

Federal Ministry of Health

GUIDELINE

FOR

**PREVENTION OF TRANSMISSION OF
TUBERCULOSIS**

**IN HEALTH CARE FACILITIES, CONGREGATE AND
COMMUNITY SETTINGS IN ETHIOPIA**

First Edition

April 2009

CONTENTS

<u>CONTENTS</u>	ii
<u>LIST OF TABLES</u>	V
<u>LIST OF BOXES</u>	V
<u>LIST OF FIGURES</u>	V
<u>ABBREVIATIONS</u>	vi
<u>FOREWORD</u>	vii
<u>ACKNOWLEDGMENT</u>	X
<u>GLOSSARY</u>	Xii
<u>1. INTRODUCTION</u>	1
<u>2. PATHOGENESIS AND TRANSMISSION OF TB</u>	3
<u>2.1 Review of transmission and pathogenesis MTB</u>	3
<u>2.2 Difference between TB infection and TB disease</u>	5
<u>2.2.1 TB Infection</u>	5
<u>2.2.2 TB Disease</u>	6
<u>2.3 Factors affecting the risk of M. tuberculosis infection</u>	7
<u>2.3.1 Patient Characteristics</u>	7
<u>2.3.2 Environmental factors</u>	8
<u>2.3.3 Host characteristics</u>	8
<u>2.4 Bacille Calmette-Guérin (BCG) vaccination and TB infection</u>	9
<u>2.5 Risk of disease following infection</u>	9
<u>2.6 Risk of Nosocomial Transmission of TB to Health Care Workers</u>	10
<u>3 TB INFECTION CONTROL SET OF INTERVENTIONS</u>	11
<u>3.1 MANAGERIAL ACTIVITIES</u>	13
<u>3.1.1 Intervention 1: Identify, strengthen coordinating bodies</u>	13
<u>3.1.2 Intervention 2: Health facility design, construction</u>	16
<u>3.1.3 Intervention 3: Surveillance and assessment</u>	20
<u>3.1.4 Intervention 4: Engage civil society</u>	22
<u>3.1.5 Intervention 5: Conduct monitoring and evaluation</u>	23
<u>3.1.6 Intervention 6: Enable and conduct operational research</u>	24
<u>3.2 Administrative controls</u>	24
<u>3.2.1 Intervention 7: Develop strategies to identify infectious cases</u>	25
<u>3.2.2 Intervention 8: Package of prevention and care</u>	28
<u>3.3 Environmental controls</u>	29
<u>3.3.1 Intervention 9: Natural ventilation</u>	30
<u>3.3.2 Intervention 10: Mechanical ventilation</u>	33

3.3.3	Intervention 11: Upper room or shielded ultraviolet irradiation	36
3.4	Personal protective interventions	39
3.4.1	Intervention 12: Use of respirators	40
3.5	Consideration for special areas	42
3.5.1	TB Hospitals and MDR-TB Treatment Facilities	42
3.5.2	Waiting areas	43
3.5.3	Radiology	43
3.5.4	Sputum induction and cough-inducing procedures	44
3.5.5	Surgical and Autopsy suites	44
3.5.6	Intensive care areas	45
3.5.7	Immunosuppression and TB	45
4.	PRIORITIZING INTERVENTIONS	47
4.1	TB infection control interventions	47
4.2	TB Infection Control Plan	50
4.2.1	Lifecycle of infection control plans	50
4.2.2	Training of Staff	51
5.	REDUCING TRANSMISSION OF TB IN HOUSEHOLDS	53
6.	TB INFECTION CONTROL FOR CONGREGATE SETTINGS	55
6.1	Managerial activities in congregate settings	55
6.2	Administrative controls in congregate settings	56
6.3	Environmental controls in congregate settings	56
6.4	Personal protective interventions in congregate settings	57
7.	LABORATORY SAFETY	57
7.1	AFB Smear preparation	58
7.2	Preparation of liquid suspensions of M. tuberculosis	59
7.3	Ventilated Cabinets	59
7.3.1	Laboratory Fume Hoods	59
7.3.2	Biological Safety Cabinets (BSCs)	61
7.4	Respiratory protection in the laboratory	61
7.5	Document laboratory accidents and investigate accordingly	62
7.6	Disinfection, sterilization and disposal of contaminated materials	64
	ANNEX 1. SUMMARY OF ADMINISTRATIVE CONTROL MEASURES	65
	ANNEX 2. SAMPLE OF INFECTION CONTROL PLAN	71
	ANNEX 3. AN EXAMPLE OF MONITORING TOOLS	72
	ANNEX 4. TB INFECTION CONTROL ASSESMENT TOOLS	72
	ANNEX 5. PROTOCOL FOR RISK ASSESSMENT	79

<u>ANNEX 6. PATIENT MANAGEMENT</u>	80
<u>ANNEX 7. AIR CHANGES IN A ROOM</u>	82
<u>REFERENCES</u>	83

LIST OF TABLES

<u>Table 1: The distinction between TB Infection versus TB Disease.....</u>	<u>6</u>
<u>Table 2: Package of interventions for TB infection control in health-care settings.</u>	<u>12</u>
<u>Table 3. Risk classification for Health care facilities.....</u>	<u>21</u>
<u>Table 4. Prioritization of TB infection control measures</u>	<u>48</u>

LIST OF BOXES

<u>Box 1. TB Risk Factors for Health Care Workers.....</u>	<u>11</u>
<u>Box 2.Critical elements in diagnostic services.....</u>	<u>24</u>

LIST OF FIGURES

<u>Figure 1 Natural ventilation; Free flow of air in and out through open windows.....</u>	<u>16</u>
<u>Figure 2. Building designs.....</u>	<u>18</u>
<u>Figure 3:HCW and patient placing.....</u>	<u>19</u>
<u>Figure 4.Propeller fans.....</u>	<u>31</u>
<u>Figure 5.Room airflow patterns to provide mixing of air</u>	<u>34</u>
<u>Figure 6. Smoke tube testing and manometer placement.....</u>	<u>35</u>
<u>Figure 7. Negative pressure room.</u>	<u>35</u>
<u>Figure 8. Lifecycle of infection control programs.....</u>	<u>51</u>
<u>Figure 9: The laboratory layout ensuring adequate ventilation.....</u>	<u>57</u>

FOREWORD

The Federal Ministry of Health of Ethiopia is translating its vision to tangible results through its Health Sector Development Program (HSDP). The HSDP focuses on five major areas to which Tuberculosis prevention and control fits in.

Tuberculosis is a major cause of morbidity and mortality in Ethiopia, and the country belongs to the list of most affected High Burden Countries. Compounded with HIV/AIDS, TB has become a formidable threat to the country. The burden of TB in Ethiopia is estimated at 163 new smear-positive cases per 100,000 population according to the World Health Organization global TB report 2009.

The estimated Multi Drug Resistant TB (MDR-TB) cases in the country is 1.6% and 12 % among all new and previously treated TB cases, respectively. This newly emerging public health problem poses another burden on the already constrained health care delivery.

Cognizant to this challenge, Federal Ministry of Health of Ethiopia is creating enabling environment at National, Regional and Facility level to contain the emerging MDR-TB challenge. To that end, there are ongoing efforts in resource mobilization, developing MDR-TB guideline, capacity building of experts, site renovation and external communications to Green Light Committee, WHO.

This TB Infection Control Guideline is an additional instrument in responding to TB infection control in general and also to the newly emerging MDR-TB challenge in the country, in particular. The guideline can serve as an important reference in the TB infection control areas: Managerial, Administrative, Environmental and Personal. This guideline will be a valuable tool for practitioners in the areas of TB and MDR-TB and for program managers in the health system as well.

Finally, I would like to express my sincere gratitude and appreciation to the TBCAP/USAID for the valuable technical and financial inputs

it provided towards the development and printing of this TB Infection Control Guideline.

Yibeltal Assefa, MD, MSc.

Director, Medical Services Directorate, FMOH

ABBREVIATIONS

ACH	Air Changes per Hour
ACSM	Advocacy Communication and Social Mobilization
AFB	Acid Fast Bacilli
AIDS	Acquired Immune deficiency Syndrome
ARV	Anti-retroviral
BCG	Bacille Calmette-Guérin (BCG) vaccine
BSC1	Biological Safety Cabinet 1
BSC2	Biological Safety Cabinet 2
CDC	Centre for disease control and Prevention
DOT	Directly Observed Treatment
DOTS	Directly Observed Treatment Strategy
HCWs	Health Care Workers
HEPA	Highly Efficiency Particulate Air Filter
HIV	Human Immune deficient Virus
IEC	Information Education communication
MDR-TB	Multi-Drug Resistant TB
MTB	Mycobacterium Tuberculosis
OPD	Out Patient department
PLHIV	People Living with HIV
PPD	Purified Protein Derivative
TB	Tuberculosis
TB IC	TB infection Control
TST	Tuberculin Skin test
UVGI	Ultra Violet Germicidal Irradiation
XDR-TB	Extensively drug resistant TB

ACKNOWLEDGMENT

Ethiopia is among the MDR-TB high burden countries, being affected the problem. Therefore it is high time to effectively respond to the MDR-TB in a comprehensive manner, jointly with all stakeholders. The development of this TB infection guideline will be of paramount importance to effectively address the challenges posed by TB and MDR-TB. The development of this guideline is an expression of the response initiated and being further strengthened by the Federal Ministry of Health and its development partners. In the development of this guideline the expertise contribution of the following resource persons deserve special mention:

Ridwan Bushra (TLCT/FMoH)	Challa Negeri (TBCAP/MSH)
Ezra Shimelis (TBCAP/KNCV)	Bekele Fekede (St Peter Hospital)
Beniam Feleke (CDC-E)	Genet Gerese (TLCT/FMoH)
Getachew Wondimagegn (CU-ICAP/FHAPCO)	Bekele Chaka (EPHA)
Dawit Assefa (CU-ICAP-E)	Haimanot G/Egzabher (AHRI)
Daniel Meresa (St Peter Hospital)	Hiwot Solomon (TLCT/FMoH)
Mohammad Abseno (St Peter Hospital)	Kedir Yimer (JHU/TSEHAI)
Tesfaye Abicho (Consultant)	Alemayehu Mekonnen (AAU, School of PH)
Diriba Agegnehu (WHO/TLCT)	Fikrite Mulatu (AHRI)
Michael Zerihun (AAU)	Fahmi Mohammad (WHO)

The following experts served as core group members and finalized the draft guideline and deserve a very special mention:

Dr Ezra Shimelis (TBCAP/KNCV)

Ms Hiwot Solomon TLCT/FMoH

Dr Getachew Wondimagegn CU-ICAP/FHAPCO

Dr Dawit Assefa CU-ICAP/E

Dr Tesfaye Abicho (Consultant)

The following international experts played key role in development of this guideline, and the Federal Ministry of health is indebted to their contribution;

Dr Amos Kutwa (KNCV-East Africa): He has been actively involved since the initial draft and throughout the whole write-up process.

Dr Max Meis (TB-IC officer, KNCV-The Hague): He has reviewed final draft and contributed important comments.

GLOSSARY

Administrative control measures: defined as patient management or work practices (e.g., early diagnosis, 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 micrometers) to remain airborne for a period of time.

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 mycobacteria.

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 recirculated 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 recirculated back into the laboratory (Type A BSC) or exhausted out of the building (Type B BSC).

CDC: Centers for Disease Control and Prevention

District 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 micrometers 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 re-infection.

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 fluoroquinolones, and to at least one of three injectable second-line anti-TB drugs used in TB treatment (capreomycin, kanamycin, and amikacin).

Fit testing: The use of a protocol to select the best 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 and IGRA, but without clinical evidence of disease.

Infection 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.

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.

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 90%, 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.

Tuberculin skin testing (TST): intracutaneous injection of purified protein derivative (PPD) to identify persons who have been sensitised to mycobacterial antigens by infection with *M. tuberculosis*, nontuberculous 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: A surveillance system in which evaluation for LTBI and TB disease are performed through initial and serial screening of HCWs, as indicated. Evaluation might comprise TST, IGRA, 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 has traditionally been done in emergency rooms, disasters and wars when limited medical resources must be allocated to maximize the number of survivors. And is recommended now for promptly identification of TB suspects in order to separate them from general patients and minimize time spent at a health facility. Triage is defined as an administrative control.

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.

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.

WHO: World Health Organization.

1. INTRODUCTION

New challenges such as the impact of dual TB and HIV epidemic and the increasing cases with drug resistant TB (M/X/DR-TB) have led to the urgent need for TB prevention and control in health care and community settings. The situation is worsened by the increasing number of patients without corresponding infrastructure expansion and health care worker enrolment, leading to overcrowding of patients, delayed diagnosis and treatment resulting into increased TB transmission. Maximization of collaboration between TB and HIV programs is therefore highly recommended.

Health care workers are at increased risk of TB infection and disease compared to the general population. Recent reviews in low and middle income countries mirror earlier studies in documenting an increased risk of TB¹². Non-medical staff in health care settings are also at risk, where undiagnosed pulmonary TB patients with cough are presenting the risk of TB infection to close contacts and health care workers. Crowding and poorly ventilated environments increase this risk. Waiting rooms and corridors where patients wait to receive medical care are often areas of particular risk. The risk of transmission increases when the prevalence of HIV in the population is high. Laboratories, particularly those carrying out *M. tuberculosis* culture procedures, are also high risk areas.

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 control is to suspect and screen patients for TB, to separate potentially infectious patients, to diagnose TB rapidly, and to treat rapidly, thereby eliminating the source of infection. Strengthening TB diagnostic procedures: laboratory services and chest X-ray should be considered as key components in all TB infection control plans.

1 Joshi, et al; Tuberculosis among health-care workers in low and middle-income countries: A systematic review. *PLoS Med* 3(12): e494. doi:10.1371/journal.pmed.0030494

2 Thesis of G. de Vries, The Netherlands

While most of the care provided to patients with TB occurs at the district level, HIV-infected TB patients and drug-resistant patients may be referred to higher levels. 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. Thus, it will be important to do infection control risk assessments at all services delivery points.

