

**State of Kuwait  
Ministry of Health  
Infection Control Directorate**

**Guidelines for preventing the Transmission of  
Mycobacterium tuberculosis in Health-Care  
Setting**

**2006**

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## **I. Introduction**

Tuberculosis (T.B) is an infection caused by bacterium of the Mycobacterium tuberculosis complex (*M. tuberculosis*, *M. bovis*, *M. africanum*). It is usually a pulmonary disease (75% or more). Extrapulmonary TB is much less common but infection may occur in any organ or tissue including lymph nodes, meninges, pleura, pericardium, kidneys, bones, joints, larynx, skin, peritoneum, intestines and eyes. *M. tuberculosis* and *M. africanum*, primarily from humans and *M. bovis* primarily from cattle.

*Mycobacterium tuberculosis* is a slow-growing aerobic bacterium that divides every 16-20 hours. This is extremely slow compared to other bacteria, which tend to have division times measured in minutes. It is not classified as either Gram-positive or Gram-negative because it does not have the chemical characteristics of either. It is a small rod-like bacillus which can withstand weak disinfectants and can survive in a dry state for weeks. It is identified microscopically by its staining characteristics; it retains certain stains after being treated with acidic solution, and is thus classified as an acid-fast bacillus” or “ AFB”. In the most common staining technique, the Ziehl-Neelsen stain, AFB are stained a bright red which stands out clearly against a blue background. Acid- fast bacilli can also be visualized by fluorescent microscopy, and by auramine- rhodamine stain.

TB was the eighth leading cause of death in children aged 1-4 years in the 1920s. As the general standard of living and medical care improved in the United States, the incidence of TB decreased. By the 1960s , it wasn't even in the top 10 causes of death among children of any age group. In the mid 1980 s, a resurgence of outbreaks in the United States brought renewed attention to TB. An increase in high risk immunosuppressed individuals, particularly those infected with HIV, lead to an increase in TB cases. Drug – resistant strains of this deadly disease also contributed to the problem. The WHO declared TB a global health emergency in 1993.

The disease is the most common major infectious disease today, infecting two billion people or one third of the world's population, with nine million new cases of active disease annually, resulting in two million deaths, mostly in developing countries. It is one of the top three infectious killing diseases in the world (with HIV/ AIDS and malaria). However through a broad range of Federal and community initiatives including the Centers for Disease Control and Prevention (CDC) 1994 publication, Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health Care Facilities, TB rates have declined steadily over the past decade. As tuberculosis is a significant public health problem, this document is prepared to make recommendations for reducing the risk for

transmitting *M. tuberculosis* to HCWs, patients, visitors, and other persons in these settings. The information also will serve as a useful resource for educating HCWs about TB.

## **II. Pathogenesis**

After inhalation, the droplet nucleus is carried down the bronchial tree and implants in a respiratory bronchiole or alveolus. Whether or not an inhaled tubercle bacillus establishes an infection in the lung depends on both the bacterial virulence and the inherent microbicidal ability of the alveolar macrophage that ingests it. If the bacillus is able to survive initial defenses, it can multiply within the alveolar macrophage. The tubercle bacillus grows slowly, dividing approximately every 25-32 hours within the macrophage. *Mycobacterium tuberculosis* has no known endotoxins or exotoxins; therefore, there is no immediate host response to infection. The organisms grow for 2-12 weeks, until they reach  $10^3$  -  $10^4$  in number, which is sufficient to elicit a cellular immune response. That can be detected by a reaction to the tuberculin skin test.

Before the development of cellular immunity, tubercle bacilli spread via the lymphatics to the hilar lymph nodes and thence through the bloodstream to more distant sites. Certain organs and tissues are notably resistant to subsequent multiplication of these bacilli. The bone marrow, liver, and spleen are almost always seeded with mycobacteria, but uncontrolled multiplication of the bacteria in these sites is exceptional. Organisms deposited in the upper lung zones, kidneys, bones, and brain may find environments that favor their growth, and numerous bacterial divisions may occur before specific cellular immunity develops and limits multiplication.

In general, persons who become infected with *M. tuberculosis* have approximately a 10% risk for developing active TB during their lifetime. This risk is greatest during the first 2 years after infection. Immuno-compromised persons have a greater risk for the progression of latent TB infection.

