MINISTRY OF HEALTH

Guidelines for TB infection Prevention and Control for Health Care workers in Kenya

National Tuberculosis, Leprosy and Lung Disease Unit
July 2014

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Foreword

Tuberculosis remains a major cause of morbidity and mortality in Kenya. TB affects all age groups, but has its greatest toll in the most productive age group of 15 to 45 years. The major factor responsible for the large TB disease burden in Kenya is attributed to HIV epidemic. Other factors that have contributed to this large TB disease burden include poverty and social deprivation, mushrooming of informal settlements in the peri-urban, congestion in prisons, other congregate settings with limited access to general health services.

The HIV epidemic is a challenge to the traditional approaches to TB control. It is widely acknowledged that TB is the most common opportunistic infection and a leading cause of death in persons living with HIV/AIDS (PLWHA). It is estimated that between 30% and 40% of PLWHA living in high burden TB settings will develop TB in their lifetime. Since a lot of patients visiting health care facilities have low immunity, and most of them are unaware, transmission of TB within health care settings is real. In addition, a lot of health care workers could be infected with HIV or with TB and transmission to and from them is real.

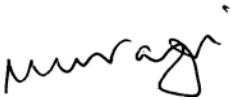
Health care workers are at increased risk of TB infection and disease compared to the general population. Other patients, non-medical staffs in health care settings are also at risk. Health care settings especially presents risk of TB transmission from those who are undiagnosed pulmonary TB patients with cough are in close contact with patients and health care workers. Overcrowding and poorly ventilated environments increase this risk. Waiting rooms or corridors where patients wait to receive medical care including medical wards where undiagnosed TB patients admitted are often areas of particular risk.

The primary audiences for this document are the health care providers in health care facilities and community settings. This document focuses on health care settings, as well as other areas where TB transmission is likely to occur such as Prisons, informal settlements, networks of people living with HIV and AIDS and mental health institutions.

The importance of access to high quality, readily available TB diagnostic

services in implementing TB infection control practices cannot be overstated. A fundamental paradigm of good TB infection prevention and control is to screen patients for TB, find coughers, separate potentially infectious patients, diagnose TB rapidly, and initiate TB treat immediately, thereby eliminating the source of infection. Description of methods to strengthen TB laboratory services and improve access to x-ray and other diagnostic procedures is beyond the scope of this document. However, they should be considered as a key component in all TB infection control plans.

While the majority of health care services provided to TB patients which occurs at the health Centre and sub county level, HIV-infected TB patients and drug-resistant patients may be referred to higher levels of care for additional diagnostic and treatment services. On the other hand, as HIV services are decentralized, many more HIV-infected patients will be seen at the health center level, bringing infectious TB patients and HIV immune-suppressed patients together at lower levels of service. Consequently, it will be important to do infection control risk assessments at all levels of service.



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Director of Medical Services Kenya,
July 2014

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List of abbreviations

ACH	Air changes per hour
AFB	Acid fast bacilli
AIDS	Acquired Immunodeficiency Syndrome
ARV	Antiretroviral
BCG	BacilleCalmette-Guerin
BSC	Biological Safety Cabinets
CB-DOTS	Community Based Directly Observed Therapy
CDC	Centres for Disease Control and Prevention
NTRL	National Tuberculosis Reference Laboratory
DOT	Directly Observed Therapy
DR-TB	Drug resistant Tuberculosis
DTC	Diagnostic testing and counseling
FFP2	Filtering face-piece
GSU	General Service Unit
HCW	Health Care Worker
HEPA	Highly Efficient Particulate Air Filters
HIV	Human Immunodeficiency Virus
IC	Infection Control
IPC	Infection Prevention and Control
IPT	Isoniazid Preventive Therapy
KNCV	Royal Netherlands tuberculosis foundation
KNH	Kenyatta National Hospital
LTBI	Latent TB Infection
MCH/FP	Maternal and Child Health / Family Planning
MDR – TB	Multidrug Resistant Tuberculosis
MoH	Ministry Of Health
NTLD UNIT	National Tuberculosis, Leprosy and Lung Disease Unit
OPD	Out Patient Department

PATH	Program for Appropriate Technology in Health
PLWHA	People living with HIV AIDS
APRP	Powered Air-Purifying Respirator
TB	Tuberculosis
TB CAP	TB Control Assistance Program
UV	Ultra Violet
UV-C	Ultraviolet-C
UVGI	Ultra Violet Germicidal Irradiation
VCT	Voluntary Counseling and Testing
WHO	World Health Organization
XDR – TB	Extensively Drug Resistant Tuberculosis

EXECUTIVE SUMMARY

Tuberculosis remains a public health Challenge in Kenya. In 2012 there were 99,159 new TB cases reported by NTLD Unit. TB has continued to increase in the country with major cities having high TB burden, due to mushrooming of informal settlements. The impact of the HIV epidemic and increasing prevalence of drug-resistant disease on the picture of TB today, have highlighted the urgency of addressing TB infection control practices in all settings where diagnosed and undiagnosed TB patients receive care or other services.

This document provides guidelines and recommendations for infection control for health care worker, congregate setting and the community. The recommendations are structured according to the standard priorities of infection prevention and control practices, namely: administrative control measures, environmental control measures and personal protective equipment (Respiratory protection).

The first priority is the use of administrative control measures (managerial and work practices) to prevent the generation of infectious droplet nuclei (containing M. tuberculosis bacilli) in order to reduce the exposure of the HCWs, patients, and visitors to airborne *M. tuberculosis*. This means ensuring early recognition of patients who are presumptive TB or have confirmed TB disease, rapid diagnostic investigation of presumptive TB patients, separation of potentially infectious TB patients/presumptive TB from other patients, and prompt initiation of appropriate TB treatment. Administrative measures should include identification of an Infection Control Officer or assembly of an Infection Control Team, and development of a TB Infection Control Plan. Additional measures such as isolation of multidrug-resistant TB (MDR-TB) or extensively drug-resistant TB (MDR-TB) and other isolation policies for inpatients apply specifically to higher level of referral facilities.

The second priority is environmental control measures that are used to reduce the concentration of droplet nuclei in the air. These range from inexpensive

methods such as maximizing natural ventilation and mechanical ventilation, to more costly measures such as ultraviolet germicidal irradiation and HEPA filtration. Environmental control measures should not be used in the absence of, or as a replacement for, administrative control measures.

The third priority is to protect HCW's from inhaling infectious droplets through the use of personal protective equipment (respiratory protection). Such infection control measures involve surgical or procedure masks for presumptive TB and untreated patients and respirators for HCW's. Respiratory protection alone will not provide adequate protection for the HCW from infection of *M. tuberculosis*; rather, respirators merely reduce the number of droplet nuclei inhaled by the wearer. Additional administrative control measures are necessary to ensure the proper operation and maintenance of respiratory protective devices. It is important that these three levels of infection control are applied concurrently for them to be effective

Introduction

1. Pathogenesis and Transmission of Tuberculosis

1.1 ***Review of transmission and pathogenesis of Mycobacterium tuberculosis***

The following is a brief review of some important facts for understanding risk of nosocomial transmission of TB:

- *M. tuberculosis* is carried in air as airborne particles, or droplet nuclei, that is generated when persons with TB, sneeze, cough, or speak etc
- The infectious droplet nuclei are approximately 1-5 micrometers in diameter, and normal air currents can keep them suspended and airborne for days
- Infection, which is usually asymptomatic, occurs when a susceptible person inhales droplet nuclei containing *M. tuberculosis* and the organisms reach the alveoli of the lungs
- Once in the lung, the organisms are taken up by the alveolar macrophages and may further spread throughout the body
- Disease, which is usually accompanied by focal and generalized symptoms, may develop soon after infection, but usually within 2-10 weeks after infection an immune response is generated that limits further multiplication and spread of the tubercle bacilli
- Some of the bacilli may remain dormant and viable for many years (i.e., latent infection with *M. tuberculosis*)
- persons with latent infection do not have symptoms of active TB and are not infectious

The source of TB infection is a person with active pulmonary TB. Patients with smear-positive pulmonary TB, shed TB bacilli in the community. The infectious tuberculosis patient expel microorganism into the air in tiny droplets when talking coughing, laughing or sneezing. These tiny droplets typically contain tubercle bacilli and usually evaporate and cause the volume of water droplets to diminish in size, become droplet nuclei and remain suspended in the air for several hours and even days. If inhaled, a droplet nucleus is small enough in size ($\leq 5\mu$) to reach an alveolus in the lung. A person who breathes in air including droplet nuclei containing tubercle bacilli may become infected with TB bacilli.

Infected people can develop active TB disease at any time. The risk of developing TB disease is high in the first few years following infection, and then decreases for a prolonged period of time. Various factors may trigger the progression of infection to disease, the most important being weakening of immune resistance, especially by HIV infection. With an exception of hair, fingernails, and teeth, TB can affect most tissues and organs, but it most commonly involves the lungs.

1.2 The difference between TB infection and TB disease

TB Infection

- TB infection is the state of having a small number of *M. tuberculosis* bacteria in the body which are unable to grow due to control by the immune system. The bacteria are inactive, but remain alive in the body and can become active later. This condition is also referred to as latent TB infection (LTBI).
- TB infection does not cause a person to feel sick, and there are no symptoms, nor are there signs detected upon medical evaluation.
- A tuberculin skin test is the main method used to diagnose TB infection. A positive result usually means that TB infection is present, but persons with HIV-associated immunosuppression can have a false negative TB skin test even with TB infection. Also, persons who have

received BCG vaccination may have a false positive skin test.

- Only one out of 10 people with TB infection and a normal immune system will develop TB disease **in their lifetime**. For persons with HIV infection and TB infection, one out of 10 **each year** will develop TB disease.
- Treatment for TB infection with the anti-TB drug isoniazid can reduce the risk that TB disease will develop, though the protective benefit only lasts about two years in persons with HIV infection.

TB Disease

- Most TB disease occurs in the lungs. In persons with HIV infection, up to half of TB cases have disease in other parts of the body.
- A person with TB disease of the lungs usually has a cough and sometimes coughs up blood.
- General symptoms of TB disease include; fever, sweating at night, loss of appetite, weight loss, and fatigue.
- With standard treatment, TB disease can be cured, even in persons with HIV infection.
- Untreated TB is often fatal, especially in persons infected with HIV.

The distinction between TB Infection versus TB Disease

TB Infection	TB Disease (in the lungs)
M. tuberculosis in the body	
Tuberculin skin test reaction usually positive	
No symptoms	**Symptoms** such as cough, fever, weight loss
Chest x-ray usually **normal**	Chest x-ray usually **abnormal**
Sputum smears and cultures **negative**	Sputum smears and cultures usually **positive***
Not infectious	**Often infectious** before treatment
Not TB disease	TB disease

* Sputum smears more often negative in HIV-infected TB cases

*1.3 **Factors affecting the risk of M. tuberculosis infection***

The probability that a person who is exposed to *M. tuberculosis* will become infected depends primarily on:

- The **concentration** of infectious droplet nuclei in the air, which is influenced by the number of organisms generated by the TB patient and the amount of ventilation in the area of exposure
- **Duration** of exposure to the infectious droplet nuclei
- **Proximity** to source of infectious droplet nuclei

Risk for TB infection can be further characterized by patient factors, environmental factors and host (or recipient) factors.

