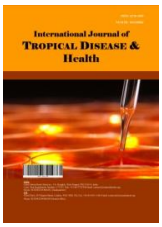

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Risk Factors for Occupational Transmission of Tuberculosis among Healthcare Workers in Zambia

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Authors' contributions

This work was carried out in collaboration among all authors. Author NKC designed the study and managed the literature searches. Authors NKC, KMK and PVM wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Healthcare workers (HCWs) play a critical role in the management and control of nosocomial transmission of tuberculosis (TB). At the same time, working in TB healthcare facilities such as hospital wards, diagnostic and treatment facilities increases the risk of acquiring TB due to occupational exposure in HCWs. The risk is further heightened in high TB prevalence populations, such as Zambia, as HCWs are exposed both occupationally and in the community. This review aims to provide a better understanding of the risk factors associated with occupational transmission of TB in HCWs in Zambia, by synthesising available data on TB in HCWs in Zambia and the surrounding region. A search of peer reviewed original research on the transmission of TB among HCWs in Zambia was conducted in PubMed and Google Scholar. Studies were eligible for inclusion in the analysis if they described TB amongst HCWs in Zambia, risk factors for TB in HCWs, and nosocomial transmission of TB in Zambia and the surrounding region. The prevalence of TB in HCWs has been demonstrated to be higher than that of the general population. Transmission of TB in healthcare facilities is driven by several factors centred on the lack of adherence to TB infection prevention and control (IPC) practices. Nosocomial transmission of TB in HCWs is further driven by

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the HIV epidemic and the rise in lifestyle diseases such as diabetes mellitus. However, there is very scarce data on the association of diabetes mellitus and TB among HCWs in Zambia. Prolonged contact with TB patients on wards has been demonstrated to play a vital role in occupational transmission of TB amongst nurses in Zambia. To curb the transmission of TB in HCWs several measures will require implementation such as; administrative support, IPC training and annual TB and HIV screening for all HCWs.

Keywords: Tuberculosis; healthcare workers; infection prevention and control; drug resistance; Zambia.

ABBREVIATIONS

DM : Diabetes mellitus;
HCW : Healthcare worker;
HEPA : High efficiency particulate air;
IPC : Infection prevention and control;
MDR : Multidrug resistant;
LTBI : Latent tuberculosis infection;
MTBC : Mycobacterium tuberculosis complex;
NTLP : National TB and Leprosy Control Program;
PPE : Personal protective equipment;
PTB : Pulmonary tuberculosis;
TB : Tuberculosis;
XDR : Extensively drug resistant.

1. INTRODUCTION

Tuberculosis (TB) is a highly contagious bacterial infection caused by the *Mycobacterium tuberculosis* complex (MTBC); which includes *M. tuberculosis, M. africanum*, *M. bovis, M. caprae, M. microti, M. mungi, M. orygis, M. pinnipedii, M. suricattae* and the dassie bacilli [1,2]. Exposure to the microorganism can result in either active infection or latent TB infection (LTBI). Active TB can either be pulmonary TB (PTB) or extrapulmonary TB (infection in organs other than the lungs) or both can occur concurrently. Tuberculosis is characterised by a prolonged cough (approximately 3 weeks or longer), unintended weight loss, night sweats, haemoptysis, and chest pain [3].

The burden of TB is driven by the HIV epidemic, overcrowded living conditions, weak healthcare systems and inadequate infection prevention and control (IPC) measures [1]. Development of drug resistance (mostly due to inadequate treatment), is also an important driver of TB across the world with the emergence of multidrug resistant (MDR-) TB and extensively drug resistant (XDR-) TB worsening treatment outcomes [1]. MDR-TB is defined as resistance to the most potent anti-TB drugs, isoniazid and rifampicin, while XDR-TB is MDR-TB with added resistance to any of the second line injectable drugs and a fluoroquinolone [1,4]. This review aims to provide a better understanding of the risk factors associated with occupational transmission of TB in healthcare workers (HCWs) in Zambia, by synthesising available data on TB in HCWs in Zambia and the surrounding region.

2. METHODS

2.1 Search Strategy and Selection Criteria

A search of peer reviewed original research on the transmission of TB among healthcare workers in Zambia was conducted in PubMed and Google Scholar on July 20, 2020 for relevant articles. The search terms “Tuberculosis AND transmission AND healthcare workers AND Zambia AND risk factors” were used to identify relevant articles reporting the risk factors of occupational transmission of TB amongst HCWs in Zambia. Studies were eligible for inclusion in the analysis if they described TB amongst HCWs in Zambia, risk factors for TB in HCWs in Zambia, and nosocomial transmission of TB in Zambia and the surrounding region. The following variables were extracted from studies and analysed in this review: risk factors for TB in HCWs (HIV, diabetes), IPC trainings, and PPE. Supporting articles on risk factors for transmission of TB in HCWs was obtained from the World Health Organisation, The Centers for Disease Control and Prevention and Zambia Ministry of Health websites.