## **III. Risk factors for TB**

### **➤ Groups of persons known to have a higher prevalence of TB infection include:-**

Characteristics of persons exposed to *M. tuberculosis* that might affect the risk for infection are not as well defined. 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 and the duration of exposure to a person with infectious TB disease. The closer the proximity and the longer the duration of exposure, the higher risk is for being infected.

In addition to close contacts, the following persons are also at higher risk for exposure to and infection with *M. tuberculosis*. Persons listed who are also close contacts should be top priority.

1. Contacts of persons who have active TB.
2. Foreign born persons from areas of world with a high prevalence of TB (e.g Asia – Africa the Eastern Europe, Latin America, and Russia).
3. HCWs who serve patients who are at high risk.
4. HCWs with unprotected exposure to a patient with TB disease.
5. Residents and employees of congregate settings that are high risk (e.g., correctional facilities, long-term care facilities [LTCFs], and homeless shelters)
6. Population at high risk who are defined locally as having an increased incidence of TB disease.
7. Infants, children and adolescents exposed to adults in high-risk categories.

➤ **Persons Whose Condition is at High Risk for Progression From LTBI to TB disease**

The following persons are at high risk for progressing from LTBI to TB disease:

1. Persons infected with HIV.
2. Persons infected with *M.tuberculosis* within the previous two years.
3. Infants and children aged <4years.
4. Persons with any of the following clinical conditions or other immunocompromising conditions:-
  - Silicosis
  - Diabetes mellitus
  - Chronic renal failure
  - Certain hematologic disorders (leukemia's and lymphomas)
  - Other specific malignancies (e.g., carcinoma of the head, neck or lung)
  - Body weight  $\geq 10\%$  below ideal body weight.
  - Prolonged corticosteroid use.
  - Other immunosuppressive treatments (including tumornecrosis, factor-alpha[TNF- $\alpha$ ] antagonists)
  - Organ transplant.
  - End-stage renal disease (ESRD).
  - Intestinal bypass or gastrectomy.
5. Persons with a history of untreated or inadequately treated TB disease, including persons with chest radiograph findings consistent with previous TB disease.
6. Persons who use tobacco or alcohol, Illegal drugs, including injection drugs and crack cocaine might also been at increased risk for infection and disease.

➤ **Characteristics of a Patient with TB disease That Increase the Risk for Infectiousness.**

The following characteristics exist in a patient with TB disease that increases the risk for infectiousness:

- Presence of cough
- Cavitations on chest radiograph
- Positive (AFB) sputum smear result
- Respiratory tract disease with involvement of the larynx (substantially infectious)
- Respiratory tract disease with involvement of the lung or pleura (exclusively pleural involvements is less infectious)
- Failure to cover the mouth and nose when coughing
- Incorrect, lack of or short duration of antituberculosis treatment
- Undergoing cough-inducing or aerosol-generating procedures (e.g., bronchoscopy, sputum induction, and administration of aerosolized medications)

▶ **Environmental factors that increase risk of probability of Transmission on *M. tuberculosis***

1. Exposure in a small enclosed space.
2. Inadequate local or general ventilation that results in insufficient dilution and removal of infectious droplet nuclei.
3. Recirculation of air containing infectious droplet nuclei.
4. Inadequate cleaning and disinfection of medical equipment.
5. Improper procedures for handling specimens.

▶ **Risk for Health-care Associated Transmission of *M.tuberculosis***

Health-care associated transmission of *M.tuberculosis* has been linked to:-

1. Close contact with persons with TB disease during aerosol-generating or aerosol-producing procedures, including bronchoscopy, endotracheal intubation.
2. Suctioning.
3. Other respiratory procedure
4. Open abscess irrigation
5. Autopsy
6. Sputum induction
7. Aerosol treatment that induces coughing

Factors contributing to these transmission included delayed diagnosis of TB disease, delayed initiation and inadequate airborne precautions, lapses in all practices and precautions for cough inducing and aerosol-generating procedures, and lack of adequate respiratory protection.

#### **IV. Epidemiology**

Tuberculosis (TB) is a contagious disease. If left untreated, each person with active TB disease will infect on average between 10 and 15 people every year.

- Someone in the world is newly infected with TB bacilli every second.
- Overall, one third of the world's population is currently infected with the TB bacillus.
- 5-10% of people who are infected with TB bacilli (but who are not infected with HIV) become sick or infectious at some time during their life.

