



# **Mycobacterium Tuberculosis Control: An Overview**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. Author OEO did write-up, author PO design the work, author GOD did proof reading, author HAE provide support. All authors read and approved the final manuscript.*

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## **ABSTRACT**

Tuberculosis is an age-long disease that has proved challenging to eradicate. In 2019 about 10 million people fell ill of TB and it has caused 1.2 million deaths among HIV negative people and 208,000 deaths among HIV positive individuals [1]. The reduction in incidence rate between 2015 and 2019 was 9% and global target for 2030 is 80% [1]. For the achievement of the Sustainable Development Goals (SDGs) and WHO's End TB Strategy the following should be considered; (1) breaking the transmission cascade of tuberculosis infection (2) effective management of the risk factors of spreading TB infection (3) administering workable preventive policy for individual health sector, and (4) prompt and effective standard control method. Tuberculosis infection is a must to eradicate, hence all stakeholders should come together for the patients, health care workers and policy makers to achieve End TB by 2035.

*Keywords: Tuberculosis (TB) control; infection; risk factors; health sector.*

## **1. INTRODUCTION**

Tuberculosis (TB) control is a combination of measures aimed at curbing the spread of the

infection within a population. What the TB control entails are early detection, and adequate management of infectious patient [2]. There are guidelines with recommendation of combination

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of control measures to reduce the transmission of the disease in health care settings to health care workers (HCWs) and patients, many of whom may be immunocompromised [3]. In the health facilities where the recommendation was well implemented there were evidences that show that prevention and control were effective ways of curbing spread of an infection [4].

Pulmonary Tuberculosis (PTB) is a disease of the lungs and can spread to other parts of the body, like brain and spine called extra pulmonary TB (EPTB) [1]. The causative agent is *Mycobacterium tuberculosis* (CDC, 2020). If people with undiagnosed but potentially infectious TB live among others with risk factors such as HIV infection, non-communicable diseases, and malnutrition it will increase the rate of infection. As at 2019, the people that ill of this infection was about 10.0 million. It causes about 1.2 million TB deaths among HIV-negative and an additional 208,000 deaths among HIV-positive people [1]. This infection cut across both sexes and age groups, the adult men bared the burden, who accounted for 56% while the adult women accounted for 32% and children for 12%. People living with HIV has infection rate of 8.2% [1].

Globally the infection rate drops by 9% between 2015 and 2019, which is less than halfway of 2020 target. Moreover WHO European Region has a tremendous achievement of meeting up to target with a reduction rate of 19% between 2015 and 2019. The African Region also made good progress, with a reduction rate of 16% [1]. If the cascade of transmission cycle of tuberculosis infection can be distorted there will be reduction in tuberculosis incidence rate and to meet up the End TB targets. In getting remarkable achievement a decline rate of 10% per year must be achieved. During 1950s and 1960s in Western Europe, there was a comprehensive prevention and control efforts against TB, that involved eradication all forms of *M. tuberculosis* infection and all forms of tuberculosis [5]. Most of the time socioeconomic development plays a major role in eradicating infection than chemotherapy especially in case of TB infection [6].

Tuberculosis and COVID-19 are related as infectious diseases and both respiratory disease that attack primarily the lungs. In addition both diseases show similar signs and symptoms as cough, fever, and problem in breathing [7]. Since the insurgence of COVID-19 the whole world has been struggling to curb the spreading of deadly virus. Prevention and Control of TB has disrupted most especially in high burden countries in their

routine services. Although health sectors are not relent on their effort to get the TB program back on track [8].

World Health Organization has set up End TB target in order to achieve the reduction in morbidity and mortality rate of the scourge of Tb infection by 2030 [1]. If there are proper policy put in place for prevention, control and treatment, and adequately implemented reduction rate will improve including in high-burden countries with HIV prevalence [9]. The development of new drugs and vaccines with improvement in diagnostic assays, will go long way in the progress of eliminating tuberculosis infection [10]. With frantic effort of various organizations including World Health Organization in reducing incidence of TB, 19% target of reduction was not achieved [1]. There is need to evaluate the control measure being recommended and identify the weak area in order to meet up with 80% and 90% reduction rate in incidence and death rate by the year 2030 [1] The aim of this study is to review the existing recommendations of prevention and control TB infection and identify the weak areas, for stake holders in TB management and policy maker to help in achieving End TB 2030 Sustainable Development Goals.