Ethiopia reported 141,909 all types of TB in 2007; this being one of the largest reported caseloads in the world after China, India, Nigeria and South Africa. Assuming that these cases were reported by 773 health facilities (138 hospitals and 668 Health centers), one health facility reports a national average of 184 TB cases. This is far in excess of the stipulated minimum of six (6) TB cases reported in a health facility per year for it to be regarded as a high risk transmission area. This means that there is an on-going potential risk of transmission of tuberculosis in most if not all health care facilities in Ethiopia.

Recent assessment established that most of these health facilities have nonexistent or ineffective TB infection control (IC). In the same settings, HIV infected persons seek or receive diagnosis, care and treatment. The PLHIV, who might also be HCWs are at an increased risk of TB infection. Another concern is the growing threat from drug resistant TB cases, especially from MDRTB patients yet to be started on treatment.

A rapid TB risk assessment done in some of these health care facilities established that common factors contributing to *M. tuberculosis* transmission can be improved with simple and, in many instances, inexpensive control measures. The first and most important being rapid diagnosis, treatment and isolation of infectious TB patients.

There is sufficient government goodwill for establishment of infection prevention and control program, what is now required is the health authorities, and HCWs themselves to prioritize infection control for their own maximum safety. This takes cognizant of the fact that HCWs are a valuable and often scarce resource, and their expertise cannot be easily

replaced in event of death from preventable diseases.

These guidelines consist of measures to reduce the risk of transmitting tuberculosis to HCWs, patients, volunteers, visitors and other persons in the health care settings. It focuses on the safety of HCWs and reduction of patient to patient transmission. Transmission from HCWs to patients, though infrequent will also be reduced.

The interventions apply to TB clinics, wards, and HIV care centers in health centers, hospitals. Prior to implementation, risk assessment should be performed in each health facility to determine the package of interventions which will form infection control plan for the facility. The plan should be reviewed annually.

These guidelines also contain interventions for infection control and prevention of tuberculosis in congregate and other community settings. They also address new challenges posed by the increasing drug resistant TB and immune-compromised patients. Infection prevention & control is multi-disciplinary. The interventions, even those that are TB specific eventually strengthen the health systems because they draw from different areas of expertise in design and implementation and improve collaboration between disciplines. Once established, a sound infection control structure can provide a basis from which other programmes can benefit from.

2. PATHOGENESIS AND TRANSMISSION OF TB

2.1 REVIEW OF TRANSMISSION AND PATHOGENESIS MTB

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

- *Mycobacterium tuberculosis* is carried in airborne particles, also called droplet nuclei, which can be generated when persons suffering from pulmonary tuberculosis disease sneeze, cough, laugh or speak.

- 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 lungs, the organisms are taken up by the alveolar macrophages and may be contained or further spread throughout the body depending on the immune response.
- 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



Picture 1. Sneezing liberates many organisms

The main source of TB infection is a person with active pulmonary TB disease. The route of transmission of TB bacilli is airborne by aerosols generated when infectious patients

speak, laugh, cough or sneeze. A sneeze liberates 4, 500 to 1 million organisms at once, a cough liberate 0-3,500 organisms and talking liberate 0-200 organisms³. When the droplet containing tubercle bacilli evaporate,

³ Number and size of organisms liberated “Wells 1934, Duguid 1945”

they diminish in size and remain suspended in the air for several hours and even days. On inhalation, the droplet nucleus ($\leq 5 \mu$ in size) reaches an alveolus in the lung leading to TB infection. Initially, macrophages and lymphocytes which migrate to the region are able to arrest multiplication of the bacilli, however, when the initial defence mechanism fails, primary TB develops.

The vast majority (90%) of HIV-negative people who are infected with TB organisms do not develop active TB disease. In these healthy, asymptomatic individuals, the only evidence of infection is usually a positive tuberculin skin test or positive whole blood Interferon Gamma Release Assay (IGRA), as an alternative to the TST. 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 decreases for a prolonged period of time. Infection may progress to TB disease due to various factors, the most important being the weakening of immune resistance, especially by HIV infection. TB disease can affect most tissues and organs, but in majority of cases commonly involves the lungs.

2.2 DIFFERENCE BETWEEN TB INFECTION AND TB DISEASE

2.2.1 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 on 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 immunosuppressant 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 isoniazid can reduce the risk that TB disease will develop, though the protective benefit only lasts about two years in persons with HIV infection.

2.2.2 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 productive cough which is sometimes blood stained.
- General symptoms of TB disease include fever, sweating at night, and 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. Table 1: The distinction between TB Infection versus TB Disease

Descriptions	TB Infection	TB Disease (in the lungs)
<i>M. tuberculosis</i> in the body		
Tuberculin skin test reaction usually positive		
Symptoms	No	Yes (Cough, fever...)
Chest x-ray	Normal	Abnormal
Sputum smears	Negative	Usually positive*
Culture	Negative	Positive
Infectiousness	No	Yes
A case of TB	No	Yes

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

2.3 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 infection can be due to patient factors, environmental factors and host (or recipient) factors.

2.3.1 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
- Untreated or insufficient anti-tuberculosis treatment

Patients with drug-susceptible TB usually become noninfectious within two weeks 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 induce coughing causing 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 and culture 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.

2.3.2 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

2.3.3 Host characteristics

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

- Severe immune suppression due to HIV infection may increase the risk of TB infection and early TB disease following exposure.^{4,5}
- HIV is the strongest known risk factor for progression from TB infection to TB disease
- Persons who use tobacco, alcohol may also be at increased risk for infection and disease.
- Persons with malnutrition and diabetes.

4 Cobo J, Moreno L, Guerrero A et al. Increased Risk of Tuberculosis Infection in HIV-Infected Patients with Severe Immunosuppression, 9th Conf Retrovir Oppor Infections. Seattle, Wash. 2004 Feb 24-28; 9; abstract no. 622-W.

5 Sonnenberg P, Glynn JR, K Fielding, et al. How Soon after infection with HIV Does the Risk of Tuberculosis Start to Increase? A Retrospective Cohort Study in South African Gold Miners. *Journal of Infectious Diseases*. 2005; 191; 150-8.

2.4 BACILLE CALMETTE-GUÉRIN (BCG) VACCINATION AND TB INFECTION

The Bacille Calmette-Guérin (BCG) vaccine is one of the most widely-used childhood vaccines. Though BCG has a documented protective effect against meningitis and disseminated childhood TB, it does not prevent primary infection or reactivation of latent infection, which is the principal source of transmission in the community. 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.

2.5 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

Factors affecting the risk of developing active TB disease:

- 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.)
- Age at time of exposure to TB bacilli

2.6 RISK OF NOSOCOMIAL TRANSMISSION OF TB TO HEALTH CARE WORKERS

The assessment of occupational risk of TB for HCWs in Ethiopia is complicated by:

- The difficulty of collecting TB incidence data among HCWs, partially due to the stigma associated with having TB and lack of special staff clinics.
- A high prevalence of *M. tuberculosis* infection and disease in the general population
- The widespread use of BCG vaccination, which often 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 HCWs friendly HIV care services
- Absence of screening tools for identifying latent TB infection in an environment of BCG vaccination and other mycobacteria

Increased risk has been documented in health care workers (HCWs) including, but not limited to, nurses, physicians, nursing and medical students, laboratory workers, and housekeeping staff.⁶ The risk is increased for those working in TB clinics, dispensaries, sputum induction rooms, and outpatient waiting rooms (or corridors) and medical wards where undiagnosed pulmonary TB patients with cough are in close contact with health staff.

The exponential expansion of HIV care and treatment in recent years has brought highly susceptible individuals, TB suspects and patients in close proximity, thereby increasing risk of TB transmission. MDR TB poses an additional risk to susceptible individuals. Other settings of concern

6 World Health Organization. Guidelines for the prevention of TB in health care facilities in resource-limited settings. Geneva, World Health Organization, 1999.

include emergency rooms, HIV wards, laboratories and congregate settings such as correctional institutions (jails, prisons, detention centers, refugee camps), orphanages and drug rehabilitation centers.

Box 1. TB Risk Factors for Health Care Workers

- Work involves diagnosis and treatment of TB patients
 - Frequent and direct patient contact
 - Duration of patient contact
 - Frequent contact with TB patients who have not yet been started on treatment
 - Work involves cough-inducing procedures
 - Work in environments with limited or no infection control procedures in place
 - HIV status
- “Undiagnosed and untreated TB suspects and patients pose the greatest threat to Health Care Workers”

In general, the level of risk of TB transmission to HCWs varies with the setting, occupation, patient population, and effectiveness of TB infection control measures. TB transmission to HCWs is higher in facilities that manage large numbers of TB patients who are not timely identified; do not receive rapid diagnosis, isolation and treatment, in the absence of infection control measures.

3 TB INFECTION CONTROL SET OF INTERVENTIONS

This chapter provides a mixture of TB infection control interventions which health facilities can choose from depending on climatic, cultural, cost and programmatic factors. They are promoted as a set because available evidence indicates that when implemented the combination reduces transmission of TB in health-care facilities. The backbone of effective TB control still remains:

- Early diagnosis of potentially infectious tuberculosis (TB) patients,
- Prompt initiation of appropriate anti tuberculosis treatment;
- Separating patients according to their potential infectiousness,

These three principles are also the primary focus of the TB infection control plan. It is recommended that all health-care facilities develop TB infection control plans (manuals and procedures) to minimize or avoid transmission.

The interventions listed in Table 2, fall into four main categories – **managerial activities, administrative controls, environmental controls and personal protective interventions**. Each intervention operates at a different point in the MTB transmission process. Managerial activities at national and facility levels must be given the highest priority since they establish the program for implementation, operation and maintenance of the other interventions.

Table 2: Package of interventions for TB infection control in health-care settings

Organizational activities
1 Identify and strengthen coordinating bodies, and develop a comprehensive human resources plan for planning and implementation at all levels
2. Health facility design, construction, renovation and use
3 Conduct surveillance and assessment at all levels of the health system
4 Engage civil society and address advocacy communication and social mobilization
5 Conduct monitoring and evaluation
6 Enable and conduct operational research
Administrative controls
7 Develop strategies to promptly identify potentially infectious cases (triage), separate them, control the spread of pathogens (cough etiquette) and minimize time in health care settings.
8. Provide a package of prevention and care for health care workers, including HIV prevention, ART and isoniazid preventive therapy for HIV-positive health care workers
Environmental controls
9 Natural ventilation
10 Mechanical ventilation
11 Ultraviolet germicidal irradiation (UVGI) fixtures
Personal protective interventions
12 Respirators

3.1 MANAGERIAL ACTIVITIES

Managerial activities involve assessing the problem, setting up of surveillance activities, establishing coordinating bodies at all levels, advocacy, communication, social mobilization, planning and evaluating the performance of control interventions. Planning includes guideline development, budgeting and building the required human resources and capacity; monitoring, evaluation and research. Managerial activities also take into consideration the proper design, construction, renovation and use of health care settings.

3.1.1 Intervention 1: Identify, create and strengthen coordinating bodies, and develop a comprehensive human resources plan for planning and implementation at all levels

The first intervention is strengthening the national infection prevention and control activities. This will help health facilities to reduce the risk of healthcare nosocomial infections. It embraces all aspects of general infection prevention including tuberculosis. The program shall do the following among others;

- sets relevant national objectives based on public health principles;
- develops and continually update guidelines for surveillance, prevention, and practice;
- develops a national system to monitor selected infections (especially TB) and assess the effectiveness of interventions;
- harmonizes initial and continuing training programmes for health care professionals;
- facilitates access to materials and products essential for hygiene and safety; and
- Encourages health care establishments to monitor health-care associated (nosocomial) infections and to provide feedback to the professionals concerned.
- Each health care facility should implement infection control measures to ensure the well being of patients, visitors and staff; develop annual work plan to assess and promote good health care, appropriate isolation, sterilization and other practices, staff

training, and epidemiological surveillance; provide sufficient resources to support the infection control programme. Prevention of nosocomial transmissions to patients and staff should be a concern of everyone in the facility including the senior administration. See national IP guidelines for the important components of the infection control programme.

In addition to implementing basic measures for infection control, health care facilities should prioritize infection control needs and design their programmes accordingly. The ultimate responsibility for prevention and control of infection rests with the health management. The health facility director should establish an infection control committee which will in turn appoint an infection control team; and mobilize adequate resources for effective functioning of the infection control plan.

Infection control committee

Every health facility should establish an infection control body which provides a forum for planning, coordination and sharing information with all health care workers. This committee should include representatives from relevant departments: e.g. management, physicians, nurses, other health care workers, clinical microbiology, pharmacy, sterilizing service, and maintenance, housekeeping and training services. The committee should report directly to the head for it to be effective. The committee is responsible for developing plans for the prevention and control of infection and to oversee the implementation of the infection control interventions. The committee should meet regularly (ideally monthly but not less than 4 times a year) to monitor and evaluate the performance. The committee has the following tasks;

- To review and approve annual infection prevention and control plan
- Review epidemiological surveillance data and identify areas for intervention;
- Assess and promote improved practice at all levels of the health facility;
- Ensure appropriate staff training in infection control and safety management, provision of safety materials such as personal

protective equipment and products; and training of health workers.

As part of overall national infection control efforts, specific TB infection control bodies could be established at national and sub national levels, and – where relevant – clear leadership and accountability among the different stakeholders should be defined.

3.1.1.1 Intervention 1a: Adopt national policy guidelines

Health facilities will adopt the national guidelines which include a package of interventions, sample tools for risk assessment and the national TB infection control plans. Health care facilities can modify these tools according to the prevailing local situation.

3.1.1.2 Intervention 1b: Conduct comprehensive planning and budgeting

Implementation of the TB infection control plan requires comprehensive planning and integration with other national infection control efforts at all levels. Accurate costing of the resources required for each intervention should be conducted and necessary resources mobilized. The roles and responsibilities of each stakeholder in implementing and monitoring each intervention of the TB IC package must be clearly defined.