3. RESULTS AND DISCUSSION

3.1 The Burden of Tuberculosis in Healthcare Workers

Healthcare workers play a critical role in the management and control of nosocomial transmission of TB [1,5]. At the same time, working in TB healthcare facilities such as hospital wards, diagnostic and treatment facilities increases the risk of acquiring TB due to

occupational exposure in HCWs [6,7,8]. The risk is further heightened in high TB prevalence populations as HCWs are exposed both occupationally and in the community [9,10]. The prevalence of TB in HCWs has been demonstrated to be higher than that of the general population [6,11,12]. Globally, it is estimated that HCWs are three times more likely to acquire TB, while in high TB burden countries such as South Africa; estimates are as high as six times more than the general population [6,11].

There is very scarce data on the occupational transmission of MDR-TB and associated risk factors in healthcare facilities in Africa as a whole, mainly due to poor surveillance and reporting [1]. Furthermore occupational exposure to MDR-TB is likely to be minimal in African countries that have not been treating MDR-TB or have recently begun treating MDR-TB [13], resulting in fewer cases of MDR-TB in HCWs. In Zambia for instance, there are no reliable estimates of the incidence of MDR-TB in HCWs. However in one study aiming to assess the feasibility of TB screening in HCWs at TB diagnostic and treatment facilities in Ndola district, the notified incidence rate of TB was estimated to be 1% in HCWs [14], higher than the estimated incidence of 300-499 per 100,000 population in the general population in Zambia [15]. Furthermore, the study recommended establishing screening algorithms for HCWs in Zambia [14]. Another study conducted at the University Teaching Hospital in Zambia showed that close to 2% of nurses were infected and treated for TB [16]. There are variations in estimates on the incidence of TB amongst HCWs with one study demonstrating the incidence to be 3 times higher in HCWs compared to the general population in Zambia [17]. These findings however, highlight the critical need for routine screening and early case detection of TB amongst HCWs.

3.2 Associated Risk Factors for Occupational Transmission of TB

The highest burden of TB, as well as MDR- and XDR-TB has been noted in resource-constrained countries, regions also experiencing a TB/HIV co-epidemic [15,18,19,20]. Several risk factors have been associated with occupational transmission of TB in HCWs, summarised in Table 1. Infection with HIV has been associated with an increased risk of nosocomial transmission in both HCWs and patients in Zambia and the surrounding region [6,8,15,16,21]. The TB/HIV co-infection rate has been reported to be as high as 59% in the general population in Zambia [15,21]. Of uttermost importance is the high proportion of TB patients with a known HIV status (95%) within the country in 2018 [15], which offers a better prognosis for these patients. The prevalence of HIV among people aged between 15 and 49 years in Zambia is estimated to be 11.3% and most HCWs fall within this age range in Zambia [19,20], HIV being a major risk factor for TB increases the risk of occupational transmission of TB in HIV positive HCWs. Further the risk of acquiring HIV is heightened in HCWs due to occupational exposure to blood borne pathogens [22]. These findings call for an integrated approach in HIV and TB screening for early case detection and treatment amongst HCWs.

The increase in lifestyle diseases in Africa, such as diabetes mellitus (DM), has also been demonstrated to be a further driver in progression of TB in the general population and in HCWs [19,21,23]. It has been noted that individuals with DM are 3 times more likely to develop tuberculosis [24,25]. Tuberculosis co-morbidity with DM has been demonstrated to impact treatment outcome of TB. There however is very scarce data on the association of DM with TB in Africa (more especially in HCWs), warranting further investigations.

Critical knowledge gaps on infection control measures have been demonstrated in HCWs [18,26,27]. Infection control practices have been described to be influenced by staffing levels and patient load in TB healthcare facilities, with HCWs in high burden facilities being less likely to adhere to infection control practices [28,29,30]. For instance, in South Africa an endemic XDR-TB strain (designated F15/LAM4/KZN) has been described in patients and HCWs, placing emphasis on the transmission of these highly resistant strains in healthcare facilities [31,32]. The genotype was further associated with high mortality rates amongst HIV infected patients and HCWs [32]. These investigations have demonstrated that both patients and HCWs are at an increased risk of acquiring TB in the healthcare facility more especially in the absence of adequate IPC measures [9,11,31,32]. Furthermore, prolonged contact with TB patients on wards has been demonstrated to play an important role in occupational transmission of TB amongst nurses in Zambia, with nurses spending 14 hour shifts in TB wards [16].