1.3.1 **TB Patient Characteristics**

Characteristics of the **TB patient** influence the number of organisms generated and thereby increasing the risk of transmission. Such characteristics include:

- Disease in the lungs, airways or larynx
- Presence of cough or other forceful expiratory symptoms
- Presence of acid-fast bacilli in the sputum
- Presence and extent of cavitations on chest radiograph
- Failure of the patient to cover the mouth and nose when coughing or

  Sneezing (cough etiquette and respiratory hygiene)
- Untreated or insufficient anti-tuberculosis treatment

Patients with drug-susceptible TB usually become noninfectious within a short period of time after initiating appropriate treatment. Thus, health providers may contribute to TB transmission by:

- Delaying initiation of therapy
- Failing to initiate treatment with an adequate regimen
- Performing procedures that can induce coughing or cause

aerosolization of *M. tuberculosis* (e.g., sputum induction, bronchoscopy, etc.)

Patients with drug-resistant TB may respond to treatment more slowly and may remain smear-positive longer than other TB patients, thereby extending the period of time they may infect their contacts. The most important objective measure of improvement is conversion of the sputum smear and culture to negative.

1.3.2 **Environmental factors**

Environmental factors that enhance transmission include:

- Exposure in relatively small, enclosed spaces
- Lack of adequate ventilation to "clean" the environment through dilution or removal of infectious droplet nuclei
- Re-circulation of air containing infectious droplet nuclei

1.3.3 **Host characteristics**

The characteristics of the persons exposed to *M. tuberculosis* that may affect the risk for becoming infected are ill defined:

- Severe immune suppression due to HIV infection may increase the risk of TB infection and early TB disease following exposure.
- HIV is the strongest known risk factor for progression from TB infection to TB disease
- Persons who use tobacco, alcohol or illegal drugs may also be at

increased risk for infection and disease.

- Persons with malnutrition and diabetes.

*1.4 **Bacille Calmette-Guérin (BCG) vaccination and TB infection***

The Bacille Calmette-Guérin (BCG) vaccine has existed for more than 80 years and is one of the most widely-used childhood vaccines. BCG has a documented protective effect against meningitis and disseminated TB in children. It does not prevent primary infection or reactivation of latent infection. The impact of BCG vaccination on transmission of TB is therefore limited. Few reports show protective efficacy following BCG vaccination in adults. BCG is contraindicated for persons with HIV and of limited use in preventing TB in health care workers.

*1.5 **Risk of disease following infection***

In most persons who are infected with *M. tuberculosis:*

- The lifetime risk of progressing to active TB is estimated to be approximately 5-10%, if infection has occurred in childhood and the person is not HIV-infected

- The risk of developing disease is greatest in the first years following infection

1.6 Recent infection with *M. tuberculosis*

- infection with HIV; persons with *M. tuberculosis* infection who are co-infected with HIV have approximately an 8%-10% risk ***per year*** for developing active TB

- Persons with HIV infection who become newly infected with *M. tuberculosis* are at high risk for progression to active TB; such progression can occur very quickly after infection

- Other conditions may pose a modest increase in the risk of progression (e.g., spontaneously healed TB with fibrotic residuals, diabetes, probably malnutrition, and renal failure and, in certain countries silicosis.)

2. Risk of Nosocomial Transmission of TB to Health Care Workers

2.1 ***Who is at risk?***

The assessment of occupational risk of TB for HCWs in resource-limited countries can be complicated by:

- The difficulty of collecting TB incidence data among HCWs, partially due to the stigma associated with having TB.
- A high prevalence of *M. tuberculosis* infection and disease in the general population
- The widespread use of BCG vaccination, which complicates interpretation of tuberculin skin testing
- The difficulty of collecting HIV prevalence data among HCWs, partially due to the stigma associated with having HIV and lack of access to HIV counseling and testing
- absence of screening tools for identifying latent TB infection in an environment of BCG vaccination and other mycobacteria

Despite the difficulties in assessing risk, many past and recent studies have shown that health care workers are vulnerable to TB exposure, infection and disease. To date, increased risk has been documented in a number of HCW groups including, but not limited to, nurses, physicians, nursing and medical students, laboratory workers, and housekeeping staff.

HCWs are at increased risk of nosocomial transmission in certain settings. These settings include areas where TB patient care is provided such as TB clinics, dispensaries, sputum induction rooms, outpatient waiting rooms (or corridors) and medical wards, where undiagnosed pulmonary TB patients with cough are in close contact with HCWs'. Of particular importance is the reality that HIV care and treatment have expanded exponentially in recent years, often bringing highly susceptible individuals and Presumptive TB and patients in close proximity, thereby increasing risk of TB transmission. MDR-TB poses

an additional layer of risk to susceptible individuals. Other settings of concern include emergency rooms, HIV wards, laboratories and congregate settings such as correctional institutions (jails, prisons, detention centres) and drug rehabilitation centres.

Risk Factors for Health Care Workers
Work involves diagnosis and treatment of TB patients

- Frequent and direct patient contact
- Duration of patient contact
- Longer duration of employment
- Frequent contact with TB patients who have not yet been placed on treatment
- Work involves cough-inducing procedures
- Work in environments with limited or no infection control procedures in place
- HIV status

"Untreated patients and TB presumptive TB , pose the greatest threat to Health Care Workers.
TB transmission to health care workers is higher in facilities that manage large numbers of patients.

3. An Introduction to TB Infection Control measures

3.1 Infection control measures

There are three levels of TB infection control measures: administrative (managerial) control measures, environmental control measures, and personal protective equipment (respiratory protection). Administrative control measures are the most important among the three levels. Environmental control measures and personal protective equipment (respiratory protection) will not work in the absence of solid administrative controls.

Each level operates at a different point in the TB infection control process:

- **1st priority**; Administrative control measures reduce HCW and patient exposure
- **2nd priority**; Environmental control measures reduce the concentration of infectious droplet nuclei
- **3rd priority**; Personal protective gear (respiratory protection) protects HCWs, patient and family members in areas where the concentration of droplet nuclei cannot be adequately reduced by administrative and environmental control measures.

3.2 Administrative (Managerial and Policy) Control Measures

Administrative control measures are defined as the managerial or work practices (e.g., early diagnosis, prompt isolation or separation of potentially TB patients, prompt initiation of appropriate anti-tuberculosis treatment and diagnosis minimize aerosol-generating procedures) to reduce significantly the risk of TB transmission by preventing the generation of droplet nuclei and limiting exposure to droplet nuclei.

This is the most important level of control measures addressing the **reduction of exposure of HCWs, patients and family members to *M. tuberculosis***. Ideally, if the risk of exposure can be eliminated, no further controls are needed. Unfortunately, the risk usually cannot be eliminated, but it can be significantly reduced with proper administrative control measures. The most important administrative control measures include early diagnosis of potentially infectious TB patients, prompt separation or isolation of infectious TB patients, and the prompt initiation of appropriate anti-tuberculosis treatment. Other important administrative control measures include

- Assessment of the risk of transmission in the facility and community
- Development of a TB Infection, Prevention and Control Plan. The detailed control plan should outline the measures that should be taken in a given health facility and community setting.
- The health care worker should be adequately trained to be able to implement the plan and educate the patient and community on TB infection, prevention and control measures.

  An individual should be identified and be assigned the responsibility of coordinating, the implementation of the TB Infection, prevention and Control Plan at all levels.

3.2.1 Infection, prevention and Control Program

An **Infection, prevention and Control Program** consists of two major components: managerial aspects and implementation of activities.

- Managerial aspects include the **TB infection, prevention and control assessment**, facility and community risk assessments, assignment of roles and responsibilities and monitoring and evaluation.
- Implementation activities are outlined in the **TB infection , prevention and control plan**, trainings, oversight, documentation, etc.

3.3 Environmental control measures

Since the exposure to infectious droplet nuclei usually cannot be eliminated, various environmental control measures can be used in high-risk areas to **reduce the concentration of droplet nuclei in the air**. Such measures include maximizing natural ventilation and controlling the direction of airflow. Although many environmental control measures require resources that may not be available in many situations (e.g., most sub county levels health facilities), some (e.g., opening windows to increase natural ventilation and use of fans to control the direction of air flow) can be implemented in resource-limited settings. Environmental control measures are discussed fully in Chapter 5.

3.4 Personal protective gear (respiratory protection)

This refers to items specifically used to protect the health care provider, the patient and the community from exposure to body substances or from droplet or airborne organisms. Personal protective equipment includes gloves, aprons, gowns, caps, surgical masks, respirators and protective eye wares.

4. Administrative Control Measures

4.1 TB Infection, prevention and Control Assessment;

This process will determine the type and mix of administrative, environmental and respiratory protection measures; the specific interventions will be expressed through the development of an infection control plan. At facility and community levels, the TB IC assessment entails an initial and ongoing evaluation of the risk of TB transmission. The IC assessment should cover the following topics:

- Collection and review of the statistical reports on TB in the community or Sub County. Data on the profile of notified cases, TB/HIV co-infection, and drug resistance is useful. The Sub County TB program is a valuable resource for these data.
- Collection and review of data on reported TB in the facility for the past several years according to the existing guidelines. Data on the profile of notified cases, TB/HIV co-infection, and drug resistance is useful. These data are found in documents such as annual reports, TB patient card archives or, in some instances, facility TB registers and/or electronic TB recording and reporting databases.
- Identification of services within the facility that is most likely to encounter persons with unrecognized TB (e.g. ARV clinics, OPD, radiology) and to which efforts to expedite recognition, diagnosis and treatment of TB should be targeted.
- In-patient settings should correlate facility-level TB data and describe current patterns of isolation and separation Presumptive TB and TB cases.
- Identification of categories of HCWs that need to be included in a TB screening program.
- Identification of mechanisms for prompt recognition and reporting of presumptive TB episodes of TB transmission in the facility and community.

- Identification of the most-at-risk settings within the facility and prioritize them for initial efforts to improve TB infection control.
- Careful record keeping should be instituted.

*4.2 **TB Infection, prevention and Control Plan.***

All relevant stakeholders should be involved in the development and review of the TB IPC plan. This Plan should be implemented and monitored according to its recommendations. In certain settings, having a TB infection, prevention and Control Plan for TB alone might not be feasible. Thus, if the facility already has a TB Infection, prevention and Control Committee, infection control measures appropriate for the control of TB could be also part of the more general Infection Control Plan.

In general, the TB Infection, prevention and Control Plan should include:

- Description of the incidence or TB and TB/HIV in the facility
- Assessment of HCW training needs and training plan
- Administrative policies with regard to triage and screening, referral and diagnosis, separation and isolation
- Using and maintaining environmental controls
- Policy on the training and use of respiratory protection
- Area-specific infection control recommendations
- Description of roles and responsibilities for implementation and monitoring the infection control plan.
- Time-line and budget (e.g., material and personnel costs)

A sample of TB infection, prevention and control plan (template) is included in annex B

*4.3 **Patient Management***

Seven Steps for Patient Management to prevent transmission of TB in Community and health care settings		
Step	**Action**	**Description**
1.	**Screen**	**Early identification and detection** of presumptive TB patients or confirmed TB disease is the first step in the protocol. It can be achieved by assigning a staff member in a health facility and trained community health workers to screen patients for prolonged duration of cough and take immediate action. Patients with cough of more than two weeks duration, or who report being under investigation or treatment for TB*, should not be allowed to wait in the line with other patients to enter, register, or get a card. The patients under investigation and on treatment should be weighed in the treatment room and not referred to the MCH/FP (well baby clinic) where mothers and infant are waiting Instead; they should be managed as outlined below. Likewise patients with similar prolonged cough should be immediately being referred to a health facility. Carry out **contact tracing** of sputum positive PTB including MDR and XDR TB. **Actively track those who have interrupted treatment** and bring them back to treatment.

