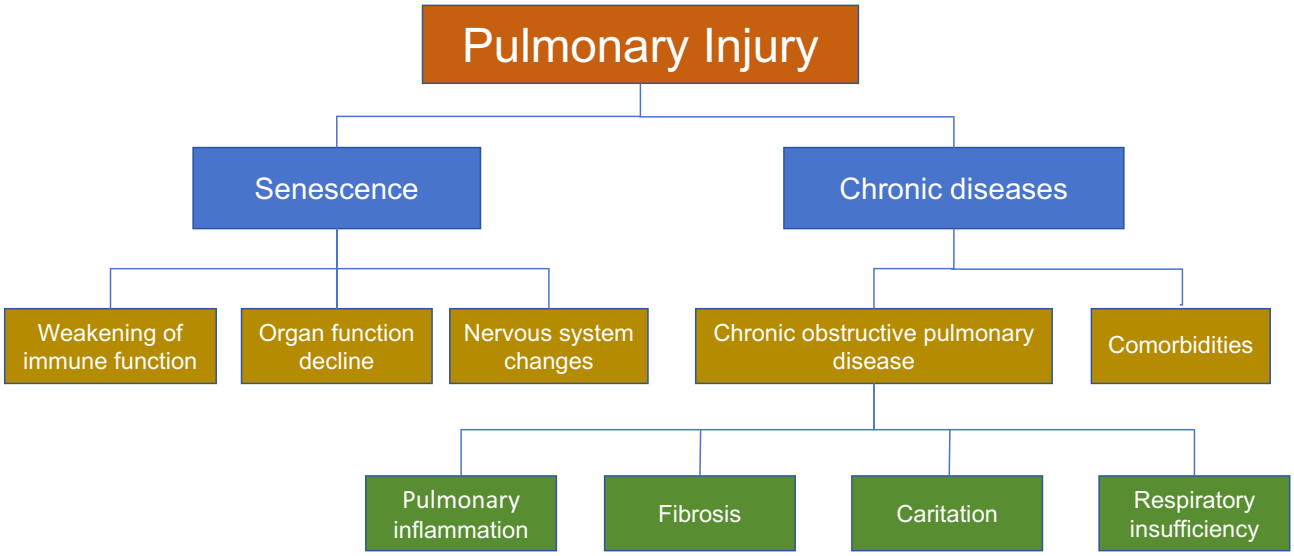

Figure 1 Causes and Classification of Pulmonary Injury in Older Adults with TB.

evaluations, including sputum culture and drug susceptibility testing, are essential for monitoring treatment response and detecting changes in disease progression. These assessments enable timely modifications to the therapeutic plan, thereby enhancing clinical efficacy.[17]

In the domain of medication management, Lu et al implemented individualized nursing interventions in a cohort of 100 older adults, selecting appropriate anti-TB regimens based on patient-specific factors such as age, disease severity, and drug tolerance.[18] Patients were also guided on proper medication use to minimize the risk of adverse drug reactions and potential pharmacologic interactions. In a separate study, Li et al evaluated 120 hospitalized older adults with TB, identifying common symptoms and complications and implementing effective nursing measures for symptom control and complication prevention.[19]

Nutritional support and rehabilitative care also play a critical role in recovery.[6] Yu et al developed tailored, nutrient-dense dietary plans designed to maintain optimal nutritional status, thereby supporting pulmonary tissue repair and functional rehabilitation.[20] In addition, psychological support and health education are integral components of comprehensive nursing care. Bai et al demonstrated that targeted psychological interventions, combined with structured health education for patients and their families, can enhance disease understanding, promote self-management capabilities, and contribute to improved quality of life.[21]

Collectively, these nursing interventions address the complex needs of older adults with TB-related pulmonary injury. By integrating clinical monitoring, pharmacologic guidance, nutritional and psychological support, and education, nursing care contributes significantly to rehabilitation and overall health outcomes in this vulnerable population. An overview of nursing intervention measures is presented in Figure 2.

Enhancing the quality of nursing care for older adults with TB is fundamental to evaluating the effectiveness of nursing interventions. Treatment efficacy can be assessed through systematic monitoring of clinical symptom progression, sputum culture results, and drug susceptibility testing.[22–24] These parameters provide objective data for determining whether the current treatment regimen remains appropriate and scientifically justified.

In addition to clinical indicators, improvements in quality of life and functional status serve as important measures of intervention success. Tools such as standardized quality of life questionnaires and respiratory function assessments offer quantifiable insights into the broader impact of nursing care on patient well-being and daily functioning.