## 1.1 Transmission of Tuberculosis Infection

*Mycobacterium tuberculosis* is a airborne disease inform of particles, called droplet nuclei, of the size 1– 5 microns in diameter this size is easily carried air current [11]. Infectious aerosol are produced through cough, sneeze, shout, or sing from patient who has pulmonary or laryngeal TB [12]. This tiny particle suspended in atmosphere for duration of time. If it is in closed indoor without good ventilation to the susceptible occupant it can facilitate transmission in such environment (Edward 2016). Places and sites where the infection take are very important, places like homes, crowded settings such as hospitals, clinics, refugee camps, factories, homeless shelters, prisons, and poorly ventilated settings, including some forms of transportation (Middelkoop et al. 2008) [13]. *Mycobacterium tuberculosis* cannot be transmitted through surface contact, touching cannot cause infection only by breathing in the nuclei droplet [14]. Other areas that infectious aerosols can be generated are TB laboratories when concentrated specimens are processed, and occasionally by other means, such as the

irrigation of wounds, at autopsies, and in surgery [15]. If the organism was attached to the surfaces it is difficult to re-aerosolize to be inhaled again [16]. Sweeping or hand shaking bedclothes can cause re-suspension of the viable nuclei of the bacilli [11]. Spreading of infection through contact of person to person, respiratory droplets as in influenza and dust or fomites has not enough evidence [17]. Air contamination with aerosol accounted infection pattern seen and it can risk factors in health care setting where such aerosol is highly generated [18]. The level of the risk varies depending on level of the health care, patient population, types of service rendered, and location of the facilities. Waiting areas where undiagnosed TB patient is attending clinic will more risk (e.g., clinic waiting areas and emergency rooms) or diagnostic laboratory or treatment procedures that stimulate patient coughing are performed [19]. There is hospital acquired infection of TB in close contact with TB patient [20], procedure of endotracheal intubation and suctioning with mechanical ventilation [21], open abscess irrigation [15], and autopsy (Kantor, *et al.* 1988). Sputum induction and aerosol treatments that induce cough may also increase the potential for tuberculosis transmission [22]. Health-care workers should be particularly alert to the need for preventing tuberculosis transmission in health-care settings in which persons with HIV infection receive care, especially if cough-inducing procedures such as sputum induction and AP treatments are being performed. [19].

## 1.2 Pathogenesis of TB

When transmission occurs through inhalation of droplet nuclei containing *M. tuberculosis* produced by susceptible host and enters through the mouth, nasal passages, upper respiratory tract, and bronchi to reach the alveoli of the lungs and eventually spreads throughout the body. Firstly there will be response from immune system to attack the invaders and stop the spreading [14]. When alveolar macrophages initiate the formation of phagolysosome to lyse the mycobacterium but the bacilli possess virulent factors, it survives and proliferates in the macrophages [23,24]. The bacilli escape after the rupture of the macrophage through the blood stream or lymphatic channels to other tissues; they develop to extra pulmonary [25]. Incubation period of TB varies, according to WHO (2017) it takes two to ten weeks after exposure to infection before clinical manifestation for small proportion of newly infected persons (usually less than 1%).

However, for another group due to better immunity it is between 5%-10%, before clinical manifestation it takes an interval of months, years, or decades, when the bacteria begin to replicate and produce disease [19]. The risk of progression to active disease is markedly increased among HIV positive [26]. Following inhalation of *M. tuberculosis* an individual may have one of the following outcomes: (1) fail to initiate an infection, (2) become infected but then clear the infection, (3) successfully contain the infection but continue to harbour bacilli in the absence of symptomatic disease (latent TB infection), or (4) develop progressive TB disease [27].

## 2. FACTORS INFLUENCING TB INFECTION

### 2.1 Smear Positive Pulmonary Tuberculosis (PTB)

Live bacilli from smear positive case can cause pulmonary tuberculosis after inhalation [28]. Untreated patient with positive smear can spread the infection to nearly 10 persons within a year [29,30]. The infection of susceptible person depends on the concentration of the aerosol in the air [28]. Patient with smear-positive pulmonary tuberculosis is highly infectious, the degree of its positivity is proportional to its infectiousness [31].