2.	**Educate**	**Educating** the above-mentioned persons identified through screening, **in cough etiquette and respiratory hygiene**. This includes instructing them to cover their noses and mouths when coughing or sneezing, and when possible providing facemasks, handkerchiefs or tissues to assist them in covering their mouths.
3.	**Special waiting areas**	Patients who are identified as Presumptive TB or cases by the screening questions should be directed to another separate waiting room away **from other patients** and requested to wait in a separate well-ventilated waiting area, and provided with a surgical mask or tissues to cover their mouths and noses while waiting.
4.	**Triage**	**Patients in special groups (known HIV positive very young and old) should be given preference in care. Triaging** symptomatic patients **to the front of the line for the services** should be done. In an integrated service delivery setting known HIV patients should be separated from smear positive TB patients. Known HIV positive clients in the community should be frequently be monitored for TB and referred promptly.
5.	**Investigate for TB or Refer**	TB **diagnostic tests** should be done **onsite or**, if not available onsite, the facility should have an established link with a TB diagnostic and treatment site to which symptomatic patients can be **referred.**

6.	**Treatment**	**Appropriate TB treatment** should be initiated in accordance with National TB guidelines at the earliest time possible. Directly observed therapy (DOT) to ensure adherence to treatment. Follow-up and monitor patients in accordance with National TB guidelines. Conduct additional diagnostic procedures to ensure the appropriate treatment is given (both for TB treatment as well as potential interactions with other medications such as ARVs). Document completion of treatment program.
7.	**Discharge Plan**	For inpatient and outpatient settings, coordinate a discharge plan with the patient (including a patient who is a HCW with TB disease) and the TB-control program of the local, Sub County or provincial health facilities. If applicable, co-management of patients with HIV or other diseases should be coordinated with the applicable local, Sub County or provincial health facilities. For MDR-TB, identify trained HW in referral sites who will be able to manage the patient according to the national multi-drug-resistant TB guidelines.

4.4 ***Administrative Control Measures for Sub County and Referral Health Care Facilities covers the following areas***

1. Outpatient facilities (health posts, dispensaries and health centers)
2. Inpatient and mixed facilities
3. Special areas and topics in Infection prevention and Control
    - Radiology
    - Sputum collection and cough-inducing procedures
    - Surgical suites, intensive care areas
    - HIV and TB
    - TB/MDR TB clinics
4. Referral level
5. Assessment of at risk settings for *M. tuberculosis* transmission
6. Early identification and diagnosis
7. Encourage outpatient TB management
8. Inpatient management: separation and isolation policies
9. Isolation of patients with Multidrug-Resistant (MDR) and Extensively Drug-

   Resistant TB (XDR-TB)
10. Enforcing isolation policies
11. Discontinuing isolation
12. Evaluating infection control interventions
13. Health care provider safety
14. Surveillance for TB among HCWs
15. Program coordination

The detailed information on the above key areas are found in the following national guidelines; NTLD UNIT treatment guideline, NTLD UNIT operation manual , MDRTB guideline, CB DOTs manual, community sensitization manual discussion guide manual , community strategy, laboratory training guideline, TB/HIV Collaborative activities training manual.

5. Environmental Control Measures

*5.1 **Introduction***

Environmental control measures refer to the use of engineering technologies to help prevent and reduce the concentration of infectious droplet nuclei in the air. These measures are the second line of defense for the prevention of nosocomial *M. tuberculosis* transmission to HCWs. In the face of inadequate or insufficient administrative control measures, environmental control measures will not eliminate the risk. Although some environmental control measures do not require a large expenditure of resources, some are expensive and technically complex. When employed in conjunction with administrative control measures (e.g., prompt triage, diagnosis, and treatment of infectious TB patients), environmental control measures can be used effectively to reduce the concentration of infectious droplet nuclei to which HCWs, patients, family members or visitors may be exposed.

The following are the four main principles of environmental control measures

- Dilution (e.g. Ventilation systems)
- Filtration (e.g. HEPA filters)
- Purification (e.g. UVGI Systems)
- Disinfection (e.g. chemical, thermal.)

*5.2 **Environmental control measures***

A variety of simple to complex environmental control measures can be used to reduce the number of aerosolized infectious droplet nuclei in the work environment:

- The simplest, extremely effective, and least expensive technique is to remove and dilute the air from TB patient areas, away from patients without TB, by maximizing natural ventilation through open windows
- More complex and costly methods involve the use of

mechanical ventilation (e.g., window fans, exhaust ventilation systems, supply and exhaust ventilation systems, etc.) in isolation rooms or wards to produce negative pressure, prevent contaminated air from escaping into hallways and other surrounding areas, and remove and dilute infectious particles

- Additional complex and costly methods include room air cleaners with air filtration to remove and dilute infectious particles or with ultraviolet germicidal irradiation (UVGI) to inactivate *M. tuberculosis* organisms

The type of environmental control measures for each facility will depend on the design of the facility, climate of the area, socioeconomic status of the catchment population, patient load, and available resources. In order to maximize the benefits, efforts to improve ventilation should involve consultation with a person trained in environmental control measures and infection, prevention and control. Necessary environmental control measures should be included in the IPC plan. These measures in place should be regularly evaluated and maintained. Other administrative control measures to ensure optimal operation of environmental control measures may include (but not limited to) assignment of a person to oversee environmental controls, to open and close windows, as appropriate, change filters, test environmental control measures periodically, clean UVGI and lamps, perform preventative maintenance, etc.

The following are the key environmental infection control methods;

1. Ventilation
    - Simple ventilation –
        - Opening windows, door, enlarge openings, open air simple fan.
    - Complex ventilation systems-
        - well-designed local exhaust,
        - general ventilation (supply and exhaust, no climate),

- Well -designed general ventilation (supply and exhaust , with climate control)

2. UVGI (Ultra Violet Germicidal Irradiation)
   - In-duct application (with closed mechanical ventilation system)
   - Upper room UVGI lamp
   - Lower room UVGI lamp
   - UVGI in conjunction with Room air cleaner
3. HEPA cleaner (High Efficiency Particulate Air cleaner.)
   - In-duct application
   - in conjunction with Room air cleaner (mobile or fixed)
4. Disinfection
   - Chemical disinfection for general equipment
   - Thermal –e.g. steam sterilization ,autoclaving

For more information see annex A,B,C,D

6. Personal Respiratory Protection among health care providers, patients and the communities

6.1 The role of respiratory protection

Respiratory protection is an important aspect for protecting HCWs against TB nosocomial infection. It goes hand in hand with administrative and environmental measures. This measure is important in high risk areas such as MDR treatment centres, and centers handling presumptive TB ed MDR specimen and surgical centers handling bronchoscopy, autopsy measures sputum induction and other aerosol –generating procedures and other people handling disposal waste from the laboratory and wards.

6.1.1 The role of surgical or procedure masks and respirators in respiratory protection

6.1.1.1 Surgical or procedure masks

There are important differences between a surgical or procedure mask and a respirator. Surgical or procedure masks (cloth or paper):

- Do prevent the spread of microorganisms from the wearer (e.g., surgeon, TB patient, etc.) to others by capturing the large wet particles near the nose and mouth and limiting the distance aerosols are expelled when coughing, sneezing, and talking.
- May provide a limited level of protection to the wearer (e.g., HCW, patient, family member) from inhaling infectious droplet nuclei in the air; however, they are not designed to be of high filtration efficiency or with a tight face seal.

6.1.1.2 Use of surgical or procedure masks for patients

In many instances the disposable/cloth surgical or procedures masks may not be available in dispensaries and most health centers but it is important to take precautions through covering mouth, using tissues or clothes, not spitting on floor, disposing of soiled tissues properly.

Disposable surgical or procedure masks should be considered for presumptive TB and known infectious TB patients leaving isolation

rooms for medically-essential procedures.

It must be considered that surgical masks may also serve to identify TB patients the risk of stigma. Patient and HCW education regarding the importance and appropriate use of wearing surgical masks should accompany their distribution. It is important to remember that a surgical mask worn by HCWs may not adequately protect them from inhalation of air contaminated with *M. tuberculosis.* Respirators are the preferred device to reduce the concentration of *M. tuberculosis* bacilli inhaled.

6.1.1.3: Respirators

Respirators are a special type of device that provide filtration for 0.3-0.4 micrometer particles and are closely fitted to the face to prevent leakage around the edges. If the respirator is not fitted correctly, infectious droplet nuclei can easily enter a person's airways, potentially resulting in infection Respirators manufactured with at least 94-95% filter efficiency for particles of 0.3-0.4 micrometers in diameter are usually recommended for use by HCWs.

Photo: Wearing and fitting a respirator properly

These face-piece respirators are disposable but can be re-used repeatedly for several weeks in TB, clinics or while performing TB procedures if they are properly stored. CDC/NIOSH-certified N95 (or greater) and CEN-certified FFP2 (or greater) filtering face-piece respirators meet these criteria.

Respirators should be stored in a clean dry location devoid of humidity, dirt and filter damage. Plastic bags should never be used since they retain humidity.

6.1.2 Protection in high risk areas

Respirators should be worn by all personnel entering high risk areas such as bronchoscopy rooms, sputum induction rooms, MDR-TB isolation wards, people handling specimens in the laboratory, MDR-TB Clinic. The use of powered air-purifying respirator (PAPR) is recommended where high risk procedures are performed, for they are cost-effective and are re-usable and does not require fit testing.

6.2 Increasing awareness of TB among health care Providers, patients and the community

There has been an increase in TB burden among health care providers and the community. In addition to this, it has also been documented that people in close proximity are at high risk not only health care providers, but also any staff, including volunteers, who have contact with persons with TB who have not yet been diagnosed and started on treatment, Peer educators, cleaners, staff, porters and cleaners, as well as peer educators, adherence supporters, and volunteers working as counselors or in support groups. PLWHA in these roles are at particular risk of rapid progression to TB disease if they become infected or re-infected due to exposure to *M. tuberculosis* in the facility. They should be included in all training programs. A third group in congregate setting, correctional institutions, and drug rehabilitation centers that have also been documented to have higher rates of TB infection and disease than the general population.

The infection prevention and control measures recommended in this policy should reduce the time persons with undiagnosed TB spend in health care settings and should improve ventilation and thus dilution of any *M. tuberculosis* particles in the environment. Nevertheless, the risk to staff will never be zero, and an additional aspect of protecting staff is promoting early recognition of TB disease and standard treatment.

It is recommended that staff be investigated for TB free of charge if they have a cough for two weeks or more. The infection prevention and control plan should list designated staff members who should be contacted to initiate TB investigations, and reinforce that all services are confidential. Deployment of Health care workers with chronic illnesses and imuno-compromised should be deployed to high risk areas with caution as they are liable to developing and progressing TB disease.

6.3 Increasing access to Voluntary HIV counseling and testing and DTC

Health care providers and the community members should be encouraged to know their HIV status. This could be achieved through providing accessible, acceptable, confidential VCT, including periodic retesting, to staff.
HIV-infected health care providers and the community members are at increased risk of developing TB disease if exposed in the workplace, and additional precautions should be taken to protect them. Imuno-compromised health care providers should be given opportunities to work in areas with a lower risk of exposure to TB and should be provided with isoniazid preventive therapy (IPT) where indicated.

Education directed to health care workers concerning HIV testing must be linked to their role in educating patients and communities about the benefits of testing and knowing one's HIV status. This may further reduce stigma.

7. TB Laboratory Safety

*7.1 **Laboratory safety***

Laboratory safety in relation to handling of sputum is not exhaustively covered in this policy guideline. For more details on laboratory safety issues, refer to National laboratory bacteriology guideline in *Tuberculosis Control*. The most important factor in the prevention of laboratory TB acquired infection is good technique on the part of the individual health care provider.