3.1.1.3 Intervention 1c: Develop human resources and build the requisite capacity

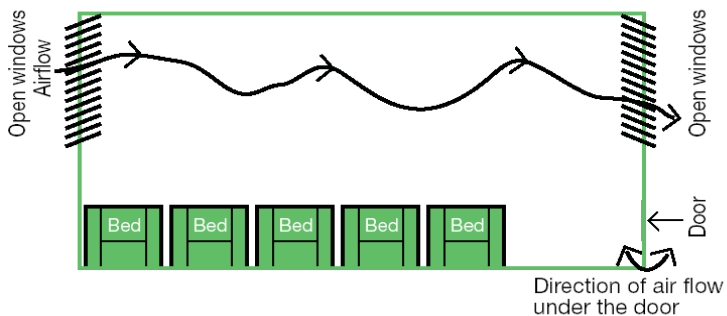
National stakeholders need to develop a human resource development plan for infection control in general and for TB in particular. The plan should ensure adequate human resources are available, are competent and sufficient including relevant expertise in engineering and architecture. The TB plan should be part of the national human resource development plan, and should include: Staff requirements for the implementation of TB infection control interventions; capacity building; provide clear national responsibilities for overseeing the implementation of the TB infection control.

3.1.2 Intervention 2: Health facility design, construction, renovation and use

Proper design and use of health facilities are crucial to TB infection control. Situations conducive to transmission of TB include crowded wards or buildings with no division, narrow corridors with no ventilation used as waiting areas, and unfit space crowded with potentially infectious patients. Such situations also represent major obstacles to the implementation of the recommended administrative and environmental controls.

Architects should include infection control considerations in new constructions, renovations and rethink the use of available spaces to optimise the implementation of infection control interventions. High-risk areas for TB transmission include:

1. TB and medical wards
2. outpatient departments to which infectious TB patients and potentially infectious TB suspects are referred
3. spaces reserved for aerosol generating procedures (e.g. sputum collection areas⁷ bronchoscopy rooms)



⁷ More information on sputum collection and biosafety issues related to sample handling and transportation is available at WHO. TB laboratory standard operation procedures (SOPs). 2009 update. Under development.

Figure 1 Natural ventilation; Free flow of air in and out through open windows
Source: WHO/TB/99.269

Design and use of space must ensure that the areas are well ventilated and that patient flow minimizes exposure of non-infectious patients to infectious patients. 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 5).

Maximizing natural ventilation patterns for the hospital, clinic, ward or room is the simplest approach to achieving better ventilation. See figure 6 below. 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 20% of the area of the room; 10% on each side to ensure cross ventilation. For example, the minimum window opening for a 3m x 5m room (15 m²) would be a 1.5 m² window, door, or other opening on opposing walls. Where ceiling fans are used, windows should also be left open as the objective is diluting and exchanging of the mixed air

Figure 2.1: Shows A Typical Clinic In Malawi Where Patients, Family Members, Visitors, And hews Are In Close Proximity. The Waiting Area Is Actually A HallwayWith Benches Or Chairs, And There Is Little Air Movement).

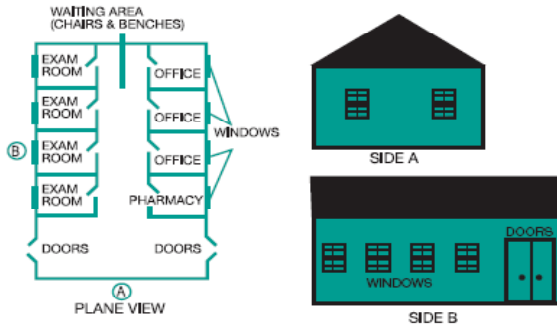


Figure 2.2: shows a simple, cost-effective alternative which proposed to add a covered area that is open on the sides. The windows to the out-of doors have been replaced with doors leading to a patio, which serves as a new waiting room.

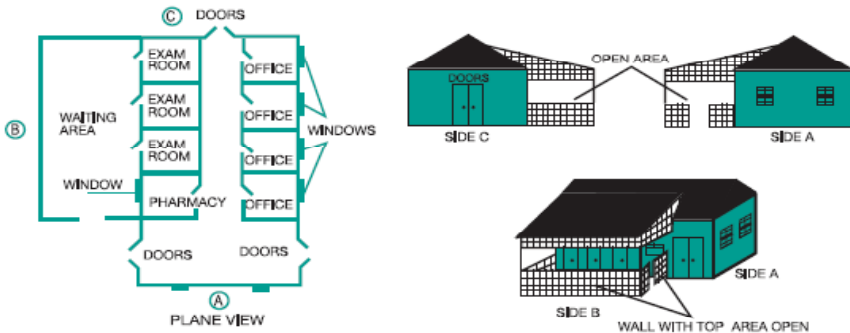


Figure 2. Building designs

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.).

Positioning of Patient-Health worker in a clinic for maximum safety of HCW.

Health care staff should be mindful of the direction of airflow to ensure the patient is closest to the exhaust fans and the staff is closest to the clean air source. 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. Figure 7 below shows patients/HCW positioning for safety of the HCWs.

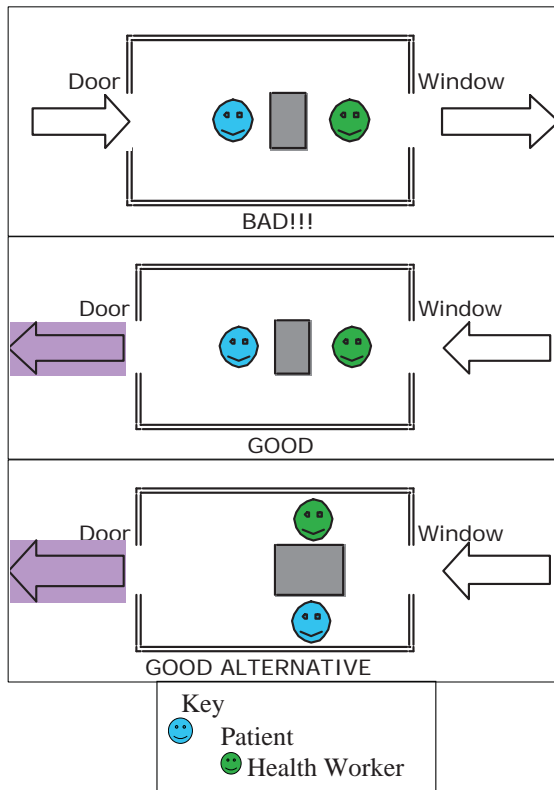


Figure 3:HCW and patient placing

3.0.1 Intervention 3: Surveillance and assessment at all levels of the health system and in congregate settings

The TB infection control program should take responsibility for the assessment of the health-care facilities, to determine the risk for TB transmission and the magnitude of the problem, and to monitor the status of implementation of TB infection control interventions. Special emphasis should be placed on assessment of the comprehensive care centers where chronic HIV care is provided. The national infection control TWG should facilitate and define responsibilities for surveillance of TB disease among health-care workers. This will require regular reporting of cases of TB among staff from all facilities, and of the overall number of staff working at that facility. The programme should set up surveillance among workers and populations in congregate settings. Further, it is important to screen for TB disease among patients admitted due other conditions especially in medical wards.

3.0.1.1 TB Infection Control (TB IC) Assessment:

This process determines the type and mix of managerial, administrative, environmental and respiratory protection measures. The mixture of interventions makes up the **Infection control plan (see 4.1)** for the facility. At facility-level, the TB IC assessment consists of an initial and important step on evaluation of the risk of TB transmission. The initial and follow-up IC assessment covers the following areas:

- Collection and revision of the statistical reports on TB in the facility, community or district. Data on the profile of notified cases, TB/HIV co-infection, and drug resistance is useful. The district TB program is a valuable resource for these data (establish trend for five years). TB patient card archives or, in some instances, facility TB registers and/or electronic TB recording and reporting databases
- Identification of services (e.g. ARV clinics, OPD, radiology) within the facility where persons with unrecognized TB are most likely to be encountered. Efforts to expedite recognition, diagnosis and treatment of TB should be targeted here.
- In-patient settings should correlate facility-level TB data and describe current patterns of isolation and separation TB suspects and TB cases.

This should take into consideration categories of HCWs that need to be included in a TB screening program.

- Identification of mechanisms for prompt recognition and reporting of suspected episodes of TB transmission in the facility.

The person assessing the risk should be well qualified. This could be the hospital epidemiologists, infectious disease specialists, chest physicians, infection control practitioners, health care administrators, occupational health personnel, engineers, HCWs or local public health personnel. This should be repeated every year and the plan modified accordingly. Detailed risk assessment procedures are in the flow chart in annex.

Table 3. Risk classification for Health care facilities

Transmission level	Risk	Number of TB patients treated/admitted in the facility in the previous year
Low		Three(3)
Medium		Three to six(3-6)
Potential on going transmission		Six(6) or more patients, High PPD conversion rates, evidence of person to person transmission

A classification of potential ongoing transmission should be applied to a specific group of HCWs or to a specific area of the health-care setting in which evidence of ongoing transmission is apparent, if such a group or area can be identified. Otherwise, a classification of potential ongoing transmission should be applied to the entire setting. This classification should be temporary and warrants immediate investigation and corrective steps after a determination has been made that ongoing transmission has ceased. The setting should be reclassified as medium risk, and the recommended timeframe for this medium risk classification is at least 1 year.

3.0.1.2 Surveillance for TB among HCWS

HCWs should be educated about the signs and symptoms of TB and instructed to report promptly for evaluation. Perform active symptom

screening on a periodic basis and investigate those found to have symptoms compatible with TB. Routinely collect data on the number of HCWs diagnosed with TB from the facility. Surveillance should include information about the main risk factors. Such as work location (e.g., outpatient clinic, medical ward etc.); Occupation (nurse, health officer, physician, cleaning person etc);History of recent exposure to TB patients at work or outside the workplace; History of treatment for TB; History of HIV testing and results

All HCWs are encouraged to have a baseline tuberculin skin test (TST) or where possible, one blood assay for M. tuberculosis (BAMT) result at each new health-care setting, even if the setting is determined to be low risk. Establishment of a reliable baseline result can be beneficial if subsequent screening is needed after an unexpected exposure to M. tuberculosis. When appropriate, active screening for symptoms of TB is more cost-effective in our setup.

3.0.2 Intervention 4: Engage civil society and address TB infection control advocacy, communication and social mobilization

3.0.2.1 Intervention 3a: Civil society involvement

Civil society and the communities should be mobilized to create demand for TB infection control and implement TB infection control activities. Existing literacy efforts should mainstream TB infection control as an evidence-based package of interventions in each health-care facility. Communication campaigns should aim to reduce stigma, as an essential component of the implementation of TB infection control activities. Communities should also be informed about the need to rapidly seek care if they have symptoms suggestive of TB and about the right to safe health care

Lack of infection control interventions is a major problem for affected communities. Therefore, civil society should be involved in every aspects of the planning, implementation and evaluation of TB infection control interventions at national and local level. The approach to implementing

TB infection control interventions should be of high quality and patient centered. It should consider human rights and dignity of the patient⁸ and health worker, and should balance the interests of individuals and public health.

3.0.2.2 *Intervention 3b: TB infection control advocacy communication and social mobilization*⁹

Ministry of health in collaboration with civil society shall formulate a clear strategy on TB infection control. Implementation plans include an information, education and communication (IEC) package for multiple target audiences (including policy makers, patients, health workers, family members and communities). Civil society should mobilize and advocate for resources for implementation of TB infection control interventions.

3.0.3 Intervention 5: Conduct monitoring and evaluation

Monitoring and evaluation provide the means to assess quality, effectiveness, coverage and delivery of TB infection control interventions, and ensure continuous improvement of performance. It might be difficult to detect a change in TB rates among HCWs at facility level 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 possible to monitor the implementation of the interventions through periodic supervision of the measures outlined in the TB Infection Control Plan. Establishing surveillance of active TB rates among HCWs in the district provides a useful means of evaluation. Another accepted indicator is to monitor the facilities with demonstrable TB infection control practices in accordance with international guidelines and meeting the standards. The evaluation of outcome measures can then be used to identify the areas

8 http://www.stoptb.org/resource_center/assets/documents/istc_charter.pdf

9 In this context, the aim of communication is to increase awareness, influence social norms, change behavior (in individuals or subpopulations) and improve communication and counseling between people with TB, their families and providers. The aim of social mobilization is to change norms, improve services, expand community support and solve social problems, often by bringing groups together to act at a community level. (See http://whqlibdoc.who.int/publications/2008/9789241596176_eng.pdf)

where improvement may be needed.

Box 2.Critical elements in diagnostic services

Measuring critical elements in diagnostic services

- Time interval from entrance to suspicion of TB
- Time interval from suspicion of TB to ordering sputum for AFB smears
- Time interval from ordering to the collection of sputum
- Time interval from the examination of the smear to the reporting of results
- Time interval from the return of laboratory examination of the smear results to the initiation of appropriate treatment

Unnecessary delays in any of these can lead to increased nosocomial transmission.

3.0.4 Intervention 6: Enable and conduct operational research

Basic and operational research is essential for evaluating the effectiveness of all interventions implemented to control TB infection. Operational research is therefore recommended as an integral component of the TB infection control package.

3.2 ADMINISTRATIVE CONTROLS

The administrative controls include policies and procedures which promptly identify potential and known infectious cases of TB, separate and treat them with the minimal delay. Interventions aimed at reducing TB transmission in health-care and congregate settings include triage, physical separation (cohorting) or isolation of patients or TB suspects, cough etiquette and minimize time spent in health care settings

3.2.1 Intervention 7: Develop strategies to promptly identify potentially infectious cases (triage); separate them; control the spread of pathogens (cough etiquette) and reduce hospital stay

The administrative interventions prevent generation and spread of droplet nuclei. The most important administrative infection control practices require prompt identification of patients with suspected TB. Diagnostic delays should be minimized by reducing sputum turnaround time, carrying out investigations in parallel rather than in sequence, and by using smear negative algorithms. For individuals with diagnosed TB, prompt initiation of adequate treatment, education, supporting adherence and ensuring completion of treatment are crucial. Patients suspected of having TB who access the health system or are in a congregate setting should access prompt diagnostic evaluation



3.2.1.1 Intervention 6a: Triage

The TB IC committee should implement strategies to promptly sort TB suspects to identify potentially infectious cases (i.e. triage) in health-care and congregate settings. TB suspects must be separated from other patients, placed in well-ventilated areas, educated on cough etiquette and access prompt TB diagnosis and treatment (e.g. fast tracking).

