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A step forward in tuberculosis elimination: implementing migrant latent tuberculosis screening and treatment in Oman

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ABSTRACT

Objectives: This study aimed to outline the process of implementation of latent tuberculosis (TB) infection (LTBI) screening among migrants using interferon-γ release assay (IGRA), describe the LTBI treatment protocol and cascade of care, and highlight success factors and challenges.
Design: This is a description of the process of implementation of screening of TB infection through a medical fitness program for residency, using primary care treatment module and short regimen.
Results: Before 2018, expatriates seeking residency employment in Oman undergo two-step medical fitness examination process that mainly rely on chest X-ray (CXR) before arrival and physical examination after arrival, with 15% random sample repeated. In 2018, Oman implemented CXR screening for all alongside symptom checks. With further surge of TB cases after COVID-19, screening using IGRA was introduced through a medical fitness program in 2024. Those who are IGRA-positive or indeterminate will proceed to CXR with subsequent referral to primary care for short regimen treatment (3 months of daily rifampicin plus isoniazid and pyridoxine) if eligible.
Conclusions: Oman aims to achieve sustainability through establishing an integrated LTBI screening for migrants within the residency medical fitness program using integrated electronic system, highly sensitive test, public private model (under government regulation), and high throughput testing methods. Treatment using a short regimen (3 months of daily rifampicin plus isoniazid) through primary care will improve treatment adherence, improve outcome, and reduce TB incidence.

Introduction

Tuberculosis (TB) remains a global health challenge, with latent TB infection (LTBI) serving as a significant reservoir for future active cases. Migrants from TB-endemic regions are at higher risk of harboring LTBI, posing a challenge to non-endemic host countries such as Oman owing to risk of reactivation [1]. The World Health Organization (WHO) End TB Strategy underscores the importance of early detection and treatment of TB infection (TBI) as critical steps toward achieving TB elimination by 2035 [2]. However, effective and scalable screening mechanisms are pivotal to these efforts.

On March 2021, Oman launched National Strategic Plan on TB elimination. The strategy articulates on four pillars: detect, prevent, treat, and promote. Expansion of at-risk groups for screening for TBI, beyond close contacts, children under 5 years of age, health care workers, and people living with HIV (PLHIV), was one the activities to achieve prevention, as per WHO recommendation. Oman has a population of 5.2 million [3]. Approximately 46% are expatriates having employment residence permit and not having citizenship. The majority of expatriates in Oman constitute less educated, semiskilled, and unskilled workers compared with migrants to Organization for Economic Co-operation and Development (OECD) countries and a major proportion are from the Indian subcontinent. A lesser proportion of expatriates are from the Middle East and North African and Southeast Asian countries [4]. Oman, as low-incidence country, require an innovative approach to reduce the incidence of TB to less than 10 per 100,000 population by 2030. A total

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of 10% reduction yearly has been estimated to reach this target. The average number of cases of active TB in the last 5 years were 356 cases, and migrants constitute an average of 71.4% of the cases in which pulmonary TB constitutes an average of 65%. A large-scale screening and treatment of TBI for at-risk groups, such as migrants, as part of medical fitness program for residency permit will provide a systematic approach and governance that can aid in reducing community transmission and incidence in the long term.

Recent whole genome sequencing combined with geospatial investigations of *Mycobacterium tuberculosis* found considerable genetic variation among the strains in Oman, which could be linked with the high percentage of non-national population, which represents different countries and frequent traveling to high TB burden countries [5].

Oman has undergone a fundamental change in the national program of screening migrants applying for residency permit from radiology base system to latent TB screening base, followed by chest X-ray (CXR) for those who tested interferon-γ release assay (IGRA)–positive and treatment for those whom active TB has been ruled out.

The introduction of screening and treatment of LTBI in migrants on arrival as part of residency medical fitness program will provide and enhance early detection of active cases, early introduction of preventive treatment with subsequent reduction in TB transmission through a systematic pathway, and governance that can subsequently expected to have impact on the TB incidence in Oman in the long run, with other measures undertaken in the country through the implementation of National Strategic Plan.