Table- (1) below shows the estimated TB incidence (the number of new cases arising each year) and mortality in each of the WHO regions. The incidence of all forms of TB, the incidence of infectious (smear-positive) cases, and mortality are shown as the total number of cases and as the rate /100 000 population.

The largest number of cases occurs in the South –East Asia Region, which accounts for 33% of incident cases globally. It is estimated that 1.75 million deaths resulted from TB in 2003. As with cases of disease, the highest number of estimated deaths is in the South- East Asian Region , but the highest mortality per capita is in the Africa Region, where HIV has led to rapid increases in the incidence of TB and increases the likelihood of dying from TB.

**Table-1**

<b>Estimated TB incidence and mortality , 2003</b>						
	Number of cases (thousands)		Cases per 100 000 population		Deaths from TB (including TB deaths in people infected with HIV)	
WHO region	All forms	Smear positive	All forms	Smear positive	Number (Thousands)	Per 100 000 population
Africa	2372 (27)%	1013	345	147	538	78
The Americas	370 (4)%	165	43	19	54	6
Eastern Mediterranean	634 (7)%	285	122	55	144	28
Europe	439 (5)%	196	50	22	67	8
South-East Asia	3062 (35)%	1370	190	85	617	38

Western Pacific	1933 (22)%	868	112	50	327	19
<b>Global</b>	<b>8810 (100)</b>	<b>3897</b>	<b>140</b>	<b>62</b>	<b>1747</b>	<b>28</b>

## **V. Mode of Transmission**

The following factors determine the likelihood of transmission of *M. tuberculosis*.

- a. The number of organisms being expelled into the air.
- b. The concentration of organisms in the air determined by the volume of the space and its ventilation.
- c. The length of time an exposed person breathes the contaminated air
- d. Presumably the immune status of the exposed individual.

### 1. Air borne transmission

*M. tuberculosis* is carried in airborne particles, or droplet nuclei, that can be generated when persons who have pulmonary or laryngeal TB sneeze, cough, speak, or sing. The particles are an estimated 1-5µm in size, and normal air currents can keep them airborne for prolonged time periods and spread them throughout a room or building.

### 2. Ingestion

Bovine tuberculosis results mainly from ingestion of unpasteurized milk and dairy products. Aerosol transmission has been reported among abattoir workers.

### 3. Inoculation

Invasion may occur through mucous membranes or damaged skin.

### 4. Persons with extra pulmonary TB disease usually are not infectious unless:

- a. They have concomitant pulmonary disease.
- b. Non pulmonary disease located in the oral cavity or the larynx.
- c. Extra pulmonary disease that includes an open abscess or lesion in which the concentration of organisms is high, especially if drainage from the abscess or lesion is extensive.
- d. If aerosolization of drainage fluid is performed. N:B Persons with TB pleural effusions might also have concurrent unsuspected pulmonary or laryngeal TB disease. These patients should be considered infectious until pulmonary TB disease is excluded. Patients with suspected TB pleural effusions or extra pulmonary TB disease should be considered pulmonary TB suspects until concomitant pulmonary disease is excluded.

Although children with TB disease usually are less likely than adults to be infectious, transmission from young children can occur. Therefore, children and adolescents with TB disease should be



evaluated for infectiousness by using the majority of the same criteria as for adults. These criteria include presence of cough lasting >3 weeks; cavitations on chest radiograph; or respiratory tract disease with involvement of lungs, airways, or larynx. Infectiousness would be increased if the

patients were on nonstandard or short duration of antituberculosis treatment or undergoing cough inducing or aerosol-generating procedures (e.g., sputum induction, bronchoscopy, and airway suction). Although gastric lavage is useful in the diagnosis of pediatric TB disease, the grade of the positive AFB smear result does not correlate with infectiousness. Pediatric patients who might be infectious include those who are not on antituberculosis treatment, who have just been started on treatment or are on inadequate treatment, and who have extensive pulmonary or laryngeal involvement (i.e., coughing >3 weeks, cavitory TB disease, positive AFB sputum smear results, or undergoing cough inducing or aerosol-generating procedures). Children who have typical primary TB lesions on chest radiograph and do not have any of these indicators of infectiousness might not need to be placed in an AII room.