Picture 2. Triage post at St Peter's TB Specialized Hospital in Addis Ababa

3.2.1.2 Intervention 6b: Separation (cohorting)

Separate infectious patients after triage. The criteria is suspect or confirmed pulmonary TB. Patients living with HIV and other forms of immunosuppressants, in particular, should be physically separated from those with suspected or confirmed infectious TB. Drug-resistant TB suspects or patients should be separated from other patients, including other TB patients.

Triage and separation should be implemented in ways to improve patient flow. They are essential for controlling respiratory infections and, based on biological considerations, are likely to help in controlling TB infection. These interventions are necessary to minimize the exposure of non-infected patients (in particular those who are immunocompromised) to infectious patients. They should be considered as priority interventions, irrespective of the likely or known drug susceptibility pattern.

3.2.1.3 Intervention 6c: Cough etiquette



Picture 2: Picture of message on cough etiquette

In order to minimize the generation of droplet nuclei, any coughing patient with a respiratory disease and in particular TB patients or suspects should be educated in cough etiquette. That is, cover their nose and mouth

when sneezing, coughing or talking. This also

applies to health workers, visitors and families in health-care or congregate settings. Alternatively, use a physical barrier which can be a piece of cloth, a tissue, a surgical mask or an arm placed in front of the mouth. IEC activities should strongly focus on cough etiquette. Respiratory hygiene includes proper disposal of tissues and masks. Patients and their families should also be educated on the signs and symptoms of TB disease, that TB is a treatable disease, the risks of not completing treatment, the public health ramifications of not being treated, and

increased risk of TB disease of people living with HIV. Public health and awareness messages could be as simple as posters on the walls and presentations by health educators to as complex as electronic media (videos, DVDs, CDs, etc.)

Surgical or Procedure Masks



Respirator: Has only tiny pores relies on an air tight seal around the entire edge



Surgical mask: Has large pores and lacks air tight seal around edges

Picture 3: HCWs wearing a Respirator (left) and Mask (right)

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

- 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.
- **Do not** provide adequate protection to the wearer (e.g., HCW, patient, family member) from inhaling infectious droplet nuclei in the air
- Masks usually have limited filtration capacity and are loosely fitted over the mouth and nose, allowing free entrance of aerosols like *M. tuberculosis*.

Use of surgical or procedure masks for patients

Cough etiquette (i.e., covering mouth, using tissues or clothes, handkerchiefs or scarves) and respiratory hygiene (i.e., not spitting on floor, disposing of soiled tissues properly) should be enforced in

immediately a TB suspect is identified.

Disposable or surgical masks should be considered for suspect and known infectious TB patients leaving the ward for medically essential procedures or other reasons. Although not the highest priority intervention, disposable/cloth masks can be used to reduce infectious TB aerosols generated from potentially infectious TB patients.

Masks may help HCWs enforce infectious TB patient separation/isolation policies, as they will facilitate identification of potentially infectious TB patients. However, for this very reason—identifying the TB patient--the risk of potential stigma needs to be considered. Patient and HCW education on the importance and appropriate wearing of masks should accompany their distribution. Cloth surgical masks can be washed and reused. A surgical mask does NOT adequately protect HCWs or other wearers from inhalation of air contaminated with *M. tuberculosis* and should NOT be used for that purpose.

3.2.1.4 Intervention 6d: Minimize time in health care settings

Hospital stay is generally not recommended for the evaluation of TB suspects or the management of patients with drug-susceptible TB, except in cases that are complicated or have concomitant medical conditions that require hospitalization. If hospitalized, TB suspects should not be placed in the same area as TB patients. To avoid nosocomial transmission of TB, time spent in health care settings including clinics should be minimized, for example by reducing diagnostic delays. Community care approaches should be prioritized, and be complemented by education of household members and other close contacts on TB infection control. Health-care workers should also minimize time spent with infectious patients as a measure of protection from TB transmission¹⁰.

3.0.2 Intervention 8: Package of prevention and care

10 Galgalo T, Dalal S, Cain K, Oeltmann J, Tetteh C, Kamau J et al. Tuberculosis risk among staff of a large public hospital in Kenya. *INT J TUBERC LUNG DIS*, 2008; 12 (7): 949–954

for health-care workers

Encouraging and enabling health care workers to know their HIV status should be a priority of all health care services, and HIV care programs, in particular. This can be facilitated by providing accessible, acceptable, confidential HIV counseling and testing, including periodic retesting, and by recognizing and mitigating any stigma attached to HIV counseling and testing. If diagnosed with HIV, they should be offered a package of prevention and care that includes regular screening for active TB and access to antiretroviral therapy. Based on the evaluation, health-care providers should be put on either IPT or a full regimen of anti-TB treatment. HIV-positive health-care workers should be given a choice to opt out of working in areas or among patients with infectious TB especially with MDR-TB and XDR-TB, and offered a position from where exposure to untreated TB is low.

3.3 ENVIRONMENTAL CONTROLS

The environmental controls reduce the concentration of infectious respiratory aerosols (i.e. droplet nuclei) in the air. For environmental controls to be implemented, managerial activities and administrative controls should also be in place to ensure proper use and maintenance of equipment, training of staff, etc. When used in conjunction with administrative control measures (e.g. prompt triage, diagnosis, and treatment of infectious TB patients), environmental control measures can effectively reduce the concentration of infectious droplet nuclei to which HCWs, patients, or visitors may be exposed. Environmental control measures which can be used to reduce the number of aerosolized infectious droplet nuclei in the work environment are:

- 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 and doors
- 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
- Room fixtures with ultraviolet germicidal irradiation (UVGI) to inactivate *M. tuberculosis* organisms

3.3.1 Intervention 9: Natural ventilation

Natural ventilation refers to fresh air that enters and leaves a room or area through openings such as open doors and /or windows and reduces the concentration of airborne droplet nuclei. Unrestricted openings (that cannot be closed) on opposite sides of a room provide the most effective natural ventilation. In order to reduce nosocomial risk, fresh air should constantly be 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. The number of air changes per hour (ACH) that prevents transmission of infectious pathogens through droplet nuclei is suggested to be at least 12 ACHs is still comfortable enough.¹¹ Architects and health facility administrators are reminded to incorporate natural ventilation at the stage of designing new buildings or renovating buildings. Natural ventilation is considered cheap, easier to maintain and most convenient control measure in Ethiopia. The only problem with natural ventilation is that patients or personnel close the windows during cold weather or at night. Furthermore, variability of airflow patterns often occurs due to varying weather or due to the presence of other structures blocking air currents.

Checking natural ventilation

People can 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

¹¹ Under ideal conditions – in which droplet nuclei are evenly distributed and incoming air is uniformly mixed – the proportion of infectious particles eliminated with each air change or one “equivalent air change” is 63%. One air change has occurred when the volume of air entering a room is equal to the volume of the room. Subsequent air changes follow a logarithmic decline.

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 or smoke tubes as described in these six steps;

1. Hold two incense sticks together and light them.
2. As soon as the incense starts to burn, blow out the flame. Now the incense should produce a continuous stream of smoke.
3. Observe the direction of the smoke.
4. Observe how quickly the smoke dissipates.
5. 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.
6. Keep records of all routine activities and dates.

Propeller fans

Propeller fans are an inexpensive way to increase the effectiveness of natural ventilation. The fans increase the mixing of airborne TB as well as assisting in the direction of air movement by pushing or pulling of the air. HCWs are cautioned to use fans in well cleaned and tidy rooms, to avoid spreading of germs from dirty floors. Propeller fans include: Ceiling fans, table or surface fans that sit on a desk or other surface, Fans that stand on the floor, and Fans mounted in a window opening.

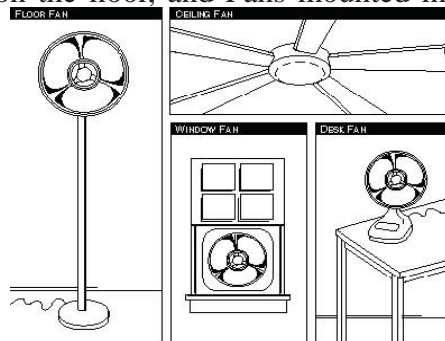


Figure 4. Propeller fans

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.

Checking fans

1. Check that all room fans are working and cleaned at least once a month. Use cloth or vacuum cleaner to remove dust and lint from fans, grilles, and ducts.
2. 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.
3. 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.
4. 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.
5. Air exchange rates (also called air-changes per hour) can be calculated as shown in annex 6. If mechanically ventilating a room, the fan should provide a minimum of six air exchanges per hour.
6. Keep records of all routine activities and dates.

3.3.2 Intervention 10: Mechanical ventilation

Mechanical ventilation is used in situations where natural ventilation is not feasible or is inadequate to reduce the concentration of infectious droplet nuclei in selected areas or rooms in the health care facility. It is recommended in wards or rooms for care of infectious TB patients, bronchoscopy rooms, sputum collection areas, laboratories processing sputum specimens for tuberculosis culture and susceptibility testing, and in mortuary rooms. Equipment used in mechanical ventilation should have 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.

Also, it is important to regulate airflow so that infectious aerosols produced by coughing patients are exhausted away from others. Direction of airflow must be maintained from clean area and HCW towards patient area, and from there out. Incoming air must be drawn from a location away from any exhaust ducts, to avoid re-circulation of contaminated air back to rooms. It should be noted, however, that if infectious TB patients were allowed to roam outside their dedicated area, the potential benefit of mechanical ventilation would not be realized.

The simplest form of mechanical ventilation is the use of exhaust fans, placed in windows and move air from inside a room to the outdoors. Exhaust fans also may be more acceptable to staff and patients than keeping windows consistently open. If exhaust fans are used, it is important to ensure that airflow is adequate, that air flows across the room (not in and out the same window or vent), and that exhaust fans and air intake (windows or vents) are not located close to each other so that short-circuiting will occur (Figure 5). This can be monitored through the use of smoke tubes or other devices designed to assess direction of airflow (Figure 6). 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.

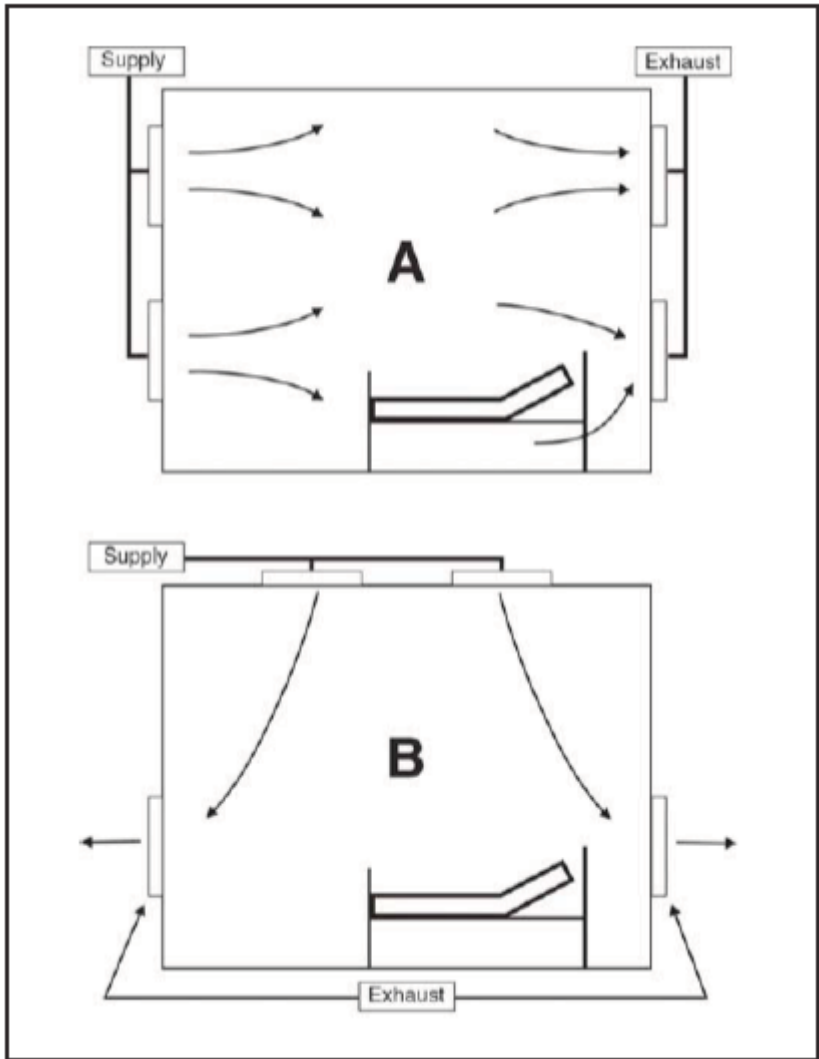


Figure 5. Room airflow patterns designed to provide mixing of air and prevent short-circuiting

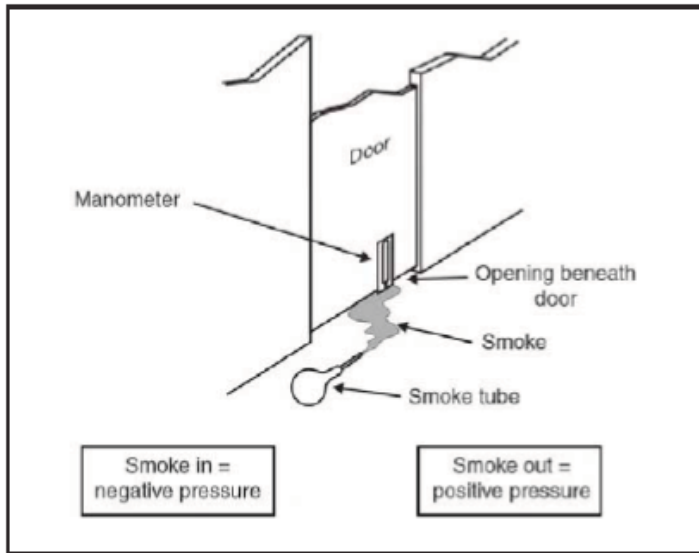


Figure 6. Smoke tube testing and manometer placement to determine the direction of airflow into and out of a room

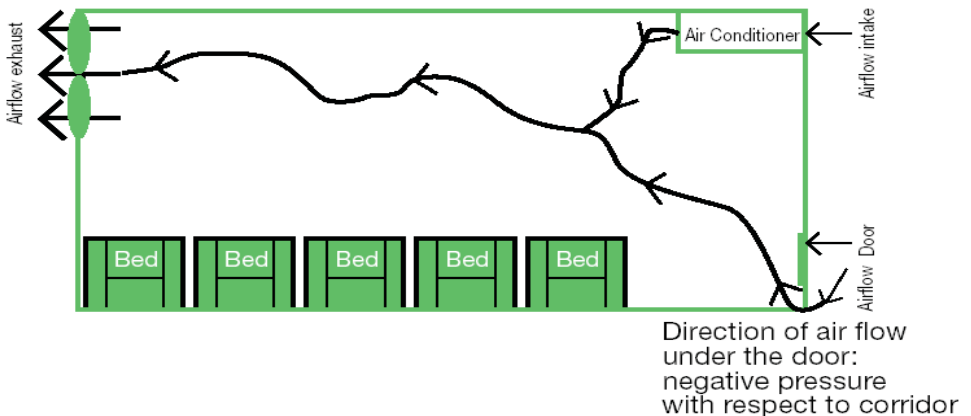


Figure 7. Negative pressure room. Diagram illustrating airflow from outside, across patients' beds and exhausted out the far side of the room

Monitoring ventilation systems

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 see figure 3, incense, paper, etc.), a tissue, or a simple flow vaneometer or tracer gas analysis to monitor proper airflow direction and calculate number of air exchanges per hour in the room or area. 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 periodically by well trained personnel and documented in a maintenance record.