*7.2 **Safety precaution in sputum smear preparation***

The most important factor in the prevention of laboratory-acquired infection is good technique on the part of the individual worker. Specialized equipment may aid good laboratory practice but does NOT replace it.

Aerosols may be produced in the TB laboratory when handling leaking specimens, opening sample containers, and preparing smears. When care and appropriate techniques are used, handling sputum presents a minimal risk of acquiring infection to a technician.

For laboratory staff, the greatest risk of infection involves sputum collection. People with presumptive TB ed TB may cough and in doing so, spread TB bacilli in tiny droplets in the air which may infect others when they are inhaled. Precautions must be taken to minimize this exposure.

The laboratory technician is at considerably more risk when sputum is processed for culture and drug susceptibility testing. These procedures require shaking and centrifugation. Consequently, special equipment such as biological safety cabinets, which are costly to purchase and maintain, are required. However, this equipment is not justified in the AFB smear microscopy laboratory.

Proper collection of sputum

Collecting sputum represents the greatest hazard to a laboratory technician because infectious aerosols may be produced by coughing. If a coughing patient comes into the laboratory, ask them to cover their mouth. Wherever possible, collect specimens outside where air movement will rapidly dilute infectious droplets and UV rays from the sun will rapidly inactivate TB bacilli. NEVER collect sputum specimens in laboratories, toilets, waiting rooms, reception rooms, or any other enclosed space. Always stand well clear and upwind when a patient is collecting a sputum sample. Sample spacemen (Sputum) to be collected through the widow.

Laboratory arrangement

Ideally, the TB laboratory should be a well-ventilated area which is dedicated to microbiology with restricted access. Establish airflow in working areas that will direct potentially infectious particles away from personnel. Air must be exhausted into a remote area. An extraction fan can be useful to vent air from a smear preparation area with poor ventilation that is closed off due to extreme climatic conditions

Gloves

Gloves do not provide any appreciable protection against airborne transmission of *M. tuberculosis* they should be used all the time when handling sputum, sputum just like any other fluid may contain other infectious agents. However lack of their availability does NOT mean that sputum smears cannot be prepared. Indeed, wearing gloves can give technicians a false sense of safety and may result in contaminated gloves being used to handle or operate equipment that may otherwise not become contaminated (e.g., microscope or telephone).

If gloves are used, there should be a guaranteed supply. Reusing single use gloves is not advised. Never wear gloves outside the laboratory. Discard gloves at any interruption of smear preparation.

Hand washing and careful techniques are mandatory for safe laboratory

practice in all countries.

Laboratory Coats

Laboratory Coats must be worn at all times when working in the laboratory. Laboratory coats of various sizes should be provided and cleaned by the laboratory organisation. They should be tied at the back, not the front, and be made from water-resistant materials to avoid liquids soaking into the gown. Laboratory coats must NOT be worn outside of the laboratory.

Masks

One of the greatest false beliefs is that a standard surgical mask will protect the wearer from becoming infected with TB. These masks are made from porous material that will not trap TB bacilli, and have an extremely poor fit creating large gaps between the face and mask.

Respirators

Respirators such as N95 "duck-bill" (often incorrectly referred as "masks") and particulate respirators are expensive and unnecessary for laboratory technicians carrying out sputum smear preparations only. Such equipment must be selected and fitted correctly to be functional.

Appropriate Disinfectants

Phenolic agents (5% phenol in water or a phenolic disinfectant product diluted as per label) are excellent disinfectants for cleaning up sputum spills and for decontaminating equipment and single use items prior to disposal. Fresh household bleach (5% sodium hypochlorite) diluted 1:10 with water can also be used as a general disinfectant. Bleach solution works well for cleaning up blood spills; however, it is somewhat less effective than phenolic agents against TB. It is important that bleach dilutions be made fresh since it loses potency with time. Seventy percent alcohol is a good agent for cleaning bench tops.

Safety practices for smear preparation

- Reject broken or leaking containers. Request another specimen.
- Once collected, allow a sputum specimen to stand undisturbed for at least 20 minutes before opening to settle any aerosols.
- Cover sputum containers with their lids at all times except when removing specimen for smear preparation.
- Open sputum containers with care and away from the face. Gently open the sputum container, especially if the lid clicks or snaps on.
- Do not forcefully shake or stir the sputum in the container.
- Avoid any rapid motion when making the smear as infectious aerosols may be produced.
- Where available, use disposable wooden sticks for smear preparation. Discard into a receptacle immediately after use.
- If wire loops are used, remove residual sputum on the wire loop before flaming. Do so by inserting the wire loop into a sand-alcohol flask and either moving it up and down or by rotating the loop. Never put a wire loop into a flame when sputum is still attached to it as sputum particles containing live AFB will produce infectious aerosols.
- After sputum is smeared onto the slide, let the slide air dry for 15–20 minutes. Wet slides can produce aerosols. Do not flame slides to expedite drying. This can produce dangerous aerosols.
- Fix smears by flaming only after they have dried completely.

Safe disposal of infectious waste

After smears have been processed, place all infected materials including closed sputum containers in a discard bag (polyethylene, if available).
Discard applicator sticks used for smearing immediately after use.
Since all sputum specimens are considered potentially infectious, treat all materials in the procedure as contaminated.

Discard specimens by one of the following methods:

- Burning
- Burying
- Autoclaving

To protect the surrounding population, the laboratory must dispose of waste safely. Burning waste in an incinerator is usually the most practical way for safe destruction of laboratory waste. If safe burning cannot be arranged, discard the waste in a deep pit of at least 1.5 meter depth. If an autoclave is available, place infected materials inside and follow procedures for safe and adequate sterilization.

7.3 ***Preparation of liquid suspensions of M. tuberculosis***

Laboratories which process MDR or liquid preparations of suspended *M. tuberculosis* (e.g., centrifugation, cultures, and drug susceptibility testing) should be considered at higher risk for nosocomial *M. tuberculosis* transmission. Safety measures may include the following:

- Proper ventilation is required in areas where culture and susceptibility testing of *M. tuberculosis* isolates is performed
- All staff working in the laboratories must be experienced and must be periodically updated to work with MDR and liquid suspensions of *M. tuberculosis*
- Using appropriate ventilated cabinets or biological safety cabinets (BSC II)

*7.4 **Ventilated Cabinets***

Ventilated Cabinets include Laboratory Fume Hoods and Biological Safety Cabinets. The details of these devices follow.

7.4.1 Laboratory Fume Hoods

The least expensive ventilated cabinet for laboratories is the Laboratory Fume Hood. This type of environmental control is designed for the purpose of worker protection (no protection of the environment or the product [specimen/ culture]). These devices, like Biological Safety Cabinets, are designed to minimize worker exposures by controlling emissions of airborne contaminants (including aerosols) through the following:

- The full or partial enclosure of a potential contaminant source
- The use of airflow velocities to capture and remove airborne contaminants near their point of generation.
- The use of air pressure relationships that define the direction of airflow into the cabinet.

7.4.1 **Biological Safety Cabinets (BSCII)**

BSCII are relatively expensive and are designed to contain airborne microorganisms in laboratories working with MDR or liquid suspensions of *M. tuberculosis*. When used with appropriate laboratory practices, the spread of aerosolized microorganisms can be minimized through the use of a biological safety cabinet.

Laboratories working with MDR or liquid suspensions of *M. tuberculosis* should be equipped with a ventilated cabinet or a BSC class II. All efforts must be made to ensure the BSC class II is functioning properly by regular inspection.

8. Multi-Drug Resistant and Extensively Drug Resistant TB

There is a risk of severe morbidity and mortality to HIV-infected persons from MDR-TB. Therefore persons with known MDR-TB should receive routine care outside of normal HIV care settings.
The health care workers working with MDR TB patients should take necessary preventive precautions.

The community should be well educated about TB infection, prevention and control. TB patients to be isolated from children. MDR-TB care providers at community level should be sensitized on risk of transmission and be provided with basic protective equipment. MDR-TB patient should be provided with basic personal protective equipment for use in the home setting where vulnerable groups like children under five, elderly and chronic ill people.

9. Prevention and Control of TB transmission within the community

Increase awareness on reducing transmission of TB in the community by creating community awareness, early identification of Presumptive TB and referral for follow-up in the health care setting.

Identified TB cases should be taught on cough etiquette and cough hygiene. Create Community awareness on importance of adherence to TB treatment.

Due to HIV TB co infection the community should be encouraged to go for Voluntary Counseling Testing.

10. Infection Control Measures in Special Settings

There are special settings in the community that are of high risk and call for special attention as far as TB infection, prevention and control is concerned.

These include:-

I. Congregate settings

- Prisons and remand cells
- Informal settlements(slums)
- Refugee and internally displaced persons (IDP) camps
- learning institutions(schools, colleges,
- security forces training camps (military, GSU, police national youth service etc)

Prisons and remand cells

TB is spread more readily in congregate setting such as prisons, remands, informal settlement and public transport. This is because of the longer duration of potential exposure, crowded environment, poor ventilation, and limited access to health care services.

All inmates on admission should be screened for TB.

The prison and remand cell should follow and implement TB infection control guidelines. There is need for active advocacy and sensitization of relevant ministry and departments for the implementation of TB infection control guidelines in the prisons.

Informal settlements (slums)

To reduce TB transmission in the informal settlement, there is need to have adequate sensitization and advocacy on proper ventilation on the existing structures/ housing and practice of cough etiquette. The implementation of community TB infection control guidelines should be emphasized. Screening, contact tracing and defaulter tracking should be highly emphasized in such

settings.

Learning institutions and security forces training camps

Learning institutions should embrace TB infection control guideline. TB infection control should be incorporated in the school health program. Learning institutions should adopt and own TB environmental measures and UVGI among others.

ii. Public services transport

- Matatus, buses and trains
- Air transport

TB infection control guidelines should be implemented in public transport sectors. There should be adequate ventilation by opening Windows on both sides of the vehicles or applying mechanized ventilation. Advocacy and sensitization with different ministries and the community is required for this to succeed. Airline services should implement TB Infection control guidelines. Transportation of presumptive TB ed MDR-TB Patient s from one facility to another should be by well ventilated means of transport with personal respiratory protective devices.

11. Infection control and legal implication

TB, MDR-TB patient, and the community should be adequately educated on the importance of adhering to DOTs and DOTs Plus strategy. Patients who may refuse to adhere to the treatment will have to be managed according to the existing laws and guidelines.

12. Monitoring and Evaluation

12.1 Evaluating infection control interventions

At facility-level, it may be difficult to detect a change in TB rates among HCWs after the implementation of TB infection control measures because of 1) the long time intervals that often occur between infection and disease and 2) the small number of HCWs working at the facility. However, it is usually possible to monitor the implementation of the interventions through periodic supervision of the measures outlined in the TB Infection, prevention and Control Plan. Establishing surveillance of active TB rates among HCWs in the Sub County may nonetheless provide a useful means of evaluation, although the complex relationship between infection and development of disease as well as other factors such as high HIV rates may complicate the interpretation of trends.

One means to evaluate TB infection control measures is by reviewing the medical records of a sample of TB patients seen in the facility. The evaluation of outcome measures can then be used to identify the areas where improvement may be needed. The process of developing and implementing the TB infection control plan is not static, but is a process that should be continually monitored and adapted, with ongoing education integrated at all steps.