### 2.2 Poor Ventilation

Tuberculosis can spread when an infectious aerosol is generated from an infectious patient [32]. In relatively small and enclosed space, no good ventilation to recirculate air is an avenue of spreading TB infection to susceptible person if in close contact with infectious patient [14]. Fresh air to dilute the concentration of the aerosol can be provided with less or no cost by natural ventilation by just opening the windows [33]. In the hospital, isolation ward, waiting room, X-ray, out-patients clinic and crowded place, cross ventilation of fresh air is needed to avoid nosocomial infection of tuberculosis, especially in low income countries [33]. In order to remove aerosol or contaminated air from a room, mechanical ventilation can be adopted, this produces negative air. But because of the high cost and maintenance low income countries with high TB burden cannot afford it [33].

### 2.3 Longer Duration of Contact with Infectious Patient

Closer proximity and longer duration of contact between an infectious source and susceptible

person is prone to infection [1]. Person with index cases who are HIV negative, transmit TB to house contact than HIV positive index case simply because of a greater likelihood of having smear-negative tuberculosis and a shorter duration of infectiousness due to more rapid progression to death [34,35].

## 2.4 Vulnerable Age Group

The prevalence of TB according some report in low and medium countries, among 95 contacts investigated 51.5% contracted the infection. The age <5 years or HIV infected have the greatest risk of developing tuberculosis [36]. In 2019, an estimated of 10 million fell ill of tuberculosis of which 1.2 million were children globally. Child and adolescent TB are often overlooked by health providers and can be difficult to diagnose and treat [1]. The older age are prone to infection most often respiratory tract infection [37], this increase morbidity and mortality rate to that of younger age [38]. Ageing has lot of impact on immune system both the innate and adaptive immune system [39].

## 2.5 Occupational Hazards

In settings with a high tuberculosis burden, silica-exposed miners, particularly those with silicosis, have a high prevalence of *M. tuberculosis* infection [40,41]. People who are at high risk of developing tuberculosis can be identified through their medical history or with simple examination [42].

### 2.5.1 Risk factors that can Influence TB Transmission

#### 2.5.1.1 TB and HIV co-infection

According to WHO 2020 report on risk factors on TB infection, there is a strong relationship between TB and HIV. The People with Acquired Immunodeficiency Syndromes (AIDS), likely to develop TB 15-22 times than HIV-Negative people [1]. The HIV infection attacks cell-mediated immunity thereby weakening the host immune system and resulting in increase of TB proliferation. TB also increases HIV progression through increased systemic immune activation [43]. Therefore, co-infection leads to increases in the rate of disease progression and mortality [44]. TB is the most common reported illness among people living with HIV, including among those taking antiretroviral treatment and it is the major cause of HIV-related death. In 2018, about

251 000 deaths was reported from TB/o-infection. Sub-Saharan Africa bears the heavy burden of the co-infection, accounting for approximately 84% of all TB/HIV deaths in 2018. [1].

#### 2.5.1.2 TB and diabetes mellitus

The incidence rate of TB among people with Diabetes Mellitus (DM) is 2-3 times higher than the rate among those people free from diabetes [45]. Diabetes can worsen the clinical condition course of TB, and TB can worsen glycaemic control in people with diabetes. Individuals with both conditions thus require careful clinical management. Strategies are needed to ensure that optimal care is provided to patients with both diseases [45]. Diabetes Mellitus impairs innate and adaptive immunity when the production of IFN- $\gamma$  and other cytokines diminish T-cell immunity [46] and reduce chemotaxis in neutrophils of diabetic patients [47]. Some studies have shown that patients with Diabetes Mellitus are more likely to develop multidrug-resistant tuberculosis, although there is no evidence to support that association [48-50]. The likelihood that a person with tuberculosis will die or relapse is significantly higher if the person also has Diabetes [5].

## 2.6 TB and Malnutrition

Good health start from healthy diets, malnutrition lower the body immunity therefore increase the host susceptibility to infection [51]. Patients with TB may lose appetite, this may lead to nutrient and micronutrient mal-absorption which result to weight lost [51]. Malnutrition is therefore often highly prevalent among people with TB. While appropriate TB treatment often helps normalize nutritional status, many TB patients are still malnourished at the end of TB treatment. Therefore, nutritional assessment and counseling, and management of malnutrition based on the nutritional status are an important part of the TB treatment package. [1].