Picture 4. Monitoring Ventilation Systems



Using a carton box and flow velometer to monitor air flow in TB patient isolation room with mechanical ventilation system, Chiang Rai Hospital, Chiang Rai, Thailand



Using a smoke tube to monitor air flow in sputum collection booth at a TB facility in Riga, Latvia

3.3.3 Intervention 11: Upper room or shielded ultraviolet germicidal irradiation

In certain high-risk areas of a facility, or inside equipment like the biological safety cabinet type 2, use of natural and mechanical ventilation may not be feasible. In these situations, ultraviolet germicidal irradiation (UVGI)¹² or room air cleaners with UVGI may provide a less expensive

12 UVGI, which is produced within the UV-C region of the electro-

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.

The major concerns about UVGI have been adverse reactions (e.g., acute and chronic cutaneous and ocular changes) in HCWs and patients from overexposure if the UVGI is not installed and maintained properly. If UVGI is to be used, manufacturer's instructions regarding installation, cleaning, maintenance, and ongoing monitoring should be carefully consulted. UVGI may be applied in several forms: bare bulbs in sputum collection booths, or BSC2 in labs to irradiate the entire booth when it is not occupied; if HCWs and patients are in the room, continuous upper air irradiation with shielding placed below the UVGI sources prevents injury to patients but the upper portion of the room is irradiated, portable UVGI floor units also may be used. An additional more expensive option involves the use of UVGI in combination with a close mechanical system

magnetic spectrum, eliminates the ability of microbes to replicate by inactivating both bacterial and viral DNA. Air must be mixed for droplets to come in contact with the UV lamps. Two studies have shown that UVGI lamps can disinfect mycobacteria in the upper air of a room that is equal to 10–20 equivalent air changes.



Picture 5: Upper air radiation with shielding placed below the UVGI source.

Continuous upper air irradiation (Picture 6) is the most applicable of the above methods in most resource-limited countries. 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, 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.

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.

Portable HEPA filter unit

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 like filters. If a filter other than specified in the original design document, the flow rate may be adversely affect. 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.

1.4 PERSONAL PROTECTIVE INTERVENTIONS

In certain settings, administrative and environmental controls cannot adequately reduce exposure to infectious particles. For example, HCWs may be exposed to high concentrations of infectious particles during sputum induction procedures, while providing bedside patient care to infectious TB patients (including drug resistant TB), while examining suspect TB patients in poorly ventilated clinic rooms, or while performing autopsies, bronchoscopy or other cough inducing or aerosol-generating procedures are performed, and homes of patients with infectious TB disease). Persons including HCWs in such situations that pose a

relatively high risk for exposure require personal protective measures. Two important personal protective measures are the use of respirators to complement administrative & environmental measures and confidential counseling and HIV testing as a gateway to comprehensive HIV care services.

3.4.1 Intervention 12: Use of respirators

Priority should be given to ensuring implementation of managerial activities, administrative controls and adequate ventilation. However, a respiratory protective device with the capacity to filter 0.3-0.4 micrometer particles that meet standards N95, FFP2 or higher when used properly may provide health-care workers with additional protection from TB. Respirators are a special type of device that provide such a level of filtration 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 (see picture 8):



Picture 6. Wearing and fitting a respirator properly

Wearing and fitting a respirator properly

Health-care workers should use respirators during aerosol generating procedures associated with high risk of TB transmission (e.g bronchoscopy, intubation, aspiration of respiratory secretions, and at autopsy or lung surgery with high-speed devices), laboratory when processing liquid cultures and when providing care to infectious MDR-TB and XDR-TB

patients. Respirators manufactured with at least 90% filter efficiency for particles of 0.3-0.4 micrometers in diameter are usually recommended for use by HCWs. CDC/NIOSH-certified N95 (or greater) and CEN-certified FFP2 (or greater) filtering face piece respirators meet these criteria.

Filtering face-piece respirators are disposable but can be re-used repeatedly for several weeks or even months for TB, if they are properly stored. The length of time that each respirator can be re-used is unknown and should be guided by both inspection and common sense. Respirators should be discarded when they become soiled, wet, or appear to lose their structural integrity, e.g., a tight seal can no longer be maintained between the edge of the respirator and the wearer's face. The main factors responsible for the deterioration of respirators are humidity, dirt, and filter damage. Respirators should be stored in a clean dry location. One method is to fold a light towel around the respirator (being careful not to crush the respirator). Plastic bags should never be used since they retain humidity. Follow manufactures instructions for inspecting, cleaning, and maintaining respirators to ensure that respirators function properly. A comprehensive training programme for use of respirators should be implemented, because correct and continuous use of respirators involves significant behavior change on the part of the health-care worker. Inherently well-fitting respirators should be used. Respiratory protection is the last line of defense for HCWs against nosocomial *M. tuberculosis* infection.

Respirator fitting testing



Picture 7. Respirator Fit Testing

Respirators are available in different sizes. It is strongly recommended that HCWs be “fit tested” to ensure selection of the appropriate respirator. Qualitative fit testing involves the use of an aerosol which may be “tasted” (see photo below). If the HCW “tastes” the aerosol (usually saccharin or a bitter-tasting material), the respirator must be adjusted (i.e., the nose clip) and retested. If the

HCW fails the test a second time, a different size or brand respirator should be tested. Beards and facial hair do not allow proper sealing of respirators to the face. Any leak between the face and the respirator is a potential entry point for infectious droplet nuclei. Spare enough time and resources (financial and staff), for the incorporation of a respirator testing program into the TB Infection Control Plan at least once a year.

1.5 CONSIDERATION FOR SPECIAL AREAS

TB infection control interventions should vary from one setting to another depending on the risk of transmission in a facility. Some areas of the health care facility could be considered high risk relative to the others. Each of high-risk area should have an independent risk assessment, or they should have a detailed section written as part of the overall facility plan.

These areas might include TB isolation rooms, emergency departments, 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. These areas should be considered high risk before, during and after procedures.

3.5.1 TB Hospitals and MDR-TB Treatment Facilities

Patients who are seriously ill at diagnosis or develop TB complications may require prolonged hospitalization. As discussed above, environmental control measures should only be implemented as a supplement to effective organizational and administrative control measures. Special consideration should be given to reducing nosocomial TB transmission in settings where patients, HCWs, or both, have HIV infection. See WHO's *Tuberculosis infection-control in the era of expanding HIV care and treatment, 2006* for additional details. This should include isolation of M(X) DR-TB patients, enforcing and discontinuing isolation, evaluation of control measures, and surveillance of TB among HCWs also are essential in these facilities.

In addition, some further precautions in these facilities may be useful to help reduce HCW risk. Environmental controls and personal respiratory protection play an important adjunctive role in HCW protection in such facilities, particularly in areas of the facility where infectious TB/M(X) DR-TB patients are under treatment. TB clinics and other settings in which patients with TB disease and LTBI are examined on a regular basis require special attention. Administrative controls with special attention to the principles of triage should be applied to TB treatment facilities. These principles include prompt identification, evaluation, and airborne precautions of patients with suspected or confirmed infectious TB disease.

3.5.2 Waiting areas

Hallways and waiting areas in hospitals are often crowded with patients and their families. They also often form lines outside various departments (e.g., radiology, pharmacy, outpatient, etc.) as they wait for services. These should be alleviated by HCWs in order to reduce the risk of *M. tuberculosis* transmissions. One way to do this is to use a number system. Patients can be given numbers in the order that they arrive and then are asked to wait outside or in a better-ventilated area until their number is called. In addition, patients at high risk for infectious TB (e.g., those with chronic coughs) should be seen more expeditiously and/or asked to wait in an outside area away from other patients.

3.5.3 Radiology

Radiology departments in referral level facilities often provide services to a variety of patients many of whom may be at particularly high risk of TB disease if they become infected with *M. tuberculosis* (e.g., young children or immune compromised patients). Therefore, radiology departments should:

- Schedule inpatient chest radiographs on infectious and suspected TB patients for non-busy times, such as the end of the afternoon
- Provide coughing patients with a surgical or procedure mask to wear; alternatively provide

tissues or cloth

- Provide expedited priority service to potentially infectious TB patients to minimize the length of time spent in the department
- Restrict access to the radiology suite during operating hours to patients and essential personnel only (e.g., post signs, enforce the policy).
- Use the room with the best ventilation for taking images of potentially infectious TB patients

3.5.4 Sputum induction and cough-inducing procedures

Cough-inducing procedures (e.g., sputum induction or bronchoscopy) should be done only when absolutely necessary on patients who may have TB. Sputum induction should only be done if the patient is unable to produce an adequate specimen without induction. Likewise, bronchoscopy should be used as a last resort after other less risky diagnostic measures have been taken. Bronchoscopy on patients with an established TB diagnosis should be avoided. 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. Administrative control measures in such settings are essential, although strong consideration should be given in such settings to implementing environmental control measures and personal protective equipment (respiratory protection).

3.5.5 Surgical and Autopsy suites

Surgical theatres and autopsy suites are often poorly ventilated and may pose considerable risk of *M. tuberculosis* infection to HCWs if procedures are performed on TB patients. In general, elective surgery on potentially infectious TB patients should be postponed till after completing treatment. Efforts should be made to establish adequate environmental control measures to protect both the patient and the HCW. In addition, personal protective equipment (respiratory protection) should be used by all personnel working in the operating room or autopsy suite when

procedures are performed on suspected or known TB patients.

3.5.6 Intensive care areas

Intensive care areas also may be high risk areas especially when potentially infectious TB patients are intubated. Intubation and management of a patient's airway (e.g., suctioning) can create aerosols and intensive care units are often small and poorly ventilated. The following should be observed to decrease the risk of nosocomial TB transmission:

- Avoid intubation on potentially infectious TB patients
- “Think TB” in intensive care patients
- Improve ventilation in intensive care areas
- Use respiratory protection for procedures that are likely to create aerosols in potentially infectious TB patients

3.5.7 Immunosuppression and TB

HCWs as well as patients who are immune suppressed are at increased risk of infection with TB, reactivation of previous TB infection or reinfection. Suspect or known infectious TB patients pose a special threat to other immune suppressed patients and HCWs. Therefore, it is especially important to prevent the exposure of immune compromised HCWs to patients who are known or suspected of having TB, particularly M(X) DR-TB. Serious outbreaks of M(X) DR-TB have occurred among immune compromised patients and HCWs exposed to infectious M(X) DR TB patients.

Immune compromised HCWs should be given opportunities to work in areas with a lower risk of exposure to *M. tuberculosis*. TB should be strongly considered as part of the differential diagnosis for immune compromised HCWs with respiratory complaints. Immune compromised HCWs suspected of having TB should be promptly evaluated and treated, preferably on an outpatient basis (where possible-in HCWs clinic). As with all HCWs, they should be exempted (sick off) from work until they:

1. Have had three negative AFB sputum smear results collected 8–24 hours apart, with at least one being an early morning specimen;
2. Have responded to anti- tuberculosis treatment that will probably be

effective based on susceptibility results;

3. A physician knowledgeable and experienced in managing TB disease determines that HCWs are noninfectious. Consideration should also be given to providing culture and drug susceptibility testing, even genetic typing for all TB cases among HCWs and, administratively, to the type of setting and the potential risk to patients (e.g., general medical office versus HIV clinic).

4. PRIORITIZING INTERVENTIONS FOR HEALTH-CARE FACILITIES AND INFECTION CONTROL PLAN

4.1 TB INFECTION CONTROL INTERVENTIONS

TB infection interventions complement general infection control efforts especially those targeting airborne infections. General infection control efforts include the standard precautions (e.g. hand hygiene and cough etiquette) that apply to all health-care facilities. Airborne infection control efforts include the airborne precautions (e.g. patient placement and use of well-ventilated areas) that apply to all health-care facilities caring for patients or suspects with airborne diseases.

Both standard precautions and those for airborne diseases must be used for TB infection control. This represents the basic minimum for all health-care facilities caring for patients or suspects with airborne diseases. The implementation of these precautions may also mitigate against stigma towards TB infection control interventions since the focus of the public health interventions is to provide universal access to patients and suspects with respiratory diseases rather than TB only.