No data exist on the transmission of *M. tuberculosis* and its association with the collection of gastric aspirate specimens. Children who do not have predictors for infectiousness do not need to have gastric aspirates obtained in an AII room or other special enclosure; however, the procedure should not be performed in an area in which persons infected with HIV might be exposed. Because the source case for pediatric TB patients might be a member of the infected child's family, parents and other visitors of all hospitalized pediatric TB patients should be screened for TB disease as soon as possible to ensure that they do not become sources of health-care– associated transmission of *M. tuberculosis*.

#### **VI. Classification of persons exposed to and /or infected with *Mycobacterium tuberculosis***

This classification is based on the broad host–parasite relationships as described by exposure history, infection, and disease.

It is intended mainly as an operational framework for public health programs. The HIV status of an individual should be known, since HIV infection may change the approach to diagnosis and therapy for tuberculosis.

#### **WHO classification:**

0. No *tuberculosis* exposure, not infected. Persons in this class have no history of exposure and a negative reaction to the tuberculin skin test (if tested).

1. *Tuberculosis* exposure, no evidence of infection. Persons in class 1 do have a history of exposure but have a negative reaction to the tuberculin skin test. Action taken for persons in this class depends mainly on the degree and recency of exposure to *M. tuberculosis*, as well as the immune status of the

exposed person. If there has been significant exposure within 3 months, a follow-up skin test should be performed 10 weeks after the last exposure and in the interim, treatment of latent tuberculosis infection should be considered, especially for children less than 15 years of age and persons with HIV infection.

2. Latent *tuberculosis* infection, no disease. Persons in class 2 have a positive reaction to the tuberculin skin test (indicate mm induration), negative bacteriologic studies (if done), and no clinical, bacteriological, or radiographic evidence of active tuberculosis. Treatment of latent tuberculosis infection may be indicated for some persons in this group:-

- ◆ Chemotherapy status
- ◆ Never received therapy
- ◆ Currently receiving chemotherapy (date and regimen)
- ◆ Therapy complete (dates and prescribed course of therapy)
- ◆ Therapy incomplete (dates and regimen)

3. *Tuberculosis*, clinically active. Class 3 includes all patients with clinically active tuberculosis whose diagnostic procedures are complete. If the diagnosis is still pending, the person should be classified as a tuberculosis suspect (Class 5). To fit into Class 3, a person must have clinical, bacteriological, and/or radiographic evidence of current tuberculosis. This is established most definitively by isolation of *M. tuberculosis*. A person who had past tuberculosis and who also currently has clinically active disease belongs to Class 3. A person remains in Class 3 until treatment for the current episode of disease is completed. This group is further defined by the following features:

I. Location of disease

- a. Pulmonary
- b. Pleural
- c. Lymphatic
- d. Bone and/or joint
- e. Genitourinary
- f. Disseminated (miliary)
- g. Meningeal
- h. Peritoneal
- i. Other

The predominant site should be listed. Other sites may also be listed. Anatomic sites may be specified more precisely.

II. Bacteriologic status

- a. Negative

Not done  
Microscopy (date)  
Nucleic acid amplification (date)  
Culture (date)

b. Positive

Microscopy (date)  
Nucleic acid amplification (date)  
Culture (date)  
Susceptibility results with method and concentrations used (date)

The following data are necessary under certain circumstances:

III. Chest radiograph findings

- e. Normal
- f. Abnormal
- g. Cavitory or noncavitory
- h. Stable or worsening or improving

IV. Tuberculin skin test reaction

- a. Positive (mm induration)
- b. Negative (mm induration)

4. *Tuberculosis*: not clinically active. This classification is defined by a history of previous episode(s) of tuberculosis or abnormal stable radiographic findings in a person with a positive reaction to tuberculin skin test (indicate mm induration), negative bacteriologic studies (if done), and no clinical and/or radiographic evidence of current disease. Persons in Class 4 may never have received chemotherapy, may be receiving treatment for latent infection, or may have completed a previously prescribed course of chemotherapy. If current clinically active disease has not been ruled out, especially in persons not adequately treated in the past, this person should be classified as a tuberculosis suspect (Class 5) until diagnostic evaluation permits classification as Class 3 or Class 4.

5. *Tuberculosis* suspects (diagnosis pending), persons should be so classified when a diagnosis of tuberculosis is being considered, whether or not treatment has been started, until diagnostic procedures have been completed. Persons should not remain in this class for more than 3 months. When diagnostic procedures have been completed, the person should be placed in one of the preceding classes.