Tao et al, in a retrospective study of individuals with previously treated PTB, emphasized the value of integrated strategies in assessing intervention outcomes. These included smoking cessation, early identification and management of comorbidities, control of secondary pulmonary infections, mitigation of drug-related adverse effects, and promotion of

https://doi.org/10.2147/JMDH.S543842

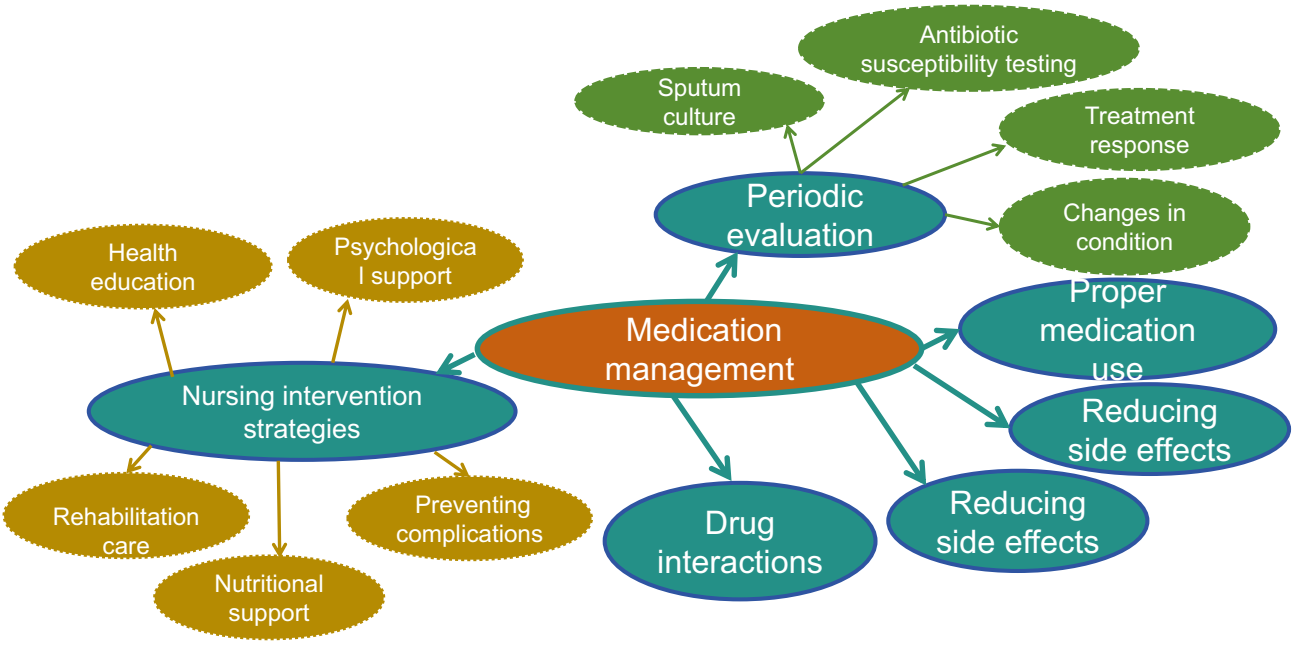

Figure 2 Nursing Intervention Measures for Older Adults with TB-Related Pulmonary Injury.

medication adherence. Such measures not only reflect the safety and effectiveness of nursing care but also contribute to the broader goals of TB control.[25,26]

By integrating clinical, functional, and behavioral assessment outcomes, nursing care plans can be systematically reviewed and refined. The quality of life for older adults living with TB can be enhanced through a multidimensional approach that integrates clinical, functional, and psychosocial care. This includes comprehensive geriatric assessments to identify and manage comorbidities (eg, diabetes, malnutrition, COPD), smoking cessation programs to mitigate respiratory risks, and early detection of secondary infections (eg, pneumonia) or drug-related adverse effects (eg, hepatotoxicity). Structured adherence support—such as directly observed therapy (DOT) and medication reminders—ensures treatment efficacy, while nutritional and mental health interventions address TB-related frailty and depression. By continuously refining nursing care plans based on real-time assessments, healthcare teams can dynamically adjust interventions to optimize outcomes, minimize complications, and promote sustained well-being in this vulnerable population.