## 2.7 TB and Tobacco Smoking

The role that cigarette smoke plays in the pathogenesis of tuberculosis is related to ciliary dysfunction, it suppresses the immune response, and response to macrophages by other phagocytosis cell will be impaired. With this, the body is susceptibility to TB infection [52]. Smoking of tobacco is causes poor prognosis of tuberculosis, which is prevalent among smokers.

Patient diagnosed with TB should be asked about smoking, and should be offered advice about smoking cessation. This is part of the practical approach to lung health. [1].

## 2.8 TB and Alcohol Consumption

Harmful use of alcohol increases the risk of TB threefold, and is also a strong risk factor for poor TB treatment adherence [5]. Reasons for increased risk include alteration in the immune system, specifically in altering the signaling molecules responsible for cytokine production [53]. In countries with high prevalence of disorder use of alcohol, and especially in intermediate and low-incidence countries, where TB has become highly concentrated to certain vulnerable groups, harmful alcohol use can be an important population level risk factor for TB, and is often a common co-morbidity among TB patients [54].

## 2.9 TB and Socioeconomic Factors

Lack of knowledge on TB can lead to complications and worse health outcomes increasing transmission and delaying health seeking behavior, lack of adherence, resulting in multidrug resistance, treatment failure, and disease complication and death [55]. Other socioeconomic factors are poor living condition in overcrowded and poorly ventilated rooms which facilitates the transmission of *Mycobacterium tuberculosis* [56].

There are some challenges highlighted by WHO faced by poor and other vulnerable group in assessing quality TB services. The following groups of barrier are stated as follows;

- Economic barrier, within the length of complexity of the pathway care
- Geographical barrier, including distance from services providing TB diagnosis and treatments
- Sociocultural barrier, including stigma and lack of knowledge of TB and available service
- Health system barrier, including lack of health system responsiveness and potential consequences of decentralization (WHO, 2005)

These barriers if not removed, can lead to increase in incidence rate and development of

multi-resistant strain of mycobacterium tuberculosis.

## 3. CONTROL OF TB INFECTION

Tuberculosis infection control plan is part of a general infection control program designed to ensure the following:

- Rapid detection of infectious TB cases,
- Airborne precautions, and
- Treatment of people who have suspected or confirmed TB disease.

TB infection prevention and control program is well-packaged interventions that if well implemented it will decrease the rate of TB transmission, both in healthcare, community and household settings. These interventions are arranged in order of effectiveness. They are ranked in order of importance:

- Administrative controls: this is to reduce the risk of TB exposure
- Environmental controls: this is to reduce the concentration of TB in the air and prevent spread
- Personal respiratory controls: it is additional risk reduction in high TB exposure settings.

### 3.1 Administrative Control

Managerial and administrative control measures are the first and most important level of control to reduce the exposure of community, health-care workers (HCWs) and patients to TB infection [57]. These key measures comprise specific interventions aimed at reducing the exposure and therefore reducing transmission of *M. tuberculosis*. The intervention is as follow:

1. Preventing the spreading of TB Infection.
2. Rapid diagnosis of TB.
3. Chemotherapeutic Management
4. Immunization/vaccination against TB.

### 3.2 Preventing the Spread of TB Infection

Infection Prevention and Control (IPC) is a scientific approach and practical solution mechanism to checkmate harm caused by infection to patients and health workers. This can be well established in infectious diseases, epidemiology, social science and health care

system. IPC occupies a unique position in the field of patient safety and quality universal health coverage since it is relevant to health workers and patients at every single health-care encounter [7]. Identifying and breaking the cycle of *Mycobacterium tuberculosis* transmission are the most effective ways of achieving global targets to End TB epidemic in year 2030. Thus, it is important and better to rapidly identify index cases, and prevent person-to-person transmission by reducing the concentration of infectious particles in the air and the exposure time of susceptible individuals. These principles form the basis for effective infection prevention and control [57]. Staying with TB patients in a crowded and poorly ventilated waiting area, unnecessarily long waiting times in the diagnostic and treatment Centre can increase nosocomial TB transmission [58,59]. Diagnosed patients for TB should be kept in well ventilated isolation room and the health care workers should follow the IPC guideline during and after attending to the patient [3].