In addition, Table 3, below, shows how priorities for implementing the components of the TB IC set of control measures will vary, depending on the burden of TB, HIV, MDR-TB (including XDR-TB). The table provides advice for health-care facilities caring for individuals with suspected or diagnosed TB; where HIV prevention, treatment and care is provided or for health-care facilities that are based in HIV-prevalent settings; and where MDR-TB is diagnosed or treated or that are based in MDR-TB priority countries.

All health-care facilities caring for patients or suspects with TB should implement the TB infection control package described in Table 3 below. The set of interventions should be clearly written out in a Facility TB

infection control plan as described in section 4.2 below.

The association of HIV and TB, MDR-TB and the emergence of multi-drug resistant TB (MDR-TB) and extensively drug resistant TB (XDR-TB) increase the need to urgently give appropriate attention to implementation of TB infection control interventions and to prioritization of such interventions.

All health care facilities caring for MDR-TB should introduce the TB infection control package (and relevant MDR-TB specific recommendations) described in Table 4 .Table 3 lays out all TB IC package interventions in a matrix with suggestions where each intervention should be applied in the three scenarios of health care facilities, HIV care services and specialized centers for management of M(X) DR-TB. Include this package in the facility infection control plan.

Table 4. Prioritization of TB infection control measures for health-care facilities based on the burden of TB, HIV, and M (X) DR-TB

Interventions	Health-care facilities where TB is diagnosed and managed	Health-care facilities where HIV prevention, treatment and care is provided	Health-care facilities where MDR is diagnosed or treated
Managerial activities			
1 Coordinating system	√	√	√
2. Health facility design	√	√	√
3 Surveillance and assessment of health-care facilities	√	√	√
4 Advocacy communication and social mobilization and civil society	√	√	√
5 Monitoring and evaluation	√	√	√
6 Operational research	√	√	√
Administrative controls			
7a Triage	√	Keep TB pts away from PLHIV	Keep M(X)DR-TB pts away from other TB patients

Interventions	Health-care facilities where TB is diagnosed and managed	Health-care facilities where HIV prevention, treatment and care is provided	Health-care facilities where MDR is diagnosed or treated
7b Separation (cohorting)	√	Keep TB pts away from PLHIV	Keep M(X)DR-TB pts away from other TB patients
7c Cough etiquette	√	√	√
7d Minimize time spent in health care facilities	√	√	Strict admission for XDRTB pts, MDRTB pts managed ambulatory if culture and smear negative on two consecutive months
8. Package for HIV prevention, care and treatment	To be prioritized as per the national standard		
Environmental			
9. Natural ventilation ^b	√	√	√
10. Mechanical ventilation ^b	√	√	√
11. Ultraviolet germicidal irradiation	√	√	√
Personal protection			
12. Respirators ^c	See section 3.4.1	See section 3.4.1	√

a All health-care facilities caring for patients or suspects with airborne diseases should implement standards and airborne precautions that are, cough etiquette, patient separation and adequately ventilated rooms (including for sputum collection).

b Ventilation in health-care facilities is necessary. The system for health-care facility ventilation should consider different options according to local conditions (i.e. building structure, climate, regulations, culture, cost, outdoor air quality, etc).

c Respirators should also be worn by health-care workers whenever performing an aerosol generating procedure (bronchoscopy) irrespective of the epidemiological situation or when in MDR-TB care facilities

4.2 TB INFECTION CONTROL PLAN

The facility I&C committee shall develop infection control plan using the findings of the risk of TB infection assessment. This is reviewed by all stakeholders including the management, district TB and HIV coordinators, and occupational health practitioners. All HCWs working in high risk areas should be trained using the plan. The districts TB control officer (or/ and the health post HCW or facility director) implements the plans recommendations and monitors progress accordingly. A sample of TB infection control (template) is included in the annex. In large facilities (e.g., district hospital), form a TB committee and give it the responsibility to develop and implement the TB Infection Control Plan. In some health facilities with an existing general infection prevention and control committee, infection control measures appropriate for the control of TB could be part of the more the general infection prevention and control plan of facility. In general, the 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
- Guidelines on the training, Fit testing 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)

4.2.1 Lifecycle of infection control plans

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 as shown in figure below.

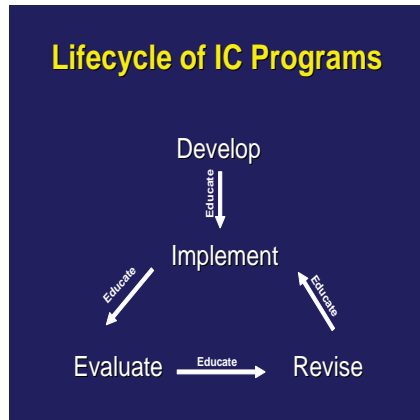


Figure 8. Lifecycle of infection control programs

The plan should be comprehensive with inputs from TB, HIV, occupational health, correctional services programmes coordinating well with existing national infection control bodies. In facilities without such committee, one should be created as a matter of urgency

4.2.2 Training of Staff

Infection control is effective only if each HCW working in a facility understands the importance of infection control policies and the role they play in implementing them. Each HCW should therefore receive instructions appropriate to their job category. Training should be received before initial assignment and each HCW should undergo annual continuing education in tedium with the infection control plan. Training should include the following components;

1. Clinical Information

- a. Basic concepts of MTB transmission, pathogenesis, diagnosis including difference between LTBI and TB disease
- b. Risk of TB transmission to HCWs
- c. Symptoms and signs of TB disease
- d. Impact of HIV infection and the increasing risk of

developing TB disease and TB as a major cause of morbidity and mortality in PLHIV.

- i. Relationship between TB and HIV, medical conditions and treatments that can lead to impaired immunity
 - ii. Tests availability, counseling and referrals of PLHIV, medical conditions etc
 - iii. Policies on voluntary work reassignments options for immune compromised HCWs
 - e. Principles of treatment for LTBI and TB disease (indications, effectiveness, adverse effects)
- 2. Epidemiology of TB** which includes epidemiology of TB in the local community, or district and Ethiopia in the context of the world and African region; Risk factors for TB disease
- 3. Infection control plan and responsibility for HCWs for success**
 - a. Overview of the facility TB infection control plan
 - b. Potential for exposure
 - c. Principles and procedures of infection control to reduce nosocomial transmission of MTB, hierarchy of infection control measures, policies ,procedures, monitoring
 - d. Rationale for BCG vaccination and its efficacy
 - e. Role of HCWs in preventing MTB spread
 - f. Responsibilities of HCWs to prompt report TB diagnosis
 - g. Proper implementation and monitoring of environmental controls
 - h. Record keeping and surveillance of TB among patients in the every setting
 - i. Proper use of respiratory protections
 - j. Success of adherence to infection control practices in decreasing the risk for transmission of MTB in health care setting
- 4. TB and Public Health.** Include role of local authorities in TB control, role of NTCP, availability of information for social mobilization and behavioral change and Responsibility of setting up infection control program

5. REDUCING TRANSMISSION OF TB IN HOUSEHOLDS

Household members are at high risk of becoming infected with TB and consequently developing the disease. Pivotal studies from India from the 1950s appear to show that the major risks for infection through contact lie in exposure to the infectious case before diagnosis^{13,14} Whether the patient subsequently remains at home or moves to a health facility appears to be of little importance, provided the patient is treated effectively.

Early case detection and treatment remains one of the most important interventions for reducing the risk of TB transmission in the household before TB is diagnosed. In addition, basic infection control literacy messages should be part of any community IEC messages. The infection control literacy messages need to promote the importance of early identification of cases, adherence to treatment and implementation of proper TB infection control measures (e.g. cough etiquette) before and after diagnosis of TB in the household.

As part of any IEC activity for management of TB patients at home, family members of smear positive TB patients and care providers should be educated on how to minimize the exposure of non-infected patients to infected ones. Methods for reducing exposure include the following:

1. Houses should be well ventilated (by natural ventilation), particularly rooms where people with infectious TB spend much. Known smear-positive TB patients should spend as much time as possible outside the room.
2. Anyone who coughs should be educated on cough etiquette and should always respect such etiquette for the sake of other people.

13 A concurrent comparison of home and sanatorium treatment of pulmonary tuberculosis in South India. Bull. Wrl Hlt Org; 1959, 21, 51–144.

14 Andrews RH, Devadatta S, Fox W, et al. Prevalence of tuberculosis among close family contacts of TB patients in South India and influence of segregation of the patient on the early attach rate. Bulletin of the World Health Organization; 1960, 23, 463–510.

3. Patients with smear-positive TB should sleep in a separate room if possible.
4. Patients with smear-positive TB should spend as little time as possible in congregate settings and public transportation.

MDR-TB patients usually remain infectious for much longer than those with drug-susceptible TB, even if treatment is initiated. MDR-TB may prolong the risk of transmission in the household, increasing the risk of morbidity and mortality, particularly when close contacts are HIV positive. Additional infection control measures should therefore be implemented for the management of MDR-TB patients at home.¹⁵ Awareness of infection control in the community should be promoted, irrespective of the drug susceptibility profile of the TB diagnosis, because most MDR-TB is undiagnosed but is nevertheless transmitted in the community:

The following guidance should be observed for household with smear-positive MDR patients in addition to the measures given above:

1. A culture-positive MDR-TB patient who coughs should always practice cough etiquette (including use of masks) when in contact with people. Ideally, care givers should wear respirators.
2. Ideally, family members living with HIV should not provide care for patients with culture positive MDR-TB. If there is no alternative, HIV-positive family members should wear respirators, if available.
3. Children below 5 years of age should spend as little time as possible in the same living spaces as culture-positive MDR-TB patients. Such children should be followed regularly with TB screening and, if positive, drug susceptibility testing.
4. Culture positive patients with XDR-TB should be isolated at all times. Any person in contact with a smear-positive XDR-TB patient should wear a respirator. HIV-positive family members should not share a household with XDR-TB patients, if at all possible.
5. Consider possibilities of renovating the patient's home to improve ventilation (e.g. installation of a window, a fan or a separate bedroom).

15 Early in the history of treatment of drug-resistant TB, strict hospitalization of patients was considered necessary. However, today, community-based care provided by trained lay and community health workers can achieve comparable results and, in theory, may decrease the spread of health-care associated disease (1,2).

6. TB INFECTION CONTROL FOR CONGREGATE SETTINGS

Congregate settings include a heterogeneous mix of settings that range from correctional facilities, orphanages, refugee camps and military barracks to homeless shelters, dormitories and nursing homes. Each facility differs in the type of population it contains, and this in turn affects the dynamics of TB transmission. The incidence of TB infection and TB among individuals in congregate settings particularly among inmates of correctional facilities in high-income countries exceeds the incidence among the general population.

This chapter discusses each of the four types of intervention – managerial, administrative, environmental and personal protection – in relation to congregate settings. The recommendations for congregate settings are less specific than those for health-care facilities, because congregate settings are so diverse. It focuses particularly on correctional facilities because evidence from such settings is more readily available; however, the recommendations also apply to other congregate settings. As more evidence becomes available, the guidance will be updated to better reflect the specific needs of particular settings. Any health-care facility (e.g. medical or infirmary) within a congregate setting should be considered as a health-care setting, in which TB infection control interventions should be implemented as in any health-care facility within the same geographical area or having the same characteristics.

6.1 MANAGERIAL ACTIVITIES IN CONGREGATE SETTINGS

The full set of managerial activities should be implemented in congregate settings. As a first step, country-level policy makers responsible for congregate settings should be made part of the national coordinating system for planning and implementing interventions to control TB infection. In particular, ministry of justice and correctional facilities medical service should be fully engaged and encouraged to implement TB IC.

Congregate settings should be part of the national surveillance activities and should be included in facility assessment for TB infection control. Such assessment will be useful in determining the level of risk of the facility or building.

Any advocacy and IEC material should include a specific focus on congregate settings, as should monitoring and evaluation activities. There is a great need for more research on TB infection control in congregate settings, to better understand the dynamic of TB transmission.

6.2 ADMINISTRATIVE CONTROLS IN CONGREGATE SETTINGS

Priority interventions to decrease TB transmission in congregate settings are aimed at early identification, followed by separation and proper treatment of infectious cases. Recommendations 6a–6c should thus be prioritized. In particular, all inmates of correctional facilities and inhabitants of other congregate settings should be screened for TB before entry into the facility. Infectious patients should always be separated and, if possible, isolated in a well-ventilated area, until sputum smear conversion. Implementation of directly observed therapy (DOT) while a patient is on treatment is also recommended.

In congregate settings with a high prevalence of HIV (in particular in correctional services), all staff and persons residing in the setting should receive or be offered HIV counseling and testing. Groups most at risk – such as injecting and other drug users – should have access to appropriate HIV counseling and testing. If diagnosed with HIV, they should be offered a package of prevention and care that includes regular screening for active TB.

6.3 ENVIRONMENTAL CONTROLS IN CONGREGATE SETTINGS

Buildings in congregate settings should comply with national norms and regulations for public buildings, and should meet the design criteria for sufficient ventilation. In congregate settings where adequate ventilation

cannot be achieved – for example because of design constraints (e.g. in correctional facilities) – use of UVGI could be considered. However, if UVGI is used, strict security regulations should be followed, and if these are not available at national level, they should be developed as a matter of urgency. Overcrowding in any congregate settings should be avoided because it can lead to non-infected individuals being exposed to TB patients.

6.4 PERSONAL PROTECTIVE INTERVENTIONS IN CONGREGATE SETTINGS

When a person residing in congregate settings is suspected or diagnosed as having TB and is physically separated, the same recommendations on infection control apply as for health-care settings.

7. LABORATORY SAFETY

Safety of Laboratory workers is in their own hands. Infection control is dependent on adopting procedures that do not produce aerosols. The laboratory should be designed to ensure adequate ventilation and directional flow as shown in the figure 12 below.