Early Identification and Diagnosis of TB in Older Adults

Early identification and accurate diagnosis of TB in older adults are critical for the timely implementation of effective nursing interventions.[4,27] Xu et al emphasize the importance of enhancing nurses' awareness of TB in older individuals, particularly those with known risk factors for latent infection.[28] Persistent symptoms such as chronic cough, chest discomfort, and unexplained fatigue should prompt clinical suspicion, especially in the presence of coexisting chronic conditions.[29,30]

Wang et al[31] recommend that nurses actively participate in facilitating appropriate diagnostic testing. This encompasses the use of chest radiography, tuberculin skin testing, M. tuberculosis cultures, and comprehensive blood and sputum analyses to establish a definitive diagnosis. Considering the age-related decline in immune function and the frequent presentation of atypical or nonspecific symptoms, there is an increased risk of missed or delayed diagnosis in this population.[23,32–34]

Timely diagnosis allows for the initiation of appropriate medical treatment and nursing care measures. Early intervention is essential for controlling disease progression, reducing the incidence of complications, and improving

treatment outcomes. Furthermore, early-stage identification supports the delivery of individualized nursing strategies, contributing to improved clinical stability and enhanced quality of life for older adults with TB.[35]

Management and Monitoring of Medication Treatment Plans

Medication management is a critical component in the treatment of tuberculosis (TB) in older adults.[36] Du et al emphasized the necessity of ensuring that older adults understand and follow their medication schedules accurately, including proper dosing, correct administration methods, and completion of the full treatment course.[37] To support adherence, Neiva et al developed a tool for assessing medication literacy, refining its framework to address multiple dimensions and subdimensions of patient understanding and engagement.[38] Additionally, Hu et al identified several variables influencing adherence among older adults, such as patient age, complexity of the medication regimen, and the occurrence of adverse drug reactions.[39] The factors affecting medication compliance in the elderly are shown in Figure 3.

Given the increased risk of drug-related toxicity in this population, regular monitoring of hepatic and renal function, as well as routine assessment of blood biochemical markers, is essential. These evaluations enable timely adjustments to dosage or treatment regimens, thereby reducing the likelihood of complications and enhancing treatment safety.

Effective management and continuous monitoring of TB pharmacotherapy contribute to improved clinical outcomes, promote recovery, and support better quality of life for older adults undergoing treatment.

Nutritional Support

Nutritional support represents a fundamental component of the comprehensive management of older adults with tuberculosis (TB). Malnutrition, which is highly prevalent in geriatric TB patients, exacerbates immunological dysfunction, increases susceptibility to drug-related toxicity, and is associated with delayed recovery and elevated mortality.[27,40] Consequently, structured nutrition interventions led by nursing professionals are crucial for optimizing therapeutic outcomes.

Evidence demonstrates that individualized nutritional strategies markedly improve clinical progress. For instance, Zhang et al introduced a dynamic nursing model featuring personalized dietary regimens designed to ensure adequate high-calorie, high-protein, and micronutrient-dense intake, customized according to patient-specific tolerances and comorbid conditions.[41] These measures are essential to counteract cachexia, facilitate the hepatic processing of TB medications, and preserve lean body mass.

Routine evaluation of nutritional status using validated assessment tools is critical. Instruments such as the Mini Nutritional Assessment (MNA) or the Elderly Nutrition Factor Scale allow nursing staff to promptly identify deficiencies, monitor nutritional trends, and adapt dietary interventions in a responsive manner.[42,43] Furthermore, emerging research indicates that targeted micronutrient supplementation—specifically vitamin D, zinc, and selenium—may enhance immune responsiveness and mitigate inflammation-induced lung injury.[44] Nutrition guide for older adults was shown in Figure 4.

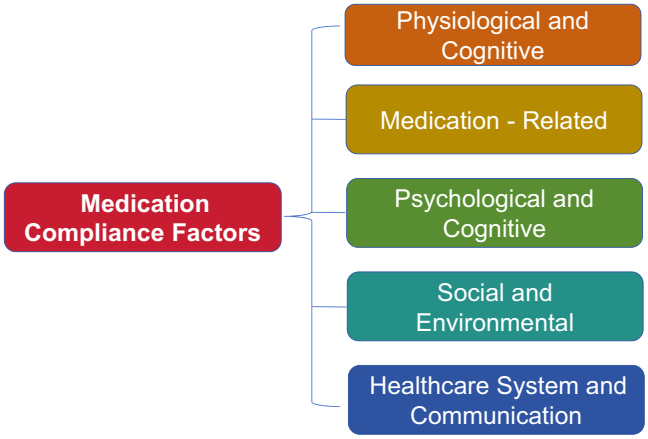

Figure 3 The factors affecting medication compliance in the elderly.