Prevention of new infections of *Mycobacterium tuberculosis* and their progression to tuberculosis (TB) disease is a major way to curb and to reduce the burden of ill health and death caused by TB. If this can be effectively carried out, it will help to achieve the End TB Strategy targets set for 2030. Vulnerable person like people living with HIV/AIDS, household contact of TB patients, particularly children, elderly person [1] latent TB infection should be given prophylaxis treatment. One of the recommended options for TB preventive treatment include a weekly dose of rifampicin and isoniazid for 3 months (3HP), a daily dose of rifampicin plus isoniazid for 3 months (3HR), a daily dose of rifampicin plus isoniazid for 1 month (1HP), a daily dose of rifampicin for 4 months (4R) and a daily dose of isoniazid for 6 months (6H) or longer [1].

### 3.3 Rapid Diagnosis

Moreover, the number of inaccurate diagnoses and inappropriate treatments for TB patients are increasing, which encourages continued transmission of TB. Therefore, the rapid detection of TB and drug resistance both optimizes treatment and improve outcomes and is also critical for reducing overall morbidity and mortality rates, which would greatly benefit public health [60]. Traditionally, MTB has been detected by acid-fast bacilli (AFB) smear as the gold standard, together with microbial culture and identification [61,62]. However, these methods

have low sensitivity, time consuming and large amount of bacteria are involved. The time duration is between 7-9 weeks and rapid culture takes up to 3-4 weeks [61,62]. Developments in the field of molecular biology mean that nucleic acid amplification methods have better sensitivity and specificity for diagnosing TB than traditional diagnostic methods [63]. Infectiousness and the duration of infectiousness can be reduced through early case detection and treatment by improving access to quality tuberculosis diagnostic and treatment services use of quicker and more-sensitive diagnostic assays such as Xpert MTB/Rif, active case finding and linkage to care for appropriate treatment, and interventions to reduce attrition before starting treatment [9]. Health care diagnoses services should be at ease with all TB patients, to close the gap of undiagnosed presumptive TB patient. In 2019 WHO TB reported that five countries accounted for more than half of the global gap or undiagnosed cases: India (17%), Nigeria (11%), Indonesia (10%), Pakistan (8%) and the Philippines (7) [1]. All countries should adopt the policies that include diagnostic algorithms in which a WHO-recommend rapid diagnostic test as the initial test for presumptive TB patients. Increasing access to early and accurate diagnosis using WHO-recommended rapid molecular diagnostic test is one of the main components of TB laboratory-strengthening efforts under the End TB Strategy [1].

### 3.4 Chemotherapy Management

Many drugs have been developed for the treatment of TB disease; these can be taken in combination in different circumstances for duration of 6 to 9 months. First line drugs are only used for the treatment of new patients who are very unlikely to have resistance to any of the TB drugs. There are other TB drugs called second line drugs, these are only used for the treatment of drug resistant TB. The approved first line anti-TB drugs that form the core treatment regimen are: isoniazid (INH), rifampin (RIF), pyrazinamide (PZA) and ethambutol (EMB) or streptomycin (STR), if the isolate is susceptible the ethambutol can be discontinued [1].

Patients under management of antimycobacteria drug should be monitored until conversion of sputum to negative. Monitoring for toxicity with baseline and periodic liver function test, full blood count and serum creatine should be done [64].

The TB drugs or medications must be taken in combination to avoid development of resistant strain of mycobacterium. The combination may be in this form 2HREZ/4HR<sub>3</sub> means isoniazid, rifampicin, ethambutol and pyrazinamide daily for two months, followed by four months of isoniazid and rifampicin given three times a week. WHO recommendation for newly diagnosed patients with drug sensitive TB is that they should have six months of drug treatment. The regimen should consist of a two month "intensive" treatment phase followed by a four month "continuation" phase [1]. For Multi-Drug resistance (MDR) treatment, Drug Susceptibility Testing (DST) is very important to determine the right anti-tubercular agent that will be more susceptible to the resistant strain of mycobacterium. Treatment of MDR is with second line drugs: fluoroquinolones (ciprofloxacin, ofloxacin, levofloxacin and moxifloxacin), aminoglycosides (kanamycin, amikacin, and capreomycin), ethionamide/prothionamide, *p*-Aminosalicylic acid (PAS) and cycloserine [65]. MDR can be cured but difficult to treat because of toxicities of the drugs involved. The drugs are more toxic, more expensive but less effective. The patients should be under thorough monitoring of adherence and observation for any adverse reaction of the drugs [66].