Annexes

Annex A: Administrative Control Measures for

Sub County and County Referral Health Care Facility

Sub County level measures **(community networks, dispensaries, health centers, and hospitals)**	**County Referral level measure** **These additional measures apply to referral-level facilities**
Identification of the person(s) responsible for the assessment, implementation and monitoring of TB-IC plan	Identification of the person(s) or team – such as the IC team who would be responsible to assist in the assessment, the implementation and monitoring of TB-IC plan
Assessment of at-risk settings for acquiring *M. tuberculosis* infection	* When medically allowable, encourage out-patient TB management
TB Infection, prevention and Control Plan	*In-patient management and isolation policies
HCW training and TB awareness	*Isolation of multidrug-resistant (MDR) and extensively drug resistant TB (XDR-TB) as long as cultures are positive
Access to HIV C&T	*Enforcing isolation policies

Early identification and diagnosis	***Special Areas and Topics in Infection, prevention and Control:** Radiology, Sputum collection and cough-inducing procedures, bronchoscopy suites, surgical suites, intensive care areas, Immuno-suppression and TB
Patient education	Evaluating infection control interventions, Surveillance for TB, disease/infection among HCWs
Sputum collection	
Triage and evaluation of presumptive TB	
Flowchart path of inpatients and outpatients, including functional procedures	
Flowchart path of specimens.	
TB patients in the health post or clinic	
Reducing exposure in the laboratory	

Evaluating infection control interventions Surveillance for TB, disease/infection among HCWs	

*** should be implemented at the Sub County hospital facilities**

Annex B. Sample of Infection Prevention and Control Plan

A. The plan will include, but not be limited to, the following policy areas:

1. Identification of responsible coordinators at all levels for the implementation IC plan.

2. Screening patients to identify persons with symptoms of TB disease or who report being under investigation or treatment for TB disease. Carry out contact tracing of sputum positive PTB including MDR-TB and XDR-TB.

3. Providing face masks or tissues to persons with symptoms of TB disease ("presumptive TB") or who report being under investigation or treatment for TB disease ("Presumptive TB or cases"), and providing waste containers for disposal of tissues and masks.

4. Placing Presumptive TB and cases in a separate waiting area.

5. Triaging Presumptive TB and cases to the front of the line to expedite their receipt of services in the facility.

6. Referring Presumptive TB to TB diagnostic services and confirming that TB cases are adhering with treatment.

7. Using and maintaining environmental control measures.

8. Educating staff periodically on signs and symptoms of TB disease including Multidrug resistant TB , specific risks for TB for HIV-infected persons, and need for diagnostic investigation for those with signs or symptoms of TB.

9. Training and educating staff on TB control, and the TB infection prevention and control plan.

10. Sensitizing and educating the community on TB disease, TB infection prevention and control.

11. Adequate budgeting and timely implementation of the activities.

12. Monitoring and evaluation of the TB infection and control implementation plan.

B. The facility will implement each policy by following the procedure(s) that accompany it.

Policy and Procedures

Purpose: Early identification, separation, receipt of services, and referral of patients with TB disease is essential in preventing spread of TB

Lead: _____ has the responsibility for overseeing the implementation of these policies and its procedures, and reports to (*Sub County health executive committee, etc).*

Policy 1: Screening patients to identify persons with symptoms or recent history of TB disease.

Procedures:

1. Before patients enter an enclosed part of the facility, a designated staff person should ask each adult and any child capable of coughing forcefully (usually age 14 or older) about symptoms or recent history of TB. The questioning should occur before patients wait in line for long periods to register or obtain services.

2. Many combinations of symptoms have been recommended as sensitive and specific for TB. A simple screen is

   "Do you have a cough?" *If patient answers" yes," ask*

   "For how long have you been coughing?"

   An adult who has coughed for two weeks or more may be

considered a TB presumptive TB .

To determine whether a patient may be under investigation or a diagnosed case of TB, who may still be infectious, ask

"Are you being investigated or treated for TB?"

If the answer to either is "yes," the screen classifies the patient as a Presumptive TB or case, and he should be managed as described in the procedures under policies 2 – 5 below.

3. As patients who are not identified as a Presumptive TB or case on the initial symptoms screen enter an examination room with the clinical officer, nurse, or counselor, they should again be asked the simple screening questions. Those patients who report a cough of two or more weeks or who are being investigated or treated for TB should be managed as follows in the procedures under policies 2 – 5 below. Staff seeing patients in examination rooms should report patients they find to be a presumptive TB or case to the infection control officer in a timely manner so that factors contributing to the potential exposure (e.g., an emergency or short staffing interfering with the designated person screening all patients) can be documented and corrected.

Policy 2: Instructions on cough hygiene

Procedures:

1. Patients who are found to be Presumptive TB or cases should immediately be informed about the importance of cough hygiene and are handed tissues (or pieces of cloth) and instructed to cover their mouths and noses when they cough. Alternatively, patients should be given a face mask, and asked to wear it while in the facility. Patients should also be instructed to dispose of used tissues or masks in identified no-touch receptacles and not on the ground.

   When tissues, cloths or face masks are not available, clients should be instructed to lift their arm up and cover their nose and mouth with the inner surface of the arm or forearm when they cough

or sneeze. *M. tuberculosis* cannot be spread from the hands, but other serious lung infections can.

2. No-touch receptacles for disposal of used tissues and masks should be available in the waiting areas.
3. Advised to wash their hands with soap before leaving.

Policy 3: Placing Presumptive TB and cases in a separate waiting area

Procedures

1. A staff person should direct or escort the patient to a separate waiting area. This special waiting area should have the highest natural ventilation possible. Patients should be assured of their place in the line for registration and/or services.

Policy 4: Triaging Presumptive TB and cases to the head of the line to receive services in the facility

Procedures

1. Presumptive TB and cases should be moved to the front in the queue of the line for whatever services they want or need, e.g., VCT, medication refills, or medical investigation. This reduces the duration of potential exposure while they wait in the facility and may be an incentive to disclose information during screening.
2. Other points should be explained about this procedure/policy.

Policy 5: Referring Presumptive TB to TB diagnostic services

Procedures

1. _____ is the designated staff person to counsel patients about obtaining TB diagnostic services.
2. Patients will be referred to _____ _____ (TB diagnostic center the HIV care facility has a previously negotiated agreement, see section __).
3. Patients should be given a card with the name, location, and operating hours of the TB diagnostic center. The card should also have the name of the referring facility on it, with date of referral marked. These cards can be collected at the TB center and used as an anonymous check on number of referrals who successfully obtain TB services. (See also the Presumptive TB and case form listed in Annex A2 below, which can be used to cross-reference referrals that are made /successful).

Policy 6: Using and maintaining environmental control measures

Procedures

1. _____ is the designated staff person to check on environmental control measures and maintain a log of monitoring and maintenance.
2. Windows and doors should be checked on a daily basis to assure they are in proper position (open or closed as called for in the plan). Generally, all windows and doors should be open when natural ventilation is the primary environmental control to allow for the free, unencumbered movement of air (e.g., across room, from window to door or vice versa). Generally, all windows and doors should be closed when using mechanical ventilation to ensure air movement in a controlled manner (air from supply vent and from slots either under or in door toward the exhaust vent).
3. Fans should be checked on a monthly basis to assure they are clean, are pulling (or pushing) the correct amount of air, and are pulling (or pushing) air in the correct direction.

Policy 7: Providing confidential TB and HIV services to health care workers and staff

Procedures

1. Health care workers and all other staff working at the facility should be educated about the signs and symptoms of TB and encouraged to seek investigations promptly if they develop symptoms and signs suggestive of TB.
2. Health care workers and other staff should be informed about the special specific risks for TB for HIV-infected persons (see section on Training of staff).
3. Health care workers and staff should be encouraged to undergo HIV testing, and given information on relevant HIV care resources.
4. Staff training should include reduction of stigma of TB and HIV.
5. _____ is responsible for determining when staffs who develop TB disease may return to work and their deployment.

6. Staff who develop TB disease may return to work when determined to be no longer infectious after:
    a. Having completed at least two weeks of standard anti-TB therapy; and
    b. Exhibiting clinical improvement; and
    c. Having continued medical supervision and monitoring of treatment until cured; and
    d. Where possible, having had three consecutive negative sputum smears obtained on three different days with at least one morning specimen. (Note: Frequent evaluation of sputum smear status may not be done routinely in resource-limited settings.)

Policy 8: Training of staff on all aspects of TB and the TB infection control plan

Procedures

1. _____ is the designated staff person to provide training to new staff as it is hired and to maintain a log indicating who has had initial training.
2. _____ is the designated staff person to provide annual training to all staff and to maintain a log indicating who has attended training. This may be incorporated into a broader training topic or be stand-alone TB infection control training.

Policy 9: Monitoring the TB infection control plan's implementation

Procedures

1. Determine the frequency of the infection control plan
    a. During initiation of procedures, monitoring and evaluation should be done frequently, perhaps monthly or bi-monthly.
    b. When procedures are running well, less frequent evaluation will be necessary – at a minimum, annually.
2. Evaluate the screening process
    a. Were patients with significant cough missed when entering the facility and only detected at a later time or in the examination room?

   b. What correctable factors were associated with these potential exposures?
3. Evaluate the success of referrals to the TB diagnostic center
   a. Did referred patients access care?
   b. Did referred patients have TB disease?
   c. What changes in screening or referral process should be made, if any?
4. Evaluate the training process
   a. Did all new staff receive training on TB infection control during their induction?
   b. Did all staff receive annual re-training on TB infection control?
5. Revise the infection control plan to reflect changes in staff responsibilities, policies, and procedures
6. Develop a plan for correcting inappropriate practices or failure to adhere to institutional policies
   a. identify incentives to participate fully and adhere to policies
   b. identify corrective actions if policies are not followed

Annex C. Sample monitoring tools

_____has the responsibility for overseeing the evaluation of the TB infection, prevention and control policies and its procedures, and reports to (*Head of the NTLD UNIT*, *Sub County health executive committee, etc).*

_____ has the responsibility for filling out the "TB case and presumptive TB log" on a daily basis, entering the date, names of patients who were found to be a case or presumptive TB that day, whether they were missed at intake screening, and to which facility they were referred.

_____ has the responsibility for conducting follow up on patients referred to a TB diagnostic facility and recording the outcomes of their investigation in the log.

_____ has the responsibility to summarize and present the results of the screening process to relevant management and staff periodically.

TB Case and Presumptive TB Log

Date	**Patient Name**	**Case or Presumptive TB** (c/s)	**Missed at intake?*** (y/n)

*Missed at intake = symptoms or history detected only after patient enters private room with clinician or counselor instead of upon entry to the facility; or after numerous visits while symptomatic yet undetected: y=yes, n=no

**Outcomes: TB diagnosed or confirmed=TB; TB ruled out after diagnostic investigation=not TB; did not present to referral facility for investigation=NS (not seen).

Staff TB Infection, prevention and Control Training Log

Staff Name	Start Date	Date first IC training	Date annual training	Date annual training	Date annual training

Annex D: TB Infection, Prevention and Control Assessment

- The purpose of this survey is to assess:
  - the extent to which infection control policies and guidelines exist
  - Knowledge and practices related to basic TB infection control measures.
- The assessment is targeted to both NTLD UNIT and NASCOP program staff.
- The results will be analyzed to identify areas in which additional technical assistance is needed for TB/HIV program implementation. A summary of results and recommendations will be shared with the in-country CDC team.