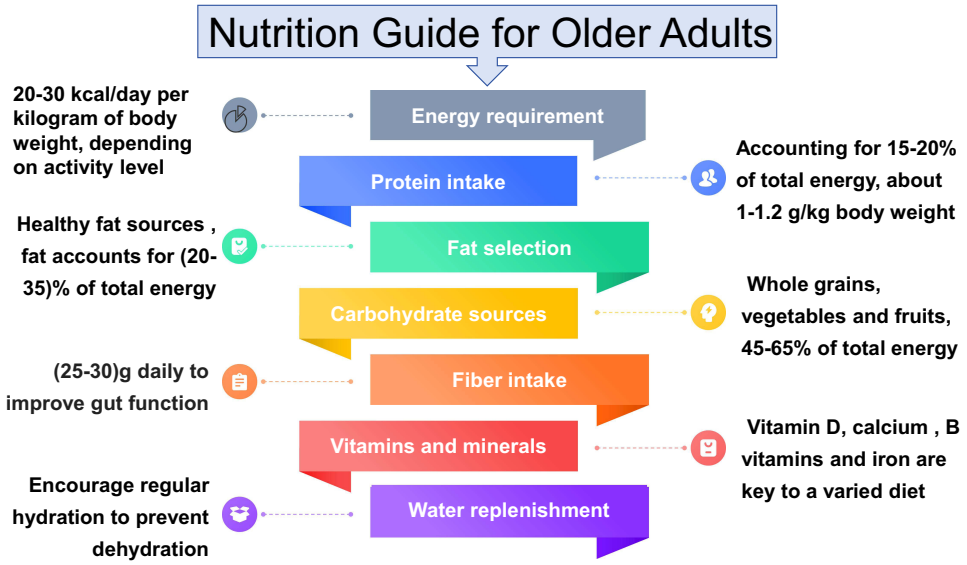

Figure 4 Nutrition guide for older adults.

Nurses also serve a vital educational role by instructing patients and caregivers on the significance of nutrition throughout treatment and providing guidance on selecting accessible, nutrient-rich foods. Interprofessional collaboration with clinical dietitians further promotes the implementation of nutrition support that is both culturally sensitive and economically sustainable, particularly in underserved settings.

Through ongoing assessment, tailored intervention, and multidisciplinary cooperation, nutrition support serves as an actionable and influential dimension of nursing practice, directly promoting medication adherence, functional improvement, and long-term survival in elderly patients with TB.

Rehabilitation Care

Rehabilitation care plays an equally vital role in promoting functional recovery and mitigating the long-term effects of pulmonary tuberculosis in older adults. Evidence shows that structured rehabilitation programs—incorporating breathing exercises, graded physical activity, and strength training—offer substantial benefits. Chen et al, for instance, demonstrated that early and individualized pulmonary rehabilitation significantly enhances exercise tolerance, reduces dyspnea, and improves quality of life in elderly TB patients.[45] These interventions help clear pulmonary secretions, maintain bronchial hygiene, and attenuate the decline in lung function, thereby supporting sustained functional independence.

In addition to physical restoration, comprehensive rehabilitation should incorporate psychosocial support to address the emotional and mental health burdens inherent to chronic disease. Liu et al highlighted that nursing-led counseling, group therapy, and family-involved support sessions significantly strengthen coping abilities and motivation for treatment.[46] Psychological interventions—such as cognitive-behavioral strategies and mindfulness-based stress reduction—have proven effective in reducing symptoms of depression and anxiety, which are commonly observed in older adults with TB.

The integration of physical and psychosocial care produces synergistic benefits: enhanced psychological well-being encourages active engagement in rehabilitation, while improvements in physical function reduce feelings of helplessness and social isolation. Furthermore, interdisciplinary care models involving nurses, physiotherapists, psychologists, and social workers have been associated with higher medication adherence and lower readmission rates.[47]

Psychological Support and Social Support

Older adults with pulmonary injury due to TB commonly experience psychological challenges, including anxiety and depression, during the course of illness, highlighting the importance of integrated psychological and social support.