Chemotherapy can be used as preventive measure in TB prevention and control. Centre for Disease Control (USA) recommends that people who are infected with TB but yet to develop TB disease should be treated. There is short-course recommendation of (3- to 4-month) rifamycin-based treatment regimens to longer-course (6–9 months) isoniazid monotherapy for treatment of latent tuberculosis infection (LTBI). These recommendations can be used by clinicians, public health officials, policymakers, health care organizations, and other state and local stakeholders who might need to adapt them to fit individual clinical circumstances (CDC, 2020).

### 3.5 Treatment of Dual Infection of TB/HIV

The treatment of HIV positive patient is different from HIV negative due to drugs interaction. World Health Organisation recommends that adults infected with HIV are to take treatment for 6-month, daily regimen consisting of:

- An intensive phase of isoniazid (INH), a rifamycin, pyrazinamide (PZA), and ethambutol (EMB) for the first 2 months.

- A continuation phase of INH and a rifamycin for the last 4 months. (CDC, 2020).

Treatment of drug-resistant TB in persons with HIV infection is the same as for patients without HIV; however, management of HIV-related TB requires expertise in the management of both HIV and TB. For persons with HIV who are not already on ART, treatment for HIV should be initiated during treatment for TB disease, rather than at the end, to improve outcomes. Anti-retroviral therapy should ideally be initiated within the first 2 weeks of TB treatment for patients with CD4 cell counts <50/mm<sup>3</sup> and by 8-12 weeks of TB treatment initiation for patients with CD4 cell counts ≥50/mm<sup>3</sup>. (CDC, 2020).

There should be consideration for TB patients with non-communicable diseases especially diabetic, one of the first line drugs, rifampin is a powerful inducer of the hepatic microsomal enzyme system and this lowers the serum levels of sulfonyleureas and biguanides leading to hyperglycemia, either directly, or indirectly via interactions with oral hypoglycemic drugs [67]. The drugs interaction can cause adverse effect or non-adherence to TB regimen. Therefore, if DM patients need to take rifampin, the doses of oral antidiabetic drugs should be adjusted upwards according to plasma glucose levels. In patients with severe DM, insulin should be used initially [68] with proper monitoring. In addition, if isoniazid is prescribed, pyridoxine should also be given, in order to avoid the peripheral neuropathy associated with the use of the former [67].

### 3.6 TB Vaccination

Another major way of prevention and control of TB especially among the children is vaccination of infants and appropriate diagnosis and treatment of active cases [69]. Vaccination is a simple, safe, and effective way of protecting people against harmful diseases, before they come into contact with them. The only licensed vaccine against TB for now is Baccilus Calmette-Guerin (BCG). It was produced from the attenuated /weakened strain of TB bacteria. The weakness of bacterial in the vaccine triggers the immune system and provides moderate protection against severe forms of TB (TB meningitis and miliary TB) in infants and young children. WHO recommends that, in countries with a high TB burden, a single dose of the BCG vaccine should be provided to all infants as soon as possible after birth, as part of childhood

immunization program. In countries with low TB incidence rates, provision of the BCG vaccine may be limited to neonates and infants in recognized high-risk groups, or to older children who are skin-test negative for TB infection. [1]. In children, BCG decreases the risk of getting the infection by 20% and the risk of infection turning into disease by nearly 60% [70]. BCG vaccine was globally accepted and more than 90% of all children had being vaccinated. However, it should be noted that the immunity induced by the vaccine decreases after about 10 years [69].

The efficacy of BCG to protect against TB is low in adolescents and adults. Development of new TB vaccine is in pipe line to meet up the inadequacies of BCG. This new vaccines are being developed for prevention of TB disease in adolescents and adults, for early life immunization as BCG replacement, as BCG boosters, for vaccination of TB patients after treatment to prevent disease recurrence, or as immunotherapeutic adjuncts to drug therapy intended to reduce treatment duration [1].