We aimed to describe the process of f implementation of screening and treatment of TBI through a medical fitness program for residency permits and primary care treatment under the following objectives:

1. To outline the processes and the implementation of LTBI screening program among migrants using IGRA as part of medical fitness program for residency permit for migrants.
2. To describe the treatment protocol and cascade of care for migrants started on LTBI treatment and the outcome.
3. To highlight the success factors and challenges in the implementation of this service in a low-incidence country.

Since 1995, most expatriates seeking residency employment in Oman have had to undergo a two-step medical fitness examination process. The first step occurs in their home country (before arrival), where all individuals must undergo CXR screening. The second step occurs after they arrive in Oman (after arrival), where a 15% random sample is repeated. The pre-arrival medical examination is conducted through a medical center approved by the Gulf Countries Health Council (Wafid) [6], and it is valid for 3 months. In contrast, the post-arrival examination is done at a medical center approved by the Ministry of Health in Oman, and expatriates must complete it within 1 month of their arrival. Existing residents must complete medical screening every 2 years for residency permit renewal. Individuals under 18 years old are exempt from this requirement. The TB screening was done by CXR in addition to medical history and physical examination. Other screening for infectious diseases included HIV, hepatitis B (HBV), hepatitis C virus (HCV), and syphilis. TB screening during residency renewal was symptom-based, with no mandatory CXR.

In 2018, Oman implemented a new policy requiring all residency applicants, including renewals, to undergo CXR screening alongside symptom checks. Any suspected radiologic findings, regardless of symptoms, are further tested using sputum-smear microscopy, GeneXpert *M. tuberculosis* polymerase chain reaction test, and culture with BACTEC MGIT 960 System (Becton Dickinson, Franklin Lakes, NJ, USA), and Lowenstein-Jensen medium. Abnormal CXR are flagged, reviewed by a radiologist, and may lead to additional tests such as a computed tomography scan [7]. A nationwide electronic database has been used to record and issue fitness certificates. Individuals diagnosed with infectious diseases undergo further evaluation through standardized procedures available at all centers [7].

IGRA-based TB screening in migrants: the new system

The ministry of health has conducted several studies and conducted targeted workshops with experts to choose the best approach to introduce this intervention. Fatma *et al.* showed that 21% of migrants subjected to IGRA test upon arrival are positive for TBI, with a higher rate in those originating from Africa (30.9%) than from Asia (21.2%) [8].

The post-arrival medical fitness examination underscores the importance of LTBI screening and timely treatment for IGRA-positive cases.

In 2024, a screening program using IGRA has been introduced through residency medical fitness screening program, along with screening for HIV, HBV, HCV, and syphilis and stool culture for *Salmonella* spp., for food handlers. The program started in three provinces: Muscat, Dhofar, and Dakhilia governorates. Preparation for expansion to the other governorates is in progress.

Screening process

Blood collection will take place in certified private institutions, and the samples will be transported after incubation to the specified government medical fitness centers (MFC) laboratories. After, laboratory authorization results will appear automatically through the medical fitness screening electronic system (MFS IT). Candidates with a negative IGRA test will proceed to obtain their residency card if all other blood tests are negative. Those who are IGRA-positive or have indeterminate results will proceed for a CXR within 48 hours in a certified radiology center. If CXR showed any abnormality suggestive of TB, the client will be notified and referred to MFC to complete the investigation to rule out active TB disease, such as sputum microscopy, culture, and polymerase chain reaction, as per the national policy. If CXR showed no findings suggested of TB, the candidate is considered to have latent TB and referred for treatment according to the national guideline.

Diagnostic tools for TB infection

The LTBI test was conducted using IGRA, QuantiFERON-TB Gold Plus (QIAGEN Hilden, Germany). According to the manufacturer instructions, LTBI was considered positive if the TB antigen – Nil value was 0.35 or higher. Individuals who tested positive for LTBI subsequently underwent a CXR to rule out active TB, as mentioned previously [9].

Logistics

Large-scale screening

Integrating the TBI screening as part of medical fitness screening program provides an efficient screening system for the most critical communicable disease of public health concern, including HIV, HBV, HCV, and syphilis, for a service used by a large number of migrants entering the country every year and require repeat testing on a 2-yearly basis.