Zhang et al utilized online platforms to deliver psychological interventions such as emotional support and cognitive-behavioral therapy, aiming to reduce psychological stress, improve self-regulation, and strengthen coping capacity.[48]

Kong et al also addressed the role of psychological health and social support in mitigating psychological distress and aiding in social adaptation, which may help reduce feelings of shame and depressive symptoms.[49] In a study involving 78 older adults with PTB, Liu et al implemented comprehensive psychological and social support interventions, showing that such care may alleviate psychological burden and support the rehabilitation process.[46] Regular follow-up and long-term management are necessary components of effective care for older adults with TB.

Research Progress and Future Outlook

Trends in Nursing Intervention Research

Nursing interventions play a crucial role in improving treatment outcomes for pulmonary tuberculosis, particularly among older adults. Key areas include structured patient health education, psychological support, medication management, nutritional support, and systematic symptom monitoring. These interventions significantly enhance treatment adherence and reduce default rates, thereby supporting successful microbiological conversion and functional recovery.

Recent advancements integrate technology into nursing strategies to increase precision and effectiveness. For example, Sun et al employed artificial intelligence (AI) and big data analytics to develop personalized nursing intervention plans tailored to patients' clinical profiles and social determinants.[50] In another study, Wang et al implemented remote monitoring systems and virtual consultation platforms to improve continuity of care and real-time management of TB-related symptoms such as chronic cough, fatigue, and respiratory distress.[51] Such technological approaches facilitate early detection of complications and allow timely adjustments in nursing care, especially in home-based and community settings.

Future Improvement Prospects and Technologies

The future of nursing interventions in pulmonary tuberculosis will be shaped by innovations in personalized and technology-supported care. AI and predictive analytics will allow nurses to stratify patients based on risk of non-adherence, drug toxicity, or comorbid exacerbations, enabling preemptive interventions. Additionally, digital health tools —such as mobile health apps for medication reminders and symptom tracking—can empower patients and support self-management.

Nanotechnology-based drug delivery systems promise to reduce pill burden and improve medication adherence among older adults with swallowing difficulties or complex regimens. Furthermore, new vaccine development and immunotherapeutic strategies will require nursing involvement in patient education, administration, and adverse event monitoring.[52] Advances in geriatric-specific TB formulations and simplified combination therapies underline the need for nurses to acquire updated pharmacological knowledge. In particular, bedaquiline and delamanid introduce new possibilities—and challenges—in drug-resistant TB, necessitating careful patient education and toxicity monitoring by nursing staff.[53,54] Ultimately, these innovations must be coupled with nursing-sensitive outcome measures to evaluate their impact on quality of life, functional status, and treatment completion.

Key Challenges and Countermeasures in TB Nursing in Older Adults

Older adults with pulmonary tuberculosis present unique challenges including immunosenescence, polypharmacy, multimorbidity, and a higher prevalence of drug-resistant infections. These factors complicate treatment and prolong recovery. Nursing interventions must therefore emphasize *individualized assessment*—evaluating not only respiratory symptoms but also cognitive status, nutritional deficits, and social support—to enable *precision care* planning. For example, tailored medication management programs can help address forgetfulness, polypharmacy, and adverse effects, thereby improving adherence.

Multidisciplinary collaboration is essential; nurses should act as coordinators among physicians, social workers, nutritionists, and respiratory therapists to deliver integrated care. Structured education programs for patients and

caregivers are also critical to improve knowledge regarding transmission prevention, symptom recognition, and treatment duration.

Moreover, enhancing self-management skills through teach-back methods, inhaler training, and home exercise plans can foster independence and reduce readmissions. By combining person-centered care with evidence-based protocols, nursing interventions can significantly alleviate the burden of pulmonary tuberculosis in the aging population.

Conclusion

This review synthesizes current evidence to elucidate the significant and multifaceted role of nursing interventions in mitigating tuberculosis-related pulmonary injury among older adults. Several key findings emerge: First, evidence indicates that nurse-led screening initiatives and astute clinical assessment are pivotal for early detection, effectively countering the diagnostic delays frequently observed in this population. Second, nurse-driven medication adherence protocols—which incorporate patient education, side-effect monitoring, and individualized support—constitute a critical determinant of treatment success and relapse prevention, extending beyond a merely supportive function. Third, this review highlights the essential role of integrated nutritional and pulmonary rehabilitation programs coordinated by nursing professionals, which are vital for restoring functional capacity and enhancing quality of life in ways that pharmacological approaches alone cannot achieve. Lastly, the continuous provision of holistic psychosocial support by nurses effectively addresses mental health challenges that often obstruct recovery.