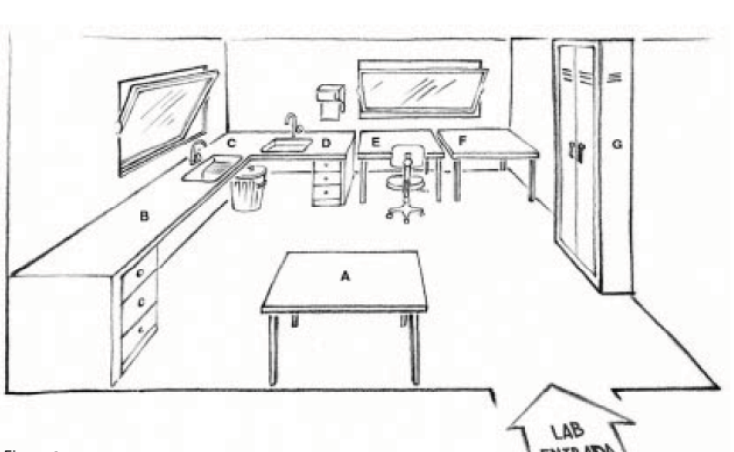


Figure 9: The laboratory layout ensuring adequate ventilation

The laboratory standard operating procedures (SOPs) should strictly be followed by HCWs. Each laboratory should assign an employee as

a biosafety officer who will be given necessary training in laboratory safety. The biosafety officer designs and implements an infection-control program for the TB laboratory, and continuously evaluates maintenance of safety at work place starting from safe working practices to monitoring of equipment and follow-up of documented risk situations. A thorough discussion of the issues involved in laboratory safety is beyond the scope of these guidelines. For more details on laboratory safety issues, consult the WHO publication *Laboratory Services in Tuberculosis Control. Edition I. Geneva: World Health Organization, 1998.*

7.1 AFB SMEAR PREPARATION

Many laboratories which process infectious sputum in Ethiopia perform only direct smear microscopy:

- Performing direct smear microscopy has not been documented to result in the transmission of *M. tuberculosis* (assuming centrifugation is not being used)
- If the infection control risk assessment indicates a low rate of drug resistance, direct smear microscopy may be safely performed on the open bench, neither environmental controls measures nor respiratory protection are necessary during the preparation of direct smears with strict adherence to safe work practices
- If the infection control risk assessment indicates other than a low rate of drug resistance, the use of a ventilated cabinet is recommended during the preparation of direct smears, with strict adherence to safe work practices

In laboratories performing only smear preparation without the use of a centrifuge, following SOPs in the *technical guide for sputum smear microscopy by the Union* shall accord adequate safety. The greatest threat to the personnel is contact with coughing patients or HCWs. However organizational and administrative control measures should be used to limit this exposure.

7.2 PREPARATION OF LIQUID SUSPENSIONS OF *M. TUBERCULOSIS*

Laboratories which process M(X) DR TB or liquid preparations of suspended *M. tuberculosis* (e.g., centrifugation, cultures, and drug susceptibility testing) should be considered high risk for nosocomial *M. tuberculosis* transmission. Safety can be improved by:

- Ensuring good laboratory standard operating procedures are followed.
- Enhancing ventilation in areas where culture and susceptibility testing of *M. tuberculosis* isolates is performed
- Reducing the number of laboratories handling concentrated specimens containing *M. tuberculosis*
- Using laboratories with experienced staff to work with M (X) DR TB and liquid suspensions of *M. tuberculosis*
- Using appropriate ventilated cabinets or biological safety cabinets (BSC I or BSC II)
- Respirator for the laboratory technician

7.3 VENTILATED CABINETS

The ventilated cabinets include Laboratory Fume Hoods and Biological Safety Cabinets. Equipment used depends on the anticipated biohazard.

7.3.1 Laboratory Fume Hoods

The Laboratory Fume Hood protects the worker (no protection of the environment or the product [specimen/culture]). They are designed to minimize exposure of workers to aerosols 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

7.3.2 Biological Safety Cabinets (BSCs)

BSCs are relatively expensive and are designed to contain airborne microorganisms in laboratories working with M(X) DR TB or liquid suspensions of *M. tuberculosis*. The two general types are BSC1 and BSC2. 7.3.2.1 BSC Class I

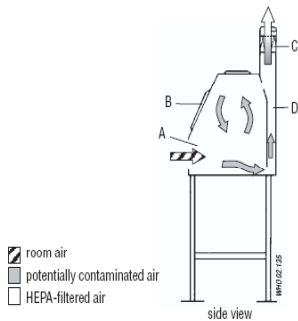
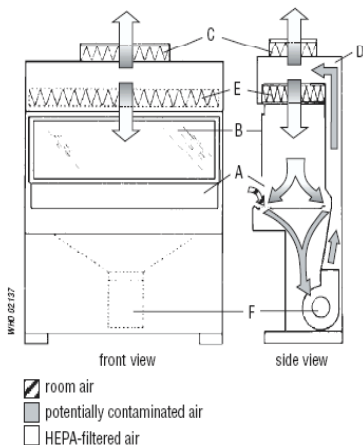


Figure 10. Biological Safety Cabinet 1 A, front opening; B, Sash; C, Exhaust HEPA filter; D Exhaust plenum

Protects the worker and the work environment from exposure to an aerosol by drawing air into the cabinet. It does not protect the specimen from contamination. Air is exhausted outside or filtered through HEPA filter and re-circulated into the room. Since the filters require maintenance, the most practical and safest cabinets simply exhaust air outside, away from windows, people, or areas where the air may be brought back into the building. Exhausting air to the outside produces negative pressure in the laboratory relative to

the surroundings. The air velocity into the cabinet should be 0.35-0.45 m/sec. A higher velocity will cause turbulence and contaminated air to flow out of the BSC. Lower velocity might not be sufficient to remove the aerosolized microorganisms from the cabinet.



7.3.2.2 BSC Class II

This is more expensive than the hood and BSCI. It has both laminar air flow in addition to exhaust thus protecting the specimen/culture as well as the worker and the work environment from contamination. BSCII should be maintained at once every 7-14 months. Without proper maintenance,

Figure 11. Biological Safety Class 2: A, front opening; B, Sash; C, exhaust HEPA filter; D, rear plenum; E, supply HEPA filter; F, blower

the laminar air flow in BSC II cabinets may actually increase the risk to HCWs by pushing contaminated air from the BSCII into the breathing zone of the HCW or by pushing contaminated air from the BSC into the laboratory through a leak in or around the exhaust HEPA filter.

Biosafety cabinets and equipment, as well as the ventilation system must be properly installed, maintained and assessed periodically by engineering staff with adequate training if biosafety measures.

For more details and proper selection of BSC, please consult the WHO Manual, *“Laboratory biosafety manual,2004.11”* and the IUATLD Manual, *“The public health service national tuberculosis reference laboratory and the national laboratory network; International Union Against TB and Lung diseases, 1998*

7.4 RESPIRATORY PROTECTION IN THE LABORATORY

In laboratories where only smear microscopy is performed only on drug-susceptible TB, respiratory protection (e.g., respirators) may not be needed. Laboratories working with M(D)R or liquid suspensions of *M. tuberculosis* should be equipped with a ventilated cabinet or a BSC class I for sputum smear processing. Respiratory protection is not recommended if the BSC is functioning appropriately and all work with M(X) DR or liquid suspensions is carried out in the BSC. However, respirators can be used in event of accidental situations where potentially infectious aerosols are released to the air.

7.5 DOCUMENT LABORATORY ACCIDENTS AND INVESTIGATE ACCORDINGLY.

Every laboratory must keep a record of risk situations and potentially work related infections. The biosafety officer implements the infection control plan for the laboratory and continuously evaluates maintenance of safety at work place starting from safe working practices to monitoring of equipment and follow-up of documented risk situations.

Each case of tuberculosis must launch a thorough investigation of potential errors in working practices in general, and evaluation of potential causes of infection in the individual tuberculosis case. Whenever increased risk

of aerosol release is suspected, all employees have to wear respiratory protection until the apparent causes of increased risk have been corrected.

Work in a TB laboratory poses increased risk of infection with *M. tuberculosis*. Biosafety precautions are paramount in laboratories performing tuberculosis culture, species identification and testing for drug susceptibility. Transfer of bacilli containing specimens or culture suspensions by pouring, pipetting, or with needle and syringe produces infective aerosols. Mixing and centrifugation, inherent steps in the process of cultivation and susceptibility testing, pose an additional high risk of accidental leak of high velocity aerosols from test tubes. Performing most of the work in biosafety cabinets, and using particularly designed aerosol proof centrifugation equipment can reduce risk of infection. Good quality robust laboratory glassware, which does not break in everyday use, is a basic demand for safe work. Specimen vials and culture tubes should have screw tops, which diminishes aerosol production at opening. Cleaning of laboratory glassware and other equipment demands adequate means of disinfection and continuous access to running hot water.

Those parts of the laboratory where aerosol-generating processes take place should have appropriate mechanical ventilation, to dilute any infectious aerosol produced outside of biosafety cabinets. Biosafety cabinets and equipment, as well as the ventilation system must be properly installed, maintained and assessed periodically by engineering staff with adequate training in biosafety measures.

7.6 DISINFECTION, STERILIZATION AND DISPOSAL OF CONTAMINATED MATERIALS

Remove lids from used containers; then place all used containers, lids and applicator sticks in waste receptacle containing 5% phenol or 0.5% sodium hypochlorite solution and make sure are fully submerged. These materials are either autoclaved or burned in an incinerator, or open pit or empty drum.

Positive slides should be broken and disposed off like other “sharps”. The

negative slides can either be disposed off or where necessity demands re-use, are washed clean by boiling in detergent water , washed under running water, wiped with cotton or cloth, air dried and cleaned with alcohol before storing for re-use. These slides should not by any means be used for smear examination again.

ANNEX 1 SUMMARY OF MANAGERIAL AND ADMINISTRATIVE CONTROL MEASURES

Outpatient facilities (Hospital & health center)	Inpatient and mixed facilities These <u>additional</u> measures may apply
<ul style="list-style-type: none"> • Identification of focal person for TBIC • Assessment of at risk-settings • TB Infection Control Plan • HCW training • Access HCT • Early identification and diagnosis • Patient education • Safe sputum collection • Triage and evaluation of suspect • Flowchart path of inpatients and outpatients, including functional procedures • Flowchart path of specimens including TB patients in the health post or clinic • Reducing exposure in the laboratory • Evaluating infection control interventions 	<ul style="list-style-type: none"> • Identification of focal person for TBIC • When medically allowable, encourage outpatient TB management** • Inpatient management and isolation policies* • Isolation of multidrug-resistant and extensively drug resistant TB (M[X]DR TB)* • Enforcing isolation policies* • Special areas in infection control: Radiology, sputum collection & cough inducing procedures, etc. • Specific policies for discontinuing isolation * <p><u>Key:</u></p> <p>*These items may be applicable to inpatient and mixed facilities</p> <p>**These items are applicable to all settings</p>

ANNEX 2. SAMPLE OF INFECTION CONTROL PLAN

- A. The plan will include, but not be limited to, the following intervention areas:
1. Screening all patients to identify persons with symptoms of TB disease or who report being under investigation or treatment for TB disease.
 2. Providing face masks or tissues to persons with symptoms of TB disease (“TB suspects”) or who report being under investigation or treatment for TB disease (“TB suspects or cases”), and providing waste containers for disposal of tissues and masks.
 3. Placing TB suspects and cases in a separate waiting area.
 4. Triaging TB suspects and cases to the front of the line to expedite their receipt of services in the facility.
 5. Referring TB suspects to TB diagnostic services and confirming that TB cases are adhering with treatment.
 6. Using and maintaining environmental control measures.
 7. Educating staff periodically on signs and symptoms of TB disease, specific risks for TB for HIV-infected persons, and need for diagnostic investigation for those with signs or symptoms of TB.
 8. Training and educating staff on TB, TB control, and the TB infection control plan.
 9. Monitoring the TB infection control plan’s implementation.
- B. The facility will implement each intervention by following the procedure(s) that accompany it.

Procedures

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

Lead: _____ (*name of TBIC focal person*) has the responsibility for overseeing the implementation of these activities and reports to _____ (*Head of the facility*) .

Component 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 triage officer should ask about symptoms or recent history of TB. This 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 suspect” for pulmonary 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 TB suspect or case, and he should be managed accordingly.

3. As patients who are not identified as a TB suspect 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 according to (component 2 – 5 below). Staff seeing patients in examination rooms should

report patients they find to be a suspect 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.

Component 2: Instructions on cough hygiene

Procedures:

1. Patients or TB suspects should immediately be informed about the importance of cough hygiene and handed tissues (or pieces of cloth) and instructed to cover their mouths and noses when they cough. Alternatively, if possible they be given a face mask, and asked to wear it while in the facility. They should also be instructed to dispose of used tissues or masks in identified no-touch receptacles and not on the ground. In absence of tissues, instruct them 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.
2. No-touch receptacles for disposal of used tissues and masks should be available in the waiting areas.

Component 3: Placing TB suspects 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.

Component 4. Triaging TB suspects and cases to the head of the line to receive services in the facility

Procedures

1. TB suspects and cases should be moved to the head of the

line for whatever services they want or need, e.g., VCT, medication refills, or medical investigation. This reduces the duration of exposure while they wait in the facility and may be an incentive to disclose information during screening.

Component 5. Referring TB suspects 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).
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.

Component 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 per TBIC plan). Generally, all windows and doors should be open when natural ventilation is the primary environmental control to allow for the free 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 at least 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.

Component 7. Providing confidential TB and HIV voluntary 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 of TB for HIV-infected persons.
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.
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;
 - b. Exhibiting clinical improvement;
 - c. Having continued medical supervision and monitoring of treatment;

Component 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 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.

Component 9. Monitoring the implementation of the TBIC plan

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 employment?
 - b. Did all staff receive annual re-training on TB infection control?
5. Revise the infection control plan to reflect changes in staff responsibilities, activities and procedures
6. Develop a plan for correcting inappropriate practices or failure to adhere to institutional rules
 - a. identify means of motivation to participate fully and adhere to guidelines
 - b. identify corrective actions if guidelines are not followed

ANNEX 3. AN EXAMPLE OF MONITORING TOOLS

_____ has the responsibility for overseeing the evaluation of the TB infection control interventions and its procedures, and reports to _____ (*Head of the facility*).