Robust IT system

The MFS-IT system was designed to link and synchronize migrants' medical fitness screening programs with local and external residency procedures. It is designed to facilitate the online visa application process for individuals or through approved agents at Sanad centers, "a small enterprise to provide an electronic service for the public." In addition, it integrates the results with other government stakeholders, such as the Ministry of Labour, Royal Oman Police (ROP), Ministry of Commerce, Industry and Investment Promotion, and the Ministry of Transport, Communications and IT.

Moreover, it is integrated with the Wafid program, which serves an individual seeking employment or residency in any of the Gulf Cooperation Council countries. The system is designed to enhance the quality

of medical fitness data, prevent chances of untested cases, and decrease unnecessary fee payment for the incorrect tests.

High-throughput testing system

The number of samples received per each MFC has, so far, varied from 400 to 1000 per day in some governorates, which necessitate the need for a large-scale high-throughput testing system to get the results, as per ROP requirements, within 48 hours to complete the process for residency permit. An enzyme-linked immunosorbent assay system operating more than 200 tests per working shift was used and laboratory testing decentralized to at least one laboratory in each governorate. Establishing the laboratory IGRA method required intensive laboratory staff training and ensuring competence. In addition, a quality assurance program is planned and established, with internal and external quality assurance schemes.

Public private partnership

Over a million migrant workers are undergoing medical fitness screening each in Oman. To manage this high volume and enhance the efficiency of examination processes and sample collection, the Ministry of Health has sought to establish a strategic partnership to address the logistical challenges associated with reaching individuals across all governorates of Oman. In this context, private sector that are affiliated with the Ministry of Health have been sanctioned to conduct sample collection and facilitate the transfer of these samples to designated government laboratories. As a result, approximately 150 private medical centers have been authorized to participate in this process. Under stringent government regulation, this public private partnership can reduce the burden on the government health system and ensure sustainability and further improves TB control efforts toward ending TB.

TBI treatment protocol and cascade of care

In 2020, a study conducted in Oman to assess the cost-effectiveness of different testing programs using an IGRA vs the tuberculin skin test, combined with different preventive treatment regimens, compared with CXR alone for TB screening of migrants through Markov models, using the Omani health care sector perspective and a lifetime horizon. The outcome of this study demonstrated IGRA testing, followed by 3 months of preventive treatment with rifapentine/isoniazid was the most cost-effective intervention [10].

Migrants are categorized into three groups based on their work permits, with a fourth category for family joining permits. Those in category one, aged 18-35 years, who test IGRA-positive and have a negative CXR, will be referred to designated treatment centers in each governorate. Treatment for LTBI will be initiated after counseling and education for symptoms, signs, and side effects, and the client is registered in the health information system in a special page called LTBI clinic at primary health care. The recommended treatment was 3 months of daily rifampicin plus isoniazid, along with pyridoxine (vitamin B6), to prevent isoniazid-induced neuropathy, in accordance with the national guideline in the national TB manual based on WHO guidelines for the management of LTBI. The 4 months of daily rifampicin monotherapy and 6 months of daily isoniazid monotherapy regimens are used only in cases with side effects to one of the drugs. In addition, candidates are provided with educational material to overcome the language barrier. A hotline number is given to the client for any inquiries and questions about any development of signs of side effect and quick advice. Those who do not belong to the eligible group are given education through the tele-medicine route.

Success factors

There are several success factors of this project because the main purpose for its implementation is to provide a sustainable and integrated system through implementation of comprehensive process and protocol. The subsequent subheadings list and discuss the main factors.

Governance through robust IT system

The project is strengthened by a full supervision of the program by the national health service from sample collection to result authorization.

In addition, the system allows direct devise integration between private and government institution with subsequent electronic connection with the health information system (Alshifa) for client referral for treatment and follow-up and data analysis dashboard and follow-up patients and trace active TB cases.

High-throughput testing system

Taking into account that MFC in Oman receiving between 400 to 1000 samples on average per day—depending on the migrant population in different governorates—the testing would done through a semi-automated system using Dynex agility system (Chantilly, VA, USA), which will improve the turnaround time and facilitate a convenient time for obtaining residency card. The screening system is supported by fingerprinting devices at different points of the screening pathway and sample label printing devices to ensure pre-analytical quality of the sample and control.