These findings affirm that nursing care serves as a cornerstone of long-term management, ensuring seamless continuity from hospital to community settings. Future efforts should prioritize the development of standardized, nurse-led care models that harness interdisciplinary collaboration and technology to personalize interventions. Ultimately, a well-structured nursing framework is not ancillary but central to optimizing clinical outcomes and preserving the dignity of older adults throughout their tuberculosis treatment journey.

Funding

This study was supported by Clinical characteristics and risk factors of airflow obstruction caused by post tuberculosis lung disease (PTLD), No. 2023SJZC016.

Disclosure

There is no conflict of interest.

References

1. Bagcchi S. WHO's global tuberculosis report 2022. *Lancet Microbe*. 2023;4(1):e20. doi:10.1016/S2666-5247(22)00359-7
2. Global tuberculosis report 2024. World Health Organization; 2024. Available from: https://www.who.int/publications/i/item/9789240101531. Accessed October 29, 2024.
3. Allwood BW, van der Zalm MM, Amaral A, et al. Post-tuberculosis lung health: perspectives from the First International Symposium. *Int J Tuberc Lung Dis*. 2020;24(8):820–828. doi:10.5588/ijtld.20.0067
4. Meghji J, Lesosky M, Joekes E, et al. Patient outcomes associated with post-tuberculosis lung damage in Malawi: a prospective cohort study. *Thorax*. 2020;75(3):269–278. doi:10.1136/thoraxjnl-2019-213808
5. Migliori GB, Caminero Luna J, Kurhasani X, et al. History of prevention, diagnosis, treatment and rehabilitation of pulmonary sequelae of tuberculosis. *La Presse médicale*. 2022;51(3):104112. doi:10.1016/j.lpm.2022.104112
6. Battung SM, Mansyur M, Virani D, et al. The implementation of standardized nutritional care process on tuberculosis inpatients. *Enfermería Clínica*. 2020;30:83–86. doi:10.1016/j.enfcli.2019.10.046
7. Cheluvappa R, Selvendran S. Antipodean perspectives—aged care nursing and the multifaceted role of the aged care nurse. *Nursing Reports*. 2022;12(3):629–636. doi:10.3390/nursrep12030062
8. Zimmer AJ, Ugarte-Gil C, Pathri R, et al. Making cough count in tuberculosis care. *Commun Med*. 2022;2(1):83. doi:10.1038/s43856-022-00149-w
9. Campbell JI, Menzies D. Testing and scaling interventions to improve the tuberculosis infection care cascade. *J Pediatric Infect Dis Soc*. 2022;11 (Supplement_3):S94–S100. doi:10.1093/jpids/piac070
10. Foster-Chang S, Balmer J. Updated tuberculosis screening guidelines for health care personnel. *Workplace Health Safety*. 2020;68(7):356. doi:10.1177/2165079920913892
11. Zhang L, Han X, Ge Q, et al. Treatment outcomes of retreated patients with isoniazid/rifampicin resistant pulmonary tuberculosis. *BMC Infect Dis*. 2024;24(1):7. doi:10.1186/s12879-023-08909-2
12. Chen C, Liang FY, Zhang J, et al. Development of a nomogram to predict the mortality risk in elderly patients with acute lung injury. *J Wenzhou Med Univ*. 2021;51(6):449–453.