National Level

1	Question	Response or Code	Additional Comments
1	**Country:** **Name of Respondent:** **Respondent Title:** **Program: Circle one: NTLD UNIT NAP** **Date Form Completed (dd/mm/yyyy):**		
2	How many administrative Sub Countys currently exist?		
3	Is there a designated national TB/HIV coordinating committee? ***(0=No, 1=Yes)***		
4	Does the **NTLD UNIT** national manual address TB infection, prevention and control? ***(0=No, 1=Yes)***		

	Is there a written national policy that addresses TB infection control? ***(0=No, 1=Yes)*** If yes, describe it (who developed? Target audience? Status of implementation?)		
	Has this national policy been disseminated? ***(0=No, 1=Yes)***		
	Has training on implementation of this national policy been conducted? ***(0=No, 1=Yes)***		
	Has the implementation of this national policy been evaluated? ***(0=No, 1=Yes)***		
	Request copy of most recent annual report/statistical profile.		

Sub County Level

	Question	**Response or Code**	**Additional Comments**
1	**Sub County:** **Name of Respondent:** **Respondent Title:** **Date Form Completed (dd/mm/yyyy):**		
2	What is the total number of TB clinic sites in the Sub County?		

3	How many TB patients were reported in the last quarter? Last year quarter? Sub County population: _____		Qtr __ ### ____ Yr ___ ### ____	
4	What is the total number of HIV care and treatment sites providing ARV treatment in the Sub County?			
5	Do HIV care and treatment sites in the Sub County screen patients for active TB? ***(0=no, 1=yes) If YES, how? Obtain pt encounter from***.			
6	How many of the TB sites and HIV care and treatment sites are co-located? Describe co-location			
7	Is there a Sub County-level TB/HIV coordinator? ***(0=No, 1=Yes)***			
8	Has training on TB infection control been provided…? ***(0=no, 1=yes)***	9.1 For staff in HIV care and treatment programs 9.2 For staff in TB clinics 9.3 For staff in hospitals		
9	Is there a Sub County policy on TB infection control? ***(0=No, 1=Yes)*** ***If yes, request a copy.***			

	Do facilities in the Sub County report on the number of TB cases among HCWs in the Sub County? ***(0=No, 1=Yes)*** ***If yes, request a copy.***			

Facility-level

Facility name: _____

Province / Sub County: _____

Name of person administering the interview: _____

Title of respondent: _____

Program (circle one): TB Program HIV/AIDS care/Rx

Date form completed (dd/mm/yyyy): _____ / _____ / _____

Period of time covered by evaluation: _____ / _____ / _____ to _____ / _____ / _____

	Question	**Response or Code**	**Additional comments**
General information			
1	Type of facility? (***1. Ministry of public health & sanitation, 2. NGO (including faith-based), 3. other)***		

2	Type of facility? ***(0=TB service clinic in primary health center, 1=TB clinic in a hospital, 2=TB clinic (standalone) 3= Out-Patient Department (OPD) clinic, 4=HIV care and treatment site 5=In-patient ward 6= Other)***		
3	Does this facility have a designated infection control officer? ***(0=no, 1=yes)***		
4	How many full time staff works at this clinic? (Doctors, nurses, counselors, pharmacists, cleaners etc)?		
5	How many part time staff works at this clinic? (Doctors, nurses, counselors, pharmacists, etc)?		
6	In the last year, how many staff members were diagnosed with TB?		

Administrative (workplace)			
1	Has a facility risk assessment been conducted? ***(0=no, 1=yes)***		
2	Does this facility have a written infection control policy? ***(0=no, 1=yes)*** (if yes, OBTAIN a copy)		

3	What training has staff received on TB infection control?		
4	Are staffs screened for TB? If yes, how? ***(0=no, 1=yes)***		
5	Are staffs offered confidential HIV counseling and testing? ***(0=no, 1=yes)***		
6	At peak time, describe the waiting area? What is the estimated waiting time from registration until seen by a nurse? ***(## min/hr)***		
7	What procedures are in place to identify patients observed to have chronic cough and to fast-track to diagnosis? "Cough officers?"		
8	Are clients observed with chronic cough isolated in separate room or outside while waiting to see a nurse/doctor? ***(0=no, 1=yes)***		
9	Describe education procedures in-place for cough hygiene for TB presumptive TB /patients.		

10	Are posters displaying cough hygiene prominently displayed? ***(0=no, 1=yes)***		
11	Review the path of the patient. Identify bottlenecks such as crowded interior waiting rooms, evaluate time separation & space separation, etc.		
12	HIV care and treatment sites: Do you screen patients for active TB? ***(0=no, 1=yes) If YES, how? Obtain pt encounter from***.		
13	What is the sputum turn-around time for specimens collected on presumptive TB ? (**## days)**		
14	In-patient: Describe any cohort nursing practices observed.		
Respiratory Protection			
1	Are surgical masks or tissue paper available for coughing patients who cannot be separated? ***(0=no, 1=yes)***		
2	Are NIOSH or CEN-rated respirators available for staff? If yes, describe when they are utilized. ***(0=no, 1=yes)***		

Environmental controls			
1	Describe the natural ventilation: - In the waiting area. - In the consultation room - On the ward (in-patient)		
2	Cross-ventilation for air movement: sketch placement windows and doors		
3	In-patient wards: Are windows kept open at night? ***(0=no, 1=yes)***		
4	Is there electricity at this facility? ***(0=no, 1= intermittent, 2=yes)***		
5	If electricity is available, assess options to increase air mixing via use of fans.		

ANNEX E

1. Ventilation

Ventilation is the movement of air to achieve dilution and air exchange in a specific area. This process reduces the concentration of airborne droplet nuclei. To reduce nosocomial risk, the most ideal situation would be one in which fresh air is constantly pulled into a room and the contaminated air is exhausted to the outside, such that the air in the room is changed several times every hour **(Figure 1)**. The most common way in such ventilation can be established is through the use of negative pressure ventilation, in which a room is kept at negative pressure relative to the surrounding area and air is drawn into the room from the corridor and exhausted directly outside. If designed properly, such rooms can be cost-effective. However, the equipment needed requires ongoing maintenance and the air exchange rate may be less that the average air exchange rate from well-designed natural ventilation. More feasible in most settings is the use of natural ventilation or of mechanical ventilation in which the movement of air is facilitated by the use of fans. However, if administrative policies are not in place to ensure windows are open, this environmental control is of minimal effectiveness. Table X shows the time necessary to clear the air of 90%, 99%, and 99.9% of airborne contaminants, in a well-mixed room. The recommended is 12-15 air changes per hour (ACH) designed to achieve 99% effectiveness.

Table X. Air changes per hour (ACH) and time required for removal efficiencies of 90%, 99%, an 99.9% of airborne contaminants*

ACH	Minutes required for removal efficiency†		
	90%	99%	99.9%
2	72	138	207
4	36	69	104
6	24	46	69
12	12	23	35
15	10	18	28
20	7	14	21
24	6	12	17
30	5	9	14
40	4	7	10
50	3	6	8
60	2	5	7
70	2	4	6
80	2	3	5
100	1	3	4
200	<1	1	2
400		<1	1

*This table can be used to estimate the time necessary to clear the air of airborne Mycobacterium tuberculosis after the source patient leaves the area or when aerosol-producing procedures are complete. †Time in minutes to reduce the airborne concentration by 90%, 99%, and 99.9%.

HIERARCHY OF VENTILATION

The hierarchy of ventilation for patient areas is:

A. Keep windows/doors open.

B. Enlarge openings to >20% of floor space (>10% on opposing sides).

C. For new construction, design for proper natural ventilation.

D. Well-designed exhaust-only ventilation.

E. Well-design general ventilation (supply and exhaust, no climate control)

F. Well-designed general ventilation (supply and exhaust, with climate control).

a) Natural ventilation

Ventilation is the movement of air in a building and replacement of air in a building with air from outside. Natural ventilation refers to fresh dilution air that enters and leaves a room or other area though openings such as open doors and/or windows. Natural ventilation is controlled when openings are deliberately secured open to maintain air flow. Unrestricted openings (i.e., cannot be closed) on opposite sides of a room provide the optimal natural ventilation. Propeller fans may be an inexpensive way to increase the effectiveness of natural ventilation, by increasing the mixing of airborne TB as well as assisting in the direction of air movement by pushing or pulling of the air.

Natural ventilation is controlled when openings are deliberately secured open to maintain air flow. Unrestricted openings (that cannot be closed) on opposite sides of a room provide the most effective natural ventilation.

Types of propeller fans

Propeller fans include:

- Ceiling fans,
- Small fans that sit on a desk or other surface,
- Fans that stand on the floor, and
- Fans mounted in a window opening.

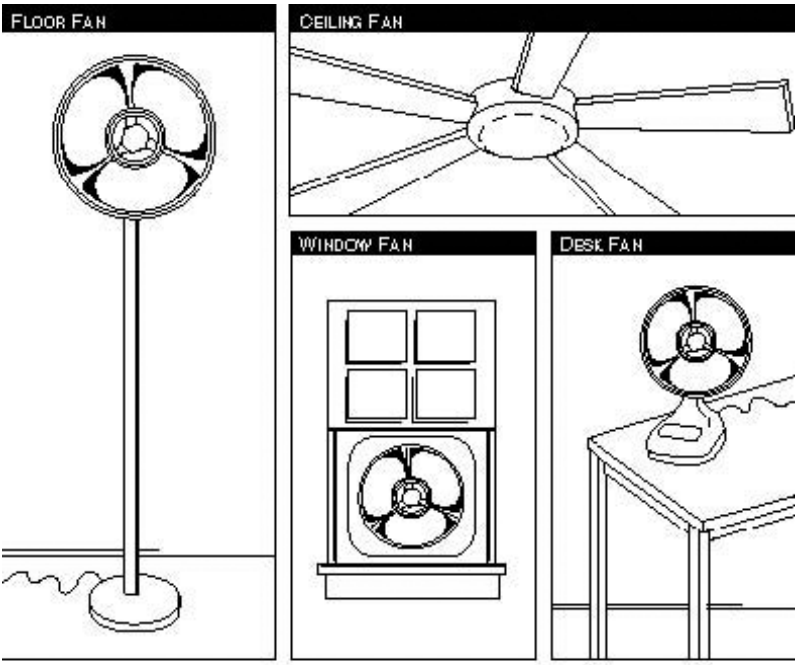

Figure 1. Propeller fans

Air mixing and removal

A propeller fan helps mix air in a room. Mixing of air will reduce pockets of high concentrations, such as in the corners of a room or in the vicinity of patients where natural ventilation alone is not enough. The total number of infectious particles in the room will not change with mixing; however, the concentration of particles near the source will be reduced, and the concentration in other parts of the room may increase.

If this dilution effect is combined with a way to replace room air with fresh air, such as by opening windows and doors, the result will be fewer infectious particles in the room.

A room with an open window, open door, and a fan will have less risk than an enclosed room with no fan, an enclosed room with a fan, or a room with an

open window but no fan. In addition, mixing may increase the effectiveness of other environmental controls.

Directional airflow

If placed in or near a wall opening, propeller fans can also be used to enhance air movement into and out of a room.

Consider fans installed in the windows or through wall openings on the back wall of a building. The fans exhaust air outside, away from people or areas where air may come back into the building. If doors and windows in the front of the building are kept open, the overall effect should be to draw in fresh air through the front of the building and exhaust air through the rear. Health care staff should be mindful of the direction of airflow to ensure the patient is closest to the exhaust fans and the staffs are closest to the clean air source. This arrangement should done every morning.