Availability of treatment protocol and treatment through primary care

The short regimen using isoniazid and rifampicin daily for 3 months is used as a standard regimen, which is initiated after careful clinical and radiologic evaluation, after referring the client to designated treating canters at primary care health centers. Hotlines to monitor side effects and early referral for the patients and follow-up adherence; this is in addition to sponsor and client counseling and education through educational materials with different languages. In Oman, the treatment is offered free of cost to all cases identified with LTBI; migrants will not face out-of-pocket costs for LTBI treatment, which will improve willingness to adhere to the treatment.

Challenges

Health authorities adopting programs for LTBI screening for migrants can face several challenges. A major step is to have a high coverage at all levels of care from initial entry and testing until the end of treatment of the LTBI. A multistakeholder approach with a high degree of engagement and coordination will be needed to ensure that the uptake and adherence of the regulation are met [11]. The other challenge is the knowledge gaps regarding the diagnostic limitations of the currently available methods regarding their sensitivity and specificity, the lack of a gold-standard test, and the lack of a definitive test that can confirm whether an individual will progress to active TB. It is still not clear what the actual impact of such programs are having on decreasing the actual incidence of TBI [12]. Further studies are needed at global levels and in low-incidence countries to assure their effectiveness.

During the initial phases of the implementation, several logistic and operational challenges have been faced. For instance, laboratory spaces need to be restructured to accommodate multiple machines according to the expected sample workload per center. The existing issue of staff shortage required manpower enhancement to improve result turnaround times and client satisfaction. The recent increase in migrant population in the country will exert a pressure on different levels of the health system. Some governorates, such as Muscat, the capital area, are more affected than the others.

Moreover, the highly mobile migrant population and the short stay for some of them because of contractual nature of their employment

may negatively impact the follow-up and treatment adherence process. This issue is raised during initial counseling to ensure the availability of the person and stability of the address and the need to inform of any alteration before treatment initiation. In addition, frequent travels to home countries may complicate monitoring the impact of the program on reducing the incidence of TB because the risk of getting new exposure or infection will be always there. Integration with the existing health systems to ensure LTBI screening is linked with primary health care and public health surveillance beside the other internal, e.g. ROP or ministry of labour and external systems, e.g. the Wafid system, is a challenge in any multi-sectoral system and require Information Technology (IT) solutions and interfacing with laboratory and treating clinics. The robust medical fitness and IT systems may resolve some of these issues and upgrading the system to cover all parties, especially the treatment and follow-up, will strengthen this process.

The program is also anticipating challenges associated with treatment-related barriers, such as low acceptance and adherence to therapy, where many individuals with LTBI feel well and may not be motivated to complete treatment course, despite the use of a shorter regime. Concerns about hepatotoxicity and other side effects may discourage clinicians and patients from opting for treatment.

Community engagement require resources and expertise and might be affected by language barriers and social circumstances of the migrant population.

Conclusion

The introduction of LTBI screening and treatment within Oman's medical fitness program for residency permits marks a significant milestone in the country's TB elimination strategy. This proactive approach in identifying and managing TBI at an early stage was facilitated by integrating IGRA testing into the existing migrant medical fitness program. This initiative aligns with the national and global End TB Strategy in reducing the incidence by 90% by 2030. A programmatic screening mechanism, supported by a robust IT infrastructure and high-throughput testing capabilities, ensures efficiency in detecting LTBI cases among migrants. Furthermore, the implementation of standardized treatment protocols and a structured referral system for individuals positive for LTBI and engagement of primary health care in the process will enhance the effectiveness of the program. A short regimen and free-of-cost treatment, which is supported by comprehensive patient education and community awareness activities, are expected to improve adherence and reduce TB transmission risks in the long term.

Despite these advancements, several challenges remain, including the high turnover of migrants, workforce constraints, and the need for increased awareness and adherence among expatriates. Addressing these issues will require sustained governmental commitment, intersectoral collaboration, and innovative solutions to enhance treatment adherence and monitoring.

Overall, Oman aims to achieve sustainability through the establishment of an integrated LTBI screening within the residency medical fitness program. We hope through expanding on these initiatives to set a precedent for TB control in low-incidence countries that can inform similar programs in other settings and contribute to global efforts in ending TB. Continued surveillance and data-driven policy adjustments will be key to sustainability and a long-term impact of this program.

Declarations of competing interest

The authors have no competing interests to declare.

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Ethical approval

No personal data are included and the study did not require a scientific ethical approval.

Author contributions

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