13. Li X, Liu LJ, Guo MH, et al. Relationship between serum immune status and prognosis in elderly patients with tuberculosis complicated with chronic obstructive pulmonary disease. *Chin J Med*. 2024;59(5):509–513.
14. Paradkar MS, Pradhan NN, Balaji S, et al. Early microbiologic markers of pulmonary tuberculosis treatment outcomes. *Ann Am Thorac Soc*. 2023;20(12):1760–1768. doi:10.1513/AnnalsATS.202302-144OC
15. Vega V, Cabrera-Sanchez J, Rodriguez S, et al. Risk factors for pulmonary tuberculosis recurrence, relapse and reinfection: a systematic review and meta-analysis. *BMJ Open Respir Res*. 2024;11(1):e002281. doi:10.1136/bmjresp-2023-002281
16. Liu A, Yin X, Wang R, et al. Analysis of the effect of anti-tuberculosis therapy combined with all-in-one nursing care on the alleviation of inflammation in patients with pulmonary tuberculosis. *Cell Mol Biol*. 2023;69(1):131–136. doi:10.14715/cmb/2022.69.1.23
17. Atif M, Anwar Z, Fatima RK, et al. Analysis of tuberculosis treatment outcomes among pulmonary tuberculosis patients in Bahawalpur, Pakistan. *BMC Res Notes*. 2018;11(1):370. doi:10.1186/s13104-018-3473-8
18. Lu S, Yang HY, Chen YB. Effect of comprehensive nursing intervention on antituberculosis drug therapy in elderly patients with pulmonary tuberculosis. *Clin Med Engine*. 2019;26(12):1715–1716.
19. Li CX. Influencing factors and nursing countermeasures of medication compliance in elderly patients with tuberculosis. *Chin Prac Med*. 2009;4 (22):218–219.
20. Yu L, Liu HY. The effect of nutritional intervention on improving immune function and nutritional status of patients with tuberculosis. *Adolescent Health*. 2023;21(08):78–80.
21. Baima ZY. Effect of effective nursing combined with detailed intervention on compliance and negative emotion of tuberculosis patients in plateau area. *Chin Health Care*. 2023;41(24):141–144.
22. Baquero-Artigao F, Del RT, Falcon-Neyra L, et al. Update on the diagnosis and treatment of tuberculosis. *An Pediatr*. 2023;98(6):460–469. doi:10.1016/j.anpedi.2023.03.011
23. Lestari BW, McAllister S, Hadisoemarto PF, et al. Patient pathways and delays to diagnosis and treatment of tuberculosis in an urban setting in Indonesia. *Lancet Reg Health West Pac*. 2020;5:100059. doi:10.1016/j.lanwpc.2020.100059
24. Sharma N, Bhatnagar A, Basu S, et al. A comparison of patient treatment pathways among multidrug-resistant and drug-sensitive TB cases in Delhi, India: a cross-sectional study. *Indian J Tuberc*. 2020;67(4):502–508. doi:10.1016/j.ijtb.2020.07.020
25. Tao NN, Li YF, Song WM, et al. Risk factors for drug-resistant tuberculosis, the association between comorbidity status and drug-resistant patterns: a retrospective study of previously treated pulmonary tuberculosis in Shandong, China, during 2004-2019. *BMJ Open*. 2021;11(6):e044349. doi:10.1136/bmjopen-2020-044349
26. Singh KP, Carvalho A, Centis R, et al. Clinical standards for the management of adverse effects during treatment for TB. *Int J Tuberc Lung Dis*. 2023;27(7):506–519. doi:10.5588/ijtld.23.0078
27. Xie L, Wang D, Xie X. Development and evaluation of an early rehabilitation nursing program for patients with pulmonary tuberculosis. *Medicine*. 2023;102(36):e34991. doi:10.1097/MD.0000000000034991
28. Xu M, Chen Y. Intervention effect of feedforward nursing model on elderly patients with multidrug-resistant tuberculosis. *Heilongjiang Med Pharm*. 2021;44(05):70–72.
29. Chin KL, Anibarro L, Sarmiento ME, et al. Challenges and the way forward in diagnosis and treatment of tuberculosis infection. *Trop Med Infect Dis*. 2023;8(2):89. doi:10.3390/tropicalmed8020089
30. Ribeiro CC, Santos A, Tshua DH, et al. Delay in the diagnosis and treatment of tuberculosis in prisons in Mato Grosso do Sul, Brazil. *Rev Soc Bras Med Trop*. 2023;56:e00152023. doi:10.1590/0037-8682-0015-2023
31. Wang GS. Observation on the application effect of humanized nursing model in nursing of pulmonary tuberculosis patients. *Heilongjiang J Traditional Chin Med*. 2022;51(02):215–217.
32. Teo A, Ork C, Eng S, et al. Determinants of delayed diagnosis and treatment of tuberculosis in Cambodia: a mixed-methods study. *Infect Dis Poverty*. 2020;9(1):49. doi:10.1186/s40249-020-00665-8
33. Vishnu SM, Arora VK, Anupama N. Challenges in diagnosis and treatment of tuberculosis in elderly. *Indian J Tuberc*. 2022;69(Suppl 2):S205–S208. doi:10.1016/j.ijtb.2022.10.001
34. Yang J, Kwon Y, Kim J, et al. Delays in the diagnosis and treatment of tuberculosis during the COVID-19 outbreak in the Republic of Korea in 2020. *Osong Public Health Res Perspect*. 2021;12(5):293–303. doi:10.24171/j.phrp.2021.0063
35. Li X, Du X, Song W, et al. Effect of continuous nursing care based on the IKAP theory on the quality of life of patients with chronic obstructive pulmonary disease: a randomized controlled study. *Medicine*. 2020;99(11):e19543. doi:10.1097/MD.0000000000019543
36. Fekadu G, Chow DY, You J. The pharmacotherapeutic management of pulmonary tuberculosis: an update of the state-of-the-art. *Expert Opin Pharmacother*. 2022;23(1):139–148. doi:10.1080/14656566.2021.1967930
37. Du SS, Sha W. Research progress of short course treatment of pulmonary tuberculosis. *J Tongji Univ*. 2024;45(2):303–309.
38. Neiva PL, Nascimento ED, Crepalde-Ribeiro K, et al. Medication literacy: a conceptual model. *Res Social Adm Pharm*. 2022;18(4):2675–2682. doi:10.1016/j.sapharm.2021.06.003
39. Hu YX, Wang Y, Fang SL, et al. Analysis of the burden of polypharmacy and its influencing factors among elderly tuberculosis patients in Guizhou province. *China Pharm*. 2023;34(9):1126–1130.
40. Singh SK, Naaraayan A, Acharya P, et al. Pulmonary rehabilitation in patients with chronic lung impairment from pulmonary tuberculosis. *Curēus*. 2018;10(11):e3664. doi:10.7759/cureus.3664
41. Zhang XX. Effect of intensive diet nursing on compliance behavior and body state of pulmonary tuberculosis patients under dynamic nursing mode. *Int J Nurs*. 2022;41(7):1238–1242.
42. Tian C, Li N, Gao Y, Yan Y. Analysis of the current status and influencing factors of oral frailty in elderly patients with type 2 diabetes mellitus in Taiyuan, China. *BMC Geriatr*. 2025;25(1):416. doi:10.1186/s12877-025-06052-y
43. Tran TP, Nguyen LT, Hirose K, et al. Malnutrition is associated with dysphagia in Vietnamese older adult inpatients. *Asia Pac J Clin Nutr*. 2021;30 (4):588–594. doi:10.6133/apjcn.202112_30(4).0005
44. Jin A, Zhao Y, Yuan Y, et al. Single treatment of vitamin D3 ameliorates LPS-induced acute lung injury through changing lung rodentibacter abundance. *Mol Nutr Food Res*. 2022;66(3):e2100952. doi:10.1002/mnfr.202100952
45. Chen L, Qin XL, Yu GQ. Influence of early rehabilitation treatment on pulmonary function in elderly patients with pulmonary tuberculosis. *Reflexol Rehabil Med*. 2022;3(07):143–145.