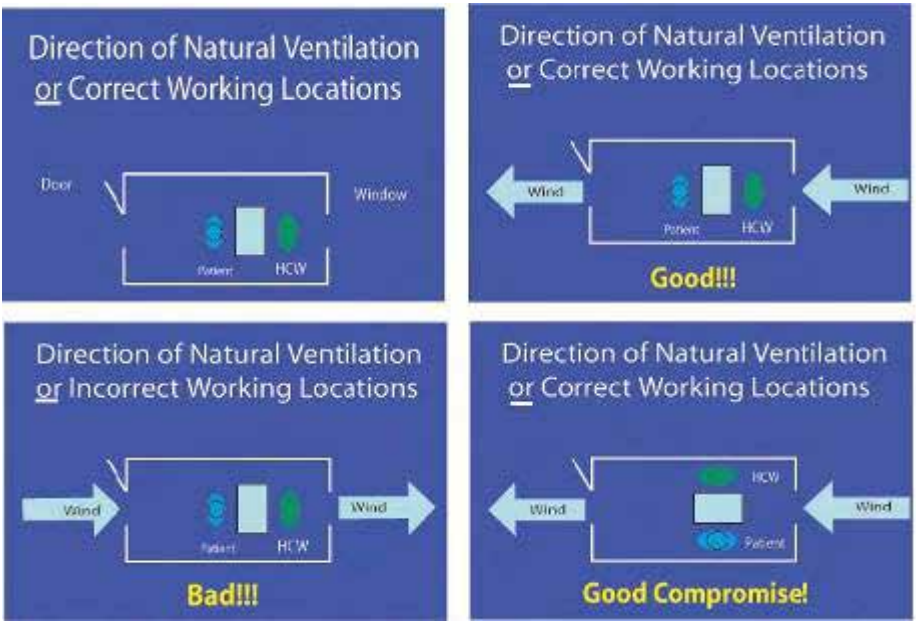

Figure 2

With this arrangement, the risk that TB will be spread is greater near the back of the building; however, once the contaminated air is exhausted, dilution into the environment will be fast.

When fresh air enters a room it dilutes the concentration of particles in room air, such as droplet nuclei containing *M. tuberculosis*. Natural ventilation can be used in medical wards or other sites in health facilities in temperate or tropical climates where windows can be left open. Natural ventilation can occur when a room or ward is of open construction with free flow of ambient air in and out through open windows **(Figure 2)**. Maximizing natural ventilation patterns for the hospital, clinic, ward or room is the simplest approach to achieving better ventilation. Also in temperate or tropical climates, waiting areas should be designed as open-air shelters with a roof to protect patients from sun and rain.

Whenever possible:

- Waiting areas, sputum collection areas, examination rooms, and wards should be "open" to the environment (e.g., established in covered open areas or in areas with open windows). Additionally, windows or other openings may be installed that would allow for more ventilation. Windows and openings should be placed on outer walls such that air moves to the outdoors, not into other wards or waiting areas. The open areas should be equal to at least 10% of the area of the room; >20% is preferable. For example, the minimum window opening for a 3m x 5m room (15 m^2) would be a 1.5 m^2 window, door, or other opening on opposing all.
- When ceiling fans are used, windows should also be left open since diluting and exchanging of the mixed air is the objective

The risk of *M. tuberculosis* transmission is greatest in an enclosed room that contains air with aerosolized infectious droplet nuclei. A room with an open window only at one end provides air exchange near the window; however,

little air is exchanged a short distance from the window. A ceiling or mixing fan may help increase the overall removal of aerosolized infectious droplet nuclei. Ideally, the minimum acceptable condition is openings on opposite ends of a room (windows, window-door, etc.).

b) Mechanical ventilation

In situations where natural ventilation is not feasible or is inadequate, mechanical ventilation can be used to reduce the concentration of infectious droplet nuclei in selected areas or rooms in the health care facility (e.g., patient rooms, waiting rooms, or examination rooms). It is important to use equipment with sufficient power to facilitate air entry into, and exhaust from, the room or area. In other words, if no air is allowed to enter the area, then it will be impossible to exhaust air. It is also important to attempt to direct air movement so that infectious droplet nuclei produced by coughing patients are exhausted *away* from others. Directional air flow should be maintained from a "clean" area, across the HCW, across the patient, and to the outside **(Figure 1)**. The area where air is entering should be located away from the exhaust area to avoid re-entry of contaminated air ("short-circuiting"). Finally, for mechanical ventilation to be acceptable to patients, HCW, and visitors, the air must be tempered (heated or cooled).Window fans are generally an inexpensive and feasible method of providing mechanical ventilation to direct air flow in many resource-limited settings. However, it is important to ensure that air flows across the room (i.e., under a door and out a window, not in and out the same window or vent). Additional methods of mechanical ventilation, which require more resources, include mechanical exhaust systems that pump clean outside air into the building and then exhaust the contaminated room air back outside. Closed recirculation filtration systems, which take room air, filter it to remove infectious droplet nuclei, and then exhausts it back into the room, are effective but expensive and require considerable maintenance. To create both negative pressure and air exchange, some controlled air leakage into the room is needed. The air leakage could be through a 2-3cm slot under the door or a grill near the bottom of the door. If possible, the efficiency of the air exchange in the room

could be enhanced by use of a fan pulling air from the corridor and pushing it into the room. Note that the flow rate of the fan pushing air into the room should be 90% or less than the flow rate of the fan pulling air from the room and exhausting out-of-doors in order that negative pressure is maintained.

c) Monitoring of ventilation and ventilation systems

Checking natural ventilation

People can usually feel the existence or lack of air movement in a space. A ventilated space has a slight draft. In the absence of ventilation, air will feel stuffy and stale and odors will linger. Use the following checklist to assess natural ventilation in your waiting areas and examination rooms:

- Check air mixing and determine directional air movement in all parts of rooms or areas. One way to visualize air movement is to use incense sticks as described in these six steps.
- Hold two incense sticks together and light them.
- As soon as the incense starts to burn, blow out the flame. Now the incense should produce a continuous stream of smoke.
- Observe the direction of the smoke.
- Observe how quickly the smoke dissipates. This is a subjective test that may require some practice (see figure 2). It does not give a definite result but is useful for comparing one room or area to another.
- Check natural ventilation once a year after the prevailing wind patterns have been determined. Recheck if any changes in the physical environment are made and confirm procedures for ensuring free movement of air are followed.
- Keep records of all routine activities and dates.

Checking fans

- Check that all room fans are working and cleaned once a month. Use cloth or vacuum cleaner to remove dust and lint from fans, grilles, and ducts.
- Check that exhaust fans are working and cleaned once a month. Use cloth or vacuum cleaner to remove dust and lint from fans, grilles, and ducts. Clean ducts behind grilles as far back as can be reached.
- To check fans that have a grille, hold a tissue or piece of paper against the grille. If the exhaust fan is working, the tissue or paper should be pulled against the grille.
- Flow rates through exhaust fans and grilles can be measured using a simple velocity meter and a means to measure that velocity over a known cross-sectional area. The air flow rates can be calculated from simple velocity measurements (see Boxes 1 and 2).
- Air exchange rates (also called air-changes per hour) can be calculated as shown in boxes below. If mechanically ventilating a room, the fan should provide a minimum of six air exchanges per hour.
- Keep records of all routine activities and dates.

Box 1. Estimating air velocity
Measure 0.5 meter distance and mark it on a table top. Move your hand from one end to the other (0.5 meters) in one second. This is equivalent to 0.5 m/s. In order to have directional control of contaminants in air, one should have air moving at least 0.5 m/s.
Example air flow circulation: Fan, duct, or box opening: 0.5m high, 0.5m wide Area = 0.5m x 0.5m = $0.25m^2$ Average air velocity through fan, duct, or box opening: 2.5m/s Average flow rate = Average times $0.25m^2$ x 2.5m/s x 3600s/hour = $2.250m^3$/hour

Box 2. Example air exchange rate calculation
Window opening: 0.5 m high, 0.5 m wide Window area = 0.5 m x 0.5 m = 0.25 m^2 Average air velocity through window: 0.5 m/s Room dimensions: 3 m wide, 5 m deep, and 3 m high Room volume = 3 m x 5 m x 3 m = 45 m^3 Average flow rate = Area of window times average air velocity.25 m^2 x 0.5 m/s x 3600 s/hour = 450 m^3/hour Air exchange rate = Average flow rate divided by room volume 450 m^3/hour ÷ 45 m^3 = 10 air exchanges per hour

Ventilation systems should be evaluated regularly to determine if they are functioning properly. The simplest evaluation includes the use of smoke (e.g., smoke tubes, incense, paper, etc.), a tissue, or a simple vinometer to monitor proper airflow direction. If window fans are being used to produce negative pressure, they should be checked frequently to ensure air movement is directional and is adequate. Evaluations should be documented in a maintenance record.

d) Special areas

Certain areas of the health care facility should be considered high risk and a priority if environmental control measures are implemented. These include TB isolation rooms, TB wards, general waiting areas, or other areas such

as intensive care units where TB patients may be housed. Unless natural ventilation is excellent in these areas, mechanical ventilation with window fans to generate directional air flow should be strongly considered.

Other high-risk areas may include sputum induction rooms, bronchoscopy suites, operating rooms, radiology, and autopsy suites **(see Table 5.1)**. These areas should be considered high risk before, during and after procedures. Since large rooms may have little or no air movement and may be difficult to ventilate, a smaller, well ventilated room should be considered for bronchoscopy or other high risk procedures. Environmental control measures should only be implemented as a supplement to effective administrative control measures

Ultraviolet germicidal irradiation (UVGI)

In certain high-risk areas of a facility, use of natural and mechanical ventilation may not be feasible. In these situations, ultraviolet germicidal irradiation (UVGI) or room air cleaners with UVGI may provide a less expensive alternative to more expensive environmental control measures that require structural alterations of a facility. These measures may be particularly useful in larger wards, TB clinic waiting areas or inpatient areas such as television or recreation rooms where TB patients congregate.

Effective use of UVGI ensures that *M. tuberculosis*, as contained in an infectious droplet, is exposed to a sufficient dose of ultraviolet-C (UV-C) radiation at 253.7 nanometers (nm) to result in inactivation. Because dose is a function of irradiance and time, the effectiveness of any application is determined by its ability to deliver sufficient irradiance for enough time to result in inactivation of the organism within the infectious droplet. Achieving a sufficient dose can be difficult with airborne inactivation because the exposure time can be substantially limited; therefore, attaining sufficient irradiance is essential.

Studies show that *M. tuberculosis* is inactivated if the organisms are exposed sufficiently to UVGI. The recommended efficiency is 90% destruction of colony formation. The major concerns about UVGI have been adverse reactions (e.g., acute and chronic coetaneous and ocular changes) in HCWs and patients from

overexposure if the UVGI is not installed and maintained properly. If UVGI is to be used, guidelines as well as manufacturer's instructions regarding installation, cleaning, maintenance, and ongoing monitoring should be carefully consulted.

UVGI may be applied in several forms:

- in sputum collection booths, bare bulbs can be used to irradiate the entire booth when it is not occupied
- If HCWs and patients are in the room, continuous upper air irradiation in which shielding placed below the UVGI sources prevents injury to patients but the upper portion of the room is irradiated can be used
- Portable UVGI floor units also may be used
- An additional more expensive option involves the use of UVGI in combination with a closed mechanical system

Continuous upper air irradiation is the most applicable of the above methods in most resource-limited settings. The advantage of this technology is that the upper air is continuously being irradiated; thus, it provides some protection to the HCW while the infectious patient is in the room. Two laboratory studies have shown a reduction by as much as 80% with incomplete air mixing. Thus, to be effective, this technology requires good air mixing to be effective. Furthermore, structural features such as ceiling height may limit the feasibility and usefulness of UVGI. If portable UVGI is used, attention should be paid to lamp placement, since corners may receive inadequate radiation

The quality of UVGI lamps is very important. Usually a good one will last 5,000 to 10,000 hours (7-14 months). After that, the irradiance may drop off. Responsibility should be assigned to ensure the lamps are cleaned and monitored properly to avoid adverse HCWs and patients' exposure, that air flow patterns maximize *M. tuberculosis* UVGI inactivation, and that UVGI output is adequate. (Maintenance and replacement of Lamps)

5.5 Room Air Cleaners

In small rooms with a limited number of patients or in other small, enclosed areas, room air cleaners with HEPA filters may be a useful alternative to mechanical ventilation requiring structural changes or to UVGI. Room air cleaners with HEPA filters may be free-standing or may be permanently attached to floors or ceilings to minimize tampering. If possible, the units can be exhausted outdoors, thereby creating a negative pressure isolation room.