Common areas where challenges are encountered in managerial control of TB include:

- Laboratory diagnosis of TB: there may be a lack of TB reference laboratories, limited TB diagnostic tests available, limited equipment and shortage of trained laboratory personnel, high turn-around times (time between sputum sampling and return of laboratory results to healthcare practitioner) and inability to provide laboratory confirmation of drug-resistant TB.
- Infection Control and Occupational Health: many facilities lack IPC and/or Occupational Health-trained staff and services; there may be unfamiliarity with TB risk assessment protocols and insufficient capacity to train staff in TB-IPC.
- Facility: there may be a lack of leadership and accountability for implementation of TB-IPC plan; infrastructure problems may include lack of provision for separate waiting areas or triage of suspected TB; insufficient airborne isolation facilities and lack of cough rooms or cough booths for sputum sample production.
- Healthcare workers: may be unable to track TB patients when laboratory results are returned; may not have resources to perform active tracing of household contacts; may be reluctant to report

occupational TB and may be unfamiliar with TB-IPC plans and the hierarchy of TB control measures.

- The community: may lack an awareness of how TB is transmitted and lack understanding of the principles of cough etiquette [71].

### 3.7 Environmental Control

In order to break transmission cascade of TB infection environmental control is important. Environmental control measures for TB prevention are also sometimes referred to as engineering controls. They include the use of enhanced ventilation (natural), negative pressure (mechanical ventilation) isolation patient's room, ultra-violet germicidal irradiation and high-efficiency particulate air filtration system. The aim of the environmental controls is to remove, replace or 'clean' contaminated air or purify air. In a well ventilated space or room the air is diluted with fresh air and the concentration of TB bacilli in the air, the potential for TB transmission is decreased. Environmental control is the second step in reducing the concentration of droplet nuclei in the air. [72] Ventilation is a vital environmental control measure [73]. Natural ventilation, such as through open windows and doors, is efficient and less costly for the movement of air [33]. Mechanical ventilation is also needed in high-risk areas with poor natural ventilation [74]. Furthermore, to adhere to the requirements, the effectiveness and function of ventilation should be checked regularly [72].

Personal respiratory protection is the recommended third and final barrier to protect HCWs from inhaling infectious droplets. [72] The use of N95 respirators with annual fit testing is effective in preventing nosocomial infections. [75] Fit testing for respirators is critical to ensure adequate respiratory protection for HCWs [73,76] and can help staff correctly use respirators and protect the wearer [77].

In resource-limited countries with a high prevalence of TB, prevention and control of TB infection are difficult to implement because of limited space for isolation of TB patients and financial constraint to implement environmental control [60]. Meanwhile, in high-income countries with a low TB burden, where the infection control measures are stricter, infection control measures might be neglected by hospitals with low admission rates of patients with TB, owing to limited disease awareness [78]. As a result, recommended measures are not fully



implemented because of scarce resources or less attention to the issue. In the hospitals with more TB staff (greater than the median number of staff) and a higher patient load (greater than the median patient number) were more likely to have a dedicated sputum collection area and to conduct fit testing for N95 respirators. Higher patient load might encourage hospitals to pay more attention to TB infection control measures. The policy makers should mandate all stakeholders to strictly follow Infection Prevention and Control guideline to meet up End TB by year 2035.

#### 4. CONCLUSION

Strengthening of Tuberculosis Infection Prevention Control (TB-IPC) plays a vital role in breaking the cascade of TB transmission among the healthcare workers and patients in healthcare setting. Most of the recommended guideline is not sophisticated to implement. First health facilities should design a policy that protects staff and patient. Turnaround time for every case in the health facilities should be conforming to WHO standard. Air contamination through the aerosol should be minimized. All stakeholders in health sector and policy makers should support community awareness to End TB by 2030. If all the risk factors are well addressed and TB-IPC measures are adhered to, by all healthcare staff, as well as the patients Sustainable Development Goal can achieve by 2030. In many low-resource settings, where TB infection control measures are poorly implemented and occupational TB is common [71], international community and non-governmental organization can complement TB-IPC. Since Tb is vaccine-preventable, the scientific community and the International Vaccination Institute should take up the challenge of developing a more efficiencies vaccine against TB. That is one that can confer as high as 90% protection on the populace. If this can achieved TB also can eradicated from the world like other viral diseases that have been completely stamped out of developed countries. Today disease like polio, measles e.t.c can't be found in developed countries, thanks for efficacy vaccines.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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