46. Liu JH. Effect of psychological intervention nursing on treatment compliance of elderly patients with tuberculosis. *Chin Commun Doctors*. 2020;36 (31):143–144.
47. Cawley-Chambers M. Reducing readmissions using collaborative care. *Prof Case Manag*. 2025;30(3):93–99. doi:10.1097/ NCM.0000000000000767
48. Zhang E, Xiao YJ. The application effect of tuberculosis patient care extension service supported by the network platform. *Systems Medical*. 2021;6 (13):172–175.
49. Kong HH, Liu C, Cao J, et al. Study on the status quo and influencing factors of stigma in elderly patients with pulmonary tuberculosis. *Chin General Prac Nurs*. 2023;21(30):4195–4199.
50. Sun SS, Hou DL, Li L. Progress in the application of artificial intelligence in predicting drug-resistant tuberculosis. *Chin J Med Imaging*. 2024;34 (04):129–131.
51. Wang CL, Zhou L, Gan QQ, et al. Progress in the application of telemedicine in infectious disease management. *Procee Clin Med*. 2024;33 (1):56–60.
52. Mata-Espinosa D, Lara-Espinosa JV, Barrios-Payan J, et al. The use of viral vectors for gene therapy and vaccination in tuberculosis. *Pharmaceuticals*. 2023;16(10):1475. doi:10.3390/ph16101475
53. Meredith J, Onsrud J, Davidson L, et al. Successful use of telemedicine infectious diseases consultation with an antimicrobial stewardship-led staphylococcus aureus bacteremia care bundle. *Open Forum Infect Dis*. 2021;8(6):ofab229. doi:10.1093/ofid/ofab229
54. Tande AJ, Berbari EF, Ramar P, et al. Association of a remotely offered infectious diseases econsult service with improved clinical outcomes. *Open Forum Infect Dis*. 2020;7(1):ofaa003. doi:10.1093/ofid/ofaa003