If portable room air cleaners are used, unrestricted airflow is essential; placing the unit close to furniture or putting items on top of the units may compromise their function. Careful regular monitoring is essential.

Room air cleaners with other air-cleaning technologies are commercially available. However, the effectiveness of portable room air cleaners has not been evaluated adequately, and there is probably considerable variation in their effectiveness. HEPA or other filters may also be used in exhaust ducts or vents that discharge air from booths or enclosures into the surrounding room; however, one must ensure that the filters are replaced with identical filters. If a filter other than specified in the original design document is used, the flow rate may be adversely affected. In any application, HEPA or other filters should be installed carefully and maintained meticulously to ensure adequate function. Manufacturers of room-air cleaning equipment should provide documentation of the HEPA or other filter efficiency, or the efficiency of the novel air-cleaning technology, and the efficiency of the installed device in lowering room-air contaminant levels.

Table 5.1

High Risk Areas for Nosocomial *M. tuberculosis* Transmission

TB patient isolation areas/rooms
Areas/rooms where sputum is collected or induced
Bronchoscopy suites
Surgical suites
Intensive care units
Autopsy suites

Glossary and Abbreviations

Administrative control measures: defined as the managerial or work practices (e.g., early diagnosis and testing prompt isolation or separation of potentially TB patients, prompt initiation of appropriate anti-tuberculosis treatment, minimize aerosol-generating procedures) to reduce significantly the risk of TB transmission by preventing the generation of droplet nuclei and limiting exposure to droplet nuclei.

Aerosol: liquid or solid particles dispersed in air, that are of fine enough particle size (0.01 to 100 micrometres) to remain airborne for a period of time.

A **bacteriologically confirmed TB case** is one from whom a biological specimen is positive by smear microscopy, culture or WRD (such as Xpert MTB/RIF). All such cases should be notified, regardless of whether TB treatment has started.

A **clinically diagnosed TB case** is one who does not fulfill the criteria for bacteriological confirmation but has been diagnosed with active TB by a clinician or other medical practitioner who has decided to give the patient a full course of TB treatment. This definition includes cases diagnosed on the basis of X-ray abnormalities or suggestive histology and extra pulmonary cases without laboratory confirmation. Clinically diagnosed cases subsequently found to be bacteriologically positive (before or after starting treatment) should be reclassified as bacteriologically confirmed

Acid-fast bacilli (AFB): rod-shaped bacteria that do not lose their stain when exposed to acid-alcohol mixture after the staining process, i.e. *Mycobacterium tuberculosis* and all mycobacterium.

Bacille Calmette-Guérin (BCG) vaccination: A live vaccine against TB derived from an attenuated strain of *Mycobacterium bovis*. Efficacious in prevention of disseminated forms of TB in children; of debatable efficacy against adult forms of TB.

Biological Safety Cabinet Class I (BSC I): cabinet that protects the worker and the environment from exposure to an aerosol by drawing air into the cabinet, but provides no product (specimen/culture) protection. It is similar in air movement to a chemical fume hood or ventilated cabinet, but has a HEPA filter

in the exhaust system to protect the environment. The exhaust air is either exhausted outside or recirculates into the room. Also see Laboratory Fume Hood.

Biological Safety Cabinets Class II (BSC II, Types A, B1, B2, and B3): cabinet that protects the worker, the environment, and the product (specimen/ culture) from exposure to an aerosol. Air flow is drawn around the worker into the front grille of the cabinet, which provides worker protection. In addition, the downward laminar flow of HEPA-filtered air provides product (specimen/ culture) protection by minimizing the chance of cross-contamination along the work surface of the cabinet. Because cabinet air exhaust is passed through a certified exhaust HEPA filter, it should be contaminant-free (environmental protection), and may be re-circulated back into the laboratory (Type a BSC) or exhausted out of the building (Type B BSC).

CDC: Centers for Disease Control and Prevention

Sub County level health care facility: defined as aid posts, dispensaries, health centres, and hospitals.

DOTS: Directly Observed Treatment, Short-course chemotherapy. World Health Organization Strategy for TB control.

Droplet nuclei: microscopic particles which are an estimated 1-5 micrometres in diameter and are produced when a person coughs, sneezes, shouts or sings. The droplets can remain suspended in the air for long periods and be carried on normal air currents.

Endogenous reactivation: The tubercle bacilli resulting from primary infection can remain alive within their human host for his/her lifetime, and at any time it can start multiplying to produce the progression to pulmonary tuberculosis.

Environmental control measures: measures that can be used in high-risk areas to reduce the concentration of droplet nuclei in the air (e.g., maximizing natural ventilation and controlling the direction of airflow).

Exhaust ventilation: most efficient control technique (e.g., laboratory hoods, tents, booths, ventilation device) to contain airborne particles near the source

before they can disperse widely into the air.

Exogenous re- infection: The inhalation of tubercle bacilli by individuals, who had a primary tuberculosis infection in the last five years, generates a high risk of development of pulmonary tuberculosis soon after this reinfection.

Extensively Drug Resistant (XDR-TB): XDR-TB is defined as resistance to at least rifampicin and isoniazid from among the first-line anti-TB drugs (which is the definition of MDR TB) in addition to resistance to any fluoroquinolone, and to at least one of three injectable second-line anti-TB drugs used in TB treatment (capreomycin, kanamicin, and amikacin).

Fit testing: The use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on a person.

HEPA filter: filter that provides a minimum removal efficiency of 99.97% of particles 0.3 micrometers in diameter.

Health care workers (HCWs): group of people that includes nurses, physicians, nursing and medical students, laboratory workers, housekeeping staff and others who work in health care settings (whether or not paid) and who may be exposed to patients with communicable diseases.

Health care setting: a place where health care is delivered.

HIV: Human immunodeficiency virus, the causative agent of the acquired immunodeficiency syndrome (AIDS).

Infection with *M. tuberculosis*: the subclinical, latent infection with tubercle bacilli, manifested by a positive tuberculin skin test, but without clinical evidence of disease.

Infection, prevention and control (IC): specific measures and work practices that reduce the likelihood of transmitting *M. tuberculosis.*

Isolation room: patient room (ideally single) where infectious TB patients should be isolated from other patients.

IUATLD: International Union Against Tuberculosis and Lung Disease.

Laboratory Fume Hood: a type of engineering control designed for purposes

of worker protection (but not protection of the environment or the product [specimen/culture]. These devices are exhausted directly out-of-doors and are designed to minimize worker exposures. They may be used for sputa smears and other aerosol-generating procedures where product protection is not critical.

Mechanical ventilation: methods used to direct airflow and to produce negative pressure in isolation rooms (e.g., window fan, exhaust ventilation systems, etc).

Multidrug-resistant tuberculosis (MDR-TB): TB caused by strains of *M. tuberculosis*, which are resistant to both isoniazid and rifampicin with or without resistance to other drugs.

Mycobacterium tuberculosis: the bacterium that causes TB.

Natural ventilation: defined as natural air movement to achieve dilution and air exchange in an area with free-flow of ambient air through the open windows, doors, and other means.

Negative pressure ventilation: permits the control of the air-flow direction so the room with negative pressure has a lower pressure than adjacent areas, which keeps air from flowing out of the room and into adjacent rooms or areas. It is the relative air pressure difference between two areas in a health care facility.

Nosocomial: referring to an occurrence, usually an infection, acquired in a health facility or as a result of medical care.

Personal protective equipment: personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, which should be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, biological hazards, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

Presumptive TB refers to a patient who presents with symptoms or signs

suggestive of TB (previously known as a *TB suspect*).

Respiratory protection: respiratory protective device used in health care setting which fits over the mouth and nose and are designed to protect against transmission of *M. tuberculosis* by reducing the number of inhaled infectious droplet nuclei.

Recirculation filtration system: more expensive option used in ventilation systems to remove droplet nuclei by a filtration system which then exhausts the air back into the room.

Referral level health care facility: defined as regional or national referral and university hospitals.

Respirators: special type of closely-fitted device with the capacity to seal to the face and filter 0.3-0.4 micrometer particles with an efficiency of at least 94-95%, to prevent the wearer from inhaling infectious droplet nuclei.

Smoke tubes: device used to generate visible, non-hazardous smoke which can be used to monitor proper airflow direction and assist in assessing the proper function of ventilation systems

Symptom screen: A procedure used during a clinical evaluation in which

Patients are asked if they have experienced any departure from normal in function, appearance, or sensation related to TB disease (e.g., cough).

Surgical or procedure mask: cloth or paper mask that prevents the spread of micro-organisms from the wearer to others by capturing the large wet particles near the source (mouth); it may not provide protection from inhaling infectious droplet nuclei, such as *M. tuberculosis* (see Respirators). Surgical or procedure masks are also known as face masks.

Treatment after loss to follow-up patients, have previously been treated for TB and were declared *lost to follow-up* at the end of their most recent course of treatment. (These were previously known as *treatment after default* patients.)

Tuberculin skin testing (TST): intracutaneous injection of purified protein derivative (PPD) to identify persons who have been sensitized to mycobacterial

antigens by infection with *M. tuberculosis*, non tuberculous mycobacteria or administration of BCG.

Tuberculosis (TB): a clinically active, symptomatic disease caused by bacteria belonging to the *M. tuberculosis* complex (*M. tuberculosis*, *M. bovis*, *M. africanum*).

TB screening: An administrative control measure in which evaluation for LTBI and TB disease are performed through initial and serial screening of HCWs, as indicated. Evaluation might comprise TST, BAMT, Chest radiograph and symptom screening. See also symptom screen

Symptom screen: A procedure used during a clinical evaluation in which patients are asked if they have experienced any departure from normal in function, appearance, or sensation related to TB disease (e.g., cough).

Triage: The process of sorting people based on their need for immediate medical treatment as compared to their chance of benefiting from such care. Triage is done in emergency rooms, disasters and wars when limited medical resources must be allocated to maximize the number of survivors.

Ultraviolet germicidal irradiation (UVGI): defined as an environmental control measure to inactivate micro-organisms like *M. tuberculosis.* UVGI is a form of electromagnetic radiation with wavelengths between the blue region of the visible spectrum and the radiograph region, and is not visible (i.e., the blue glow from a UVGI lamp is not the germicidal wavelength). UV-C radiation (short wavelengths; range: 100–280 nm) can be produced by various artificial sources (e.g., arc lamps and metal halide lamps). The majority of commercially available UV lamps used for germicidal purposes are low-pressure mercury vapor lamps that emit radiant energy in the UV-C range, predominantly at a wavelength of 253.7 nm.

WHO: World Health Organization.

References:

1. *Tuberculosis Infection Control in the Era of Expanding HIV Care and Treatment, CDC-WHO, 2006*
2. *Guidelines for the Prevention of Tuberculosis in Health Care Facilities in Resource-Limited Settings, WHO, 1999*

For more information contact:

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Website:www.nltp.co.ke

The Global Fund
To Fight AIDS, Tuberculosis and Malaria