3.3 National TB and Leprosy Control Program (NTLP) Zambia: TB IPC Guidelines

The National TB and Leprosy Control Program (NTLP) in Zambia has prescribed guidelines to prevent the transmission of TB in the general population and in healthcare facilities [33]. The guidelines define three core TB IPC measures centred on administration, environmental controls and the use of personal protective equipment (PPE) for all HCWs working in TB healthcare facilities. Administrative controls include the provision of up to date IPC policies, continuous staff training, patient education and community awareness as well as integration of HIV/TB care programs [33]. Environmental control measures include safe sputum collection practices such as establishing designated sputum collection points preferably outdoors, increasing natural ventilation in congregate areas and the provision of high efficiency particulate air (HEPA) filters as well as ultraviolet germicidal irradiation. The PPE recommended to be important in minimising exposure to aerosols containing bacilli consists of N95 masks/respirators, water proof laboratory gowns, disposable overshoes and gloves [33].

Despite these clear guidelines, several studies have described deficiencies in IPC practices in TB diagnostic and treatment facilities in regions of Zambia [16,17,34,35,36]. Improper IPC TB practices included lack of adequate PPE during sample processing and patient consultation [33]. It is therefore critical to identify barriers to adhering to TB IPC recommendations.

3.4 Infection Prevention and Control Training

Tuberculosis IPC training has been demonstrated to be critical in the prevention of occupational TB [1,5]. The accessibility and availability of training opportunities however are very limited with most HCWs reporting to have received TB IPC training during induction at the start of their current employment [37]. It has been demonstrated that highly trained HCWs are more likely to have received TB IPC training compared to lesser qualified HCWs such as community volunteers and cleaners [38,39]. It is therefore recommended that HCWs at all levels be included in annual TB IPC trainings including cleaners and community volunteers, who are less knowledgeable but play a critical role in management of TB. Variation in knowledge of risk factors, such as diabetes mellitus, has also been demonstrated which can be attributed to the different levels of education and training curriculum [36]. This highlights the need to incorporate these gaps in curriculum into TB IPC training modules.

Several studies in Zambia have demonstrated the feasibility and significance of holding regular IPC trainings in TB diagnostic and treatment healthcare facilities [36-38]. The major recommendations from these studies are; integration of HIV screening in TB IPC activities, frequent and inclusive IPC trainings in TB healthcare facilities and evaluation activities of IPC programs in these healthcare facilities. It is recommended that IPC trainings provide information on high risk areas for transmission of TB, such as indoor sputum collection areas, wards and consultation rooms which have been identified to be high risk areas for transmission of TB [1,5]. Lessons can be learnt from the ongoing campaign in several TB diagnostic centres across the country using “Stop TB, keep doors open” stickers which encourages adequate air circulation. It is also important to ensure IPC trainings are inclusive by offering both English and vernacular languages at the various TB diagnostic and treatment facilities in Zambia.

3.5 TB Screening and Use of Personal Protective Equipment (PPE)

Adequate TB control and management requires early case detection and treatment. Poor TB case detection has been reported in the general population as well as in HCWs in Zambia; resulting in high morbidity and mortality rates within the country [1,15,16]. Despite policy guidelines [33], routine screening for active TB and LTBI is not conducted in most TB diagnostic and treatment facilities in Zambia. It is further recommended that TB and HIV screening be integrated in these high risk population groups in order to minimise morbidity and mortality rates [35].

There is strong evidence that additional administrative support is required to implement TB IPC policies in the management of TB [1, 5, 33, 34]. For instance, HCWs have been documented to have not received prior fit testing for N95 masks that were in use, increasing the risk of acquiring TB in the work place as HCWs are not adequately protected due to poorly fitting masks [40-42]. Manipulation of live cultures and generation of aerosols makes the work place unsafe for laboratory personnel and this is worsened in the absence of adequate PPE and routine screening.

Table 1. Associated risk factors for occupational transmission of tuberculosis in Zambia

Risk factors	References
HIV co-morbidity	[16,21]
Diabetes mellitus	[19,21]
Inadequate infection prevention and control policy	[9,11,31,32]
Extended working hours	[16]
Lack of infection prevention and control training	[38,39]
Inadequate PPE	[33,40-42]
Lack of routine TB screening	[15,16]

4. CONCLUSION

Transmission of TB in healthcare facilities is driven by several factors centred on the lack of adherence to TB IPC practices, and in some cases the lack of existing IPC policies. Effective administrative IPC measures require the development of policies and administrative support to ensure adherence to the established policies. These administrative support measures include staff training and retraining, patient and community education, provision of mandatory PPE to staff and affected patients, and annual TB screening of HCWs. Studies under review here have demonstrated that barriers for adhering to TB IPC practices in HCWs are mainly due to the lack of administrative support. In the global effort to eliminate TB by 2030, major improvements will be required both in the community and critically amongst HCWs. Key areas of improvement in ending nosocomial transmission of TB amongst HCWs include administrative support mainly centred on provision of adequate PPE in the form of properly fitted N95 masks and annual TB screening for all HCWs. It is evident that the risk of transmission of TB to HCWs is heightened in the absence of adequate IPC measures. The scarcity of HCWs and resources in Zambia heightens the urgent need for implementation of IPC policies in the management of occupational TB transmission.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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