_____ has the responsibility for filling out the “TB case and suspect log” on a daily basis, entering the date, names of patients who were found to be a case or suspect 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 Suspect Log

Date	Patient Name	Case or Suspect (c/s)	Missed at intake?* (y/n)	Referred to (name of facility)	Outcome** (TB, not TB, NS)

*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 Control Training Log

Staff Name	Start Date (yr of employment)	Date first IC training	Date re- training (yr 02)	Date re- training (yr 03)	Date re- training (yr 04)

ANNEX 4. TB INFECTION CONTROL ASSESMENT TOOLS

The purpose of TB risk assessment is to analyze the extent to which infection control guidelines exist and the knowledge and practices related to basic TB infection control measures. The assessment is targeted to both national TB & HIV/AIDS program staff. The results will be analyzed to identify areas in which additional technical assistance is needed for TB/HIV collaborative activities implementation. A summary of results and recommendations will be shared with both programs and national IP committee.

National Level

Name and Title of respondent: _____

Program (circle one): TB Program HIV/AIDS program

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

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

_____ / /

I	Question	Response	Additional Comments
	How many regional states currently exist?		
	How many districts currently exist?		
	What is the incidence of TB in the country(5 yr trend of CNR)-include HIV rate in TB pts		
	How many TB cases are reported in HCWs		
	Is there a separate National Infection prevention committee	Yes, or No	
	Is there a sub committee addressing TB infection control	Yes, or No	
	Is there a designated national TB/HIV coordinating body?	Yes, or No	
	Does the NTP national manual address TB infection control?	Yes, or No	
	Is there a written national guidelines that addresses TB infection control? If yes, describe it (who developed? Target audience? Status of implementation?)	Yes, or No	
	Has this national guidelines been disseminated?	Yes, or No	
	Has training on implementation of this national guideline been conducted?	Yes, or No	
	Has the implementation of this national guideline been evaluated?	Yes, or No	
	Request copy of most recent annual report/statistical data.		

TB Infection control assessment:

Regional Level

Region: _____

Name and Title of respondent: _____

Program (circle one): TB Program HIV/AIDS program

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

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

	Question	Response	Additional Comments
	What is the total number of districts in the region?		
	What is the total number of TB clinic sites in the region?		
	How many TB patients were reported in the last quarter? Last year quarter? population: _____ HIV rate in TB pts--	Qtr __ ### _____ Yr __ ### _____	CNR----
	How many of the reported TB cases are HCWs		
	What is the total number of HIV care and treatment sites providing ARV treatment in the region?		
	Do HIV care and treatment sites in the region screen patients for active TB? <i>If YES, how? Obtain a copy pt encounter form.</i>	Yes, or No	
	Is there a regional-level TB/HIV coordinator?	Yes, or No	

	Has training on TB infection control been provided...? <i>(No, Yes)</i>		8.1 For staff in HIV care and treatment programs 8.2 For staff in TB clinics 8.3 For staff in hospitals	
	Do facilities in the regional report on the number of TB cases among HCWs in the district? <i>If yes, request a copy.</i>		<i>No, or Yes</i>	
	Does the region have a regional TB lab(s), how many		<i>No, or Yes</i>	
	Indicate whether it performs; - Microscopy -cultures-solid or liquid			

Facility-level

Facility name: _____

Region/District: _____

Name of person administering the interview: _____

Title of respondent: _____

Program (circle one): TB Program HIV/AIDS program

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

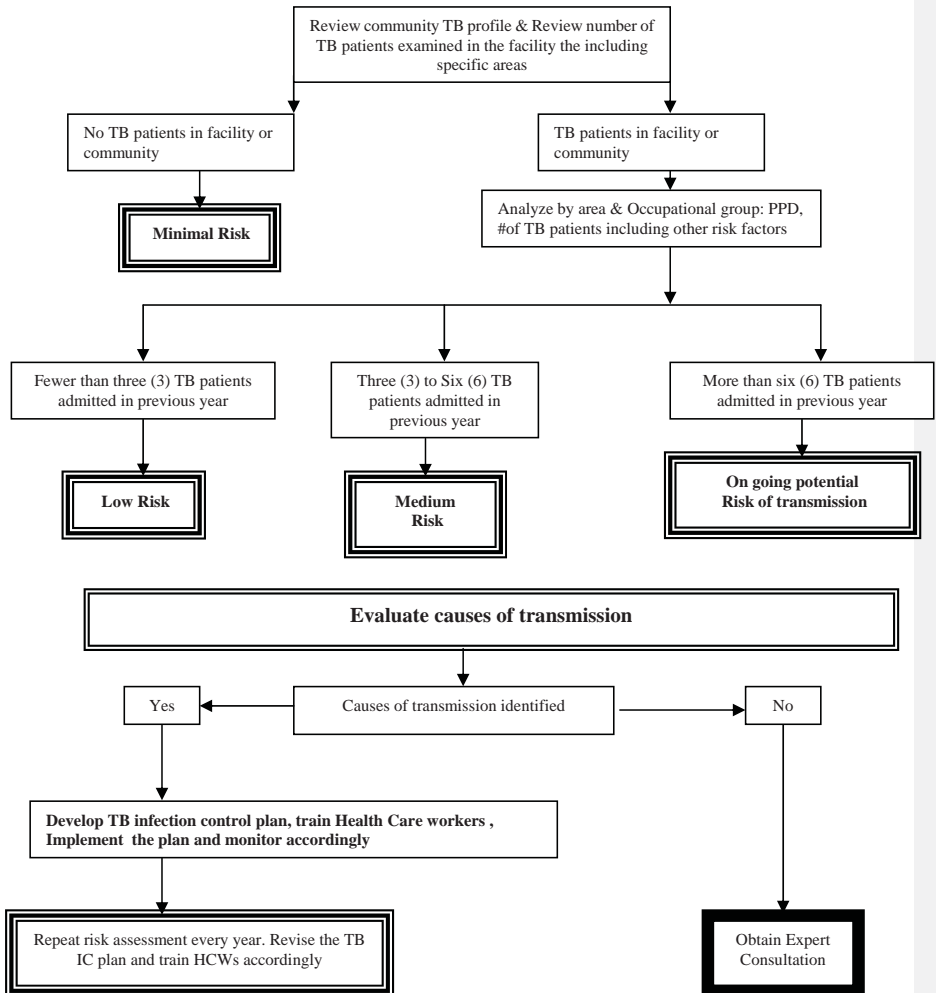
Period of time covered by evaluation: _____ / _____ / _____ to
_____ / _____ / _____

	Question	Response	Additional comments
General information			
	Facility ownership? (1. Ministry of health, 2. Private 3. NGO (including faith-based), 4. Other (specify))		
	Type of facility? (0=TB service clinic in primary health center, 1=TB clinic in a hospital, 2= Out-Patient Department (OPD) clinic, 3=HIV prevention, care and treatment site 4=In-patient ward 5= Other (specify))		
	Does this facility have a designated infection control officer/committee?	<i>No ,or Yes</i>	
	How many full time staff work at this Facility?		
	How many part time staff work at this Facility? (Doctors, nurses, counselors, pharmacists, lab technicians etc)?		
	In the last year, how many staff members were diagnosed with TB?		
Administrative (workplace)			
	Has a facility risk assessment been conducted?	<i>No ,or Yes</i>	
	Does this facility have a written infection control plan? (if yes, OBTAIN a copy)	<i>No ,or Yes</i>	
	What training has staff received on TB infection control?		
	Are staff screened for TB? If yes, how?	<i>No ,or Yes</i>	
	Are staff offered confidential HIV counseling and testing?	<i>No ,or Yes</i>	

	At peak time, describe the waiting area? What is the estimated waiting time from registration until seen by a clinician? (## min/hr)		
	What procedures are in place to identify patients observed to have chronic cough and to fast-track to diagnosis? “triage officers?”		
	Are clients observed with chronic cough isolated in separate room or outside while waiting to see a nurse/doctor?	<i>No ,or Yes</i>	
	Describe education procedures in-place for cough hygiene for TB suspects/patients.		
	Are posters on cough hygiene prominently displayed	<i>No ,or Yes</i>	
	Review the path of the patient. Identify bottlenecks such as crowded interior waiting rooms, evaluate time separation & space separation, etc.		
	HIV care and treatment sites: Do you screen patients for active TB? <i>If YES, how? Obtain pt encounter form.</i>	<i>No ,or Yes</i>	
	What is the sputum turn-around time for specimens collected on suspects? (## days)		
	In-patient: Describe any cohorted medical care practices observed.		
Respiratory Protection			
	Are surgical masks available for coughing patients who cannot be separated?	<i>No ,or Yes</i>	
	Are appropriate respirators available for staff? If yes, describe when they are utilized.	<i>No ,or Yes</i>	
Environmental controls			
	Describe the natural ventilation: <ul style="list-style-type: none"> - In the waiting area. - In the consultation room - In the ward (in-patient) 		
	Cross-ventilation for air movement: sketch placement of windows and doors		
	In-patient wards: Are windows kept open at night?	<i>No ,or Yes</i>	
4.	Is there electricity at this facility?	<i>No ,or Yes</i>	
5.	If electricity is available, assess options to increase air mixing via use of fans.		

ANNEX 5. PROTOCOL FOR CONDUCTING A TUBERCULOSIS RISK ASSESSMENT IN A HEALTH FACILITY

(Adaptation from MMWR 1994 CDC guidelines)



ANNEX 6. 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 patients with suspected or confirmed TB disease is the first step in the protocol. This 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. Patients undergoing 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 be referred to a health facility. Carry out contact tracing of sputum positive PTB including MDR and XDR TB. Actively track the defaulters 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. Respiratory hygiene includes proper disposal of tissues and masks. Patients and their families should also be educated on the signs and symptoms of TB disease, that it is a treatable disease, the risks of not completing treatment, the public health ramifications of not being treated, and increased risk of TB disease of PEOPLE LIVING WITH HIV. Public health and awareness messages could be as simple as posters on the walls and presentations by health educators to as complex as electronic media (videos, DVDs, CDs, etc.).
3.	Separate into special waiting areas	Triaging symptomatic patients to the front of the line for the services they are seeking (e.g. voluntary HIV counseling and testing, medication refills), to quickly provide care and reduce the amount of time that others are exposed to them is recommended. Patients who are identified as TB suspects 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 and provide needed services	In an integrated service delivery setting, if possible, the patient should receive the necessary healthcare services they are accessing before the TB investigation. Patients in special groups (known HIV positive very young and old) should be given preference in care. Triageing 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, district or provincial health facilities. If applicable, co-management of patients with HIV or other diseases should be coordinated with the applicable local, district or provincial health facilities. For MDRTB Identify trained HW in referral sites who will be able to manage the patient according to the national multi-drug-resistant TB guidelines.

*** the sequence of education and separation may be interchanged**

ANNEX 7. AIR CHANGES IN A ROOM

What Does Air Change Mean?

One **air change** occurs in a room when a quantity of air equal to the volume of the room is supplied and/or exhausted.

Air change rates are units of ventilation that compare the amount of air moving through a space to the volume of the space. Air change rates are calculated to determine how well a space is ventilated compared to published standards, codes, or recommendations.

Air changes per hour (ACH) are the most common unit used. This is the volume of air (usually expressed in cubic meters) exhausted or supplied every hour divided by the room volume (also usually expressed in cubic meters).

Airflow is usually measured in cubic meters per minute (CMM). This is multiplied by 60 minutes to determine the volume of air delivered per hour (in cubic meters).

To calculate room volume (in cubic meters), multiply room height (in meters) by the room area (in square meters). Room area is the room width (in meters) times the room length (in meters).

AIR CHANGES PER HOUR (ACH) EQUALS AIRFLOW PER HOUR DIVIDED BY ROOM VOLUME WHICH IS EQUAL TO MULTIPLIED BY 60 MINUTES DIVIDED BY CUBIC METERS

A room may have two airflow values, one for supply and another for exhaust. (The airflow difference between these two values is called the offset.) To calculate the air change rate, use the greater of the two airflow values. For isolation rooms, the exhaust should be greater than the supply

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 m² 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 m³

Average flow rate = Area of window times average air velocity. $25 \text{ m}^2 \times 0.5 \text{ m/s} \times 3600 \text{ s/hour} = 450 \text{ m}^3/\text{hour}$

Air exchange rate = Average flow rate divided by room volume $450 \text{ m}^3/\text{hour} \div 45 \text{ m}^3 = 10 \text{ air exchanges per hour}$

REFERENCES

1. Guidelines for the prevention of tuberculosis in health care settings in resource limited settings; WHO Geneva 1999; WHO/TB/99.269
2. Draft WHO policy on TB infection controls in health care settings, congregate settings and households. March 27th, 2009
3. Centres for Disease Control and Prevention. Guidelines for preventing the transmission of Mycobacterium tuberculosis in Health –care settings, 2005; MMWR 2005;54(No.RR-17):1-184
4. Centres for Disease Control and Prevention. Guidelines for preventing the transmission of Mycobacterium tuberculosis in Health –care settings, 2005; MMWR 1994;43(No.RR-13):1-133
5. Addendum to WHO Guidelines for the prevention of tuberculosis in health care settings in resource limited settings
6. Canadian Tuberculosis standards; 5th Edition 2000
7. Clinical Tuberculosis 2nd Edition, IUATLD, Crofton, Horne, Miller 1999
8. TB/HIV ; A clinical Manual 2nd Edition Anthony Harries, Dermot Maher and Stephen Graham ; WHO/HTM/TB/2004.329
9. Interventions for Tuberculosis Control and Elimination ,2002, IUATLD, Hans Reider
10. Epidemiological basis of Tuberculosis Control, First Edition, 1999 IUATLD; Hans Reider
11. Guidelines for the programmatic management of drug resistant tuberculosis, WHO Geneva ; WHO/HTM/TB/2006.361
12. Namibian National Tuberculosis Control Program Guidelines 2006.

13. Tuberculosis guide for specialist physicians, 2004 IUATLD;
Jose Caminero Luna
14. Manual National TB, Leprosy and TB/HIV program of Ethiopia,
Ministry of Health, fourth edition, 2008
15. FJ Curry 2007 TB IC Manual
16. TB Infection control training materials-Botswana TB CAP course
2008
17. TECHNICAL GUIDE Sputum Examination for Tuberculosis by
Direct Microscopy in Low Income Countries Fifth edition 2000