## **VII. Diagnostic Procedures for LTBI and TB Disease**

### **A. Diagnosis of LTBI:**

LTBI is a condition that develops after exposure to a person with infectious TB disease, and subsequent infection with *M. tuberculosis* occurs where the bacilli are alive but inactive in the body. Persons who have LTBI but who do not have TB disease are asymptomatic (i.e., have no symptoms), do not feel sick, and cannot spread TB to other persons. The following procedures are used in diagnosis of LTBI:

#### **1. Tuberculin Skin Test (TST):**

The TST is frequently the first step of a TB diagnostic evaluation that might lead to diagnosing LTBI. Although currently available preparations of PPD used in TST are <100% sensitive and specific for the detection of LTBI, the TST is currently the most widely used diagnostic test for *M. tuberculosis* infection. The TST is less sensitive in patients who have TB disease.

The recommended method for TST is the Mantoux method. It involves injection of 5 TU of purified protein derivative (PPD) usually 0.1 ml intradermally (ID). The TST result should be read by a designated, trained HCW 48-72 hours after the TST is placed. If the TST was not read between 48-72 hours, ideally, another TST should be placed as soon as possible and read within 48-72 hours. However, if a patient fails to return within 72 hours and has a negative test result, the TST should be repeated. Patients and HCWs should not be allowed to read their own TST results.

Reading the TST result consists of first determining the presence or absence of induration (hard, dense, and raised formation) and, if induration is present, measuring the diameter of induration transverse (perpendicular) to the long axis of the forearm. Erythema or redness of the skin should not be considered when reading a TST result.

#### **Two step TST test:**

In certain persons with LTBI, the delayed type hypersensitivity (DTH) responsible for TST reactions wanes over time. Repeated TST can elicit a reaction called boosting in which an initial TST result is negative, but a subsequent TST result is positive. For example, a TST administered years after infection with *M. tuberculosis* can produce a false-negative result. This TST might stimulate (or boost) the person's ability to react to tuberculin, resulting in a positive result to a subsequent test (including the second step of a two-step procedure). With serial testing, a boosted reaction on a subsequent TST might be misinterpreted as a newly acquired infection, compared with the false-negative result from the initial TST. Misinterpretation of a boosted reaction as a new

infection with *M. tuberculosis* or TST conversion might prompt unnecessary investigations to find the source case, unnecessary treatment for the person tested, and unnecessary testing of other HCWs. The booster phenomenon can occur in anyone, but it is more likely to occur in older persons, persons with remote infection with *M. tuberculosis* (i.e., infected years ago), persons infected with non tuberculosis mycobacterium (NTM), and persons with previous BCG vaccination.

If an initial TST result is classified as negative, a second step of a two-step TST should be administered 1-3 weeks after the first TST result was read. If the second TST result is positive, it probably represents a boosted reaction, indicating infection most likely occurred in the past and not recently. If the second TST result is also negative, the person is classified as not infected. Two-step skin testing has no place in contact investigations or in other circumstances in which ongoing transmission of *M. tuberculosis* is suspected.

All newly employed HCWs who will be screened with TST should receive baseline two-step TST upon hire, unless they have documentation of either a positive TST result or treatment for LTBI or TB disease. A reliable baseline test result is necessary to detect health-care-associated transmission of *M. tuberculosis*.

**(Table- 2). Size of induration in relation to other risk factors in patients with positive tuberculin skin test**

**Induration  $\geq 5$  mm**

- Contacts of person known to be infected
- Patients with abnormal chest film
- HIV-positive patients
- Organ-transplant recipients
- Other immunosuppressed patients (receiving equivalent of  $>15$  mg/d of prednisone for  $>1$  month)

**Induration  $\geq 10$  mm**

- Recent immigrants (ie,  $<5$  yr) from countries with high incidence of TB
- Residents of prisons, nursing homes, institutions
- Injecting drug users
- Healthcare workers (including mycobacterial laboratory personnel)
- Children aged  $<4$  yr or infants, children, and adolescents exposed to high-risk adults
- Persons with other high-risk medical factors (eg, diabetes, silicosis, renal failure, cancer, gastrectomy)

- Locally identified high-risk groups

**Induration  $\geq 15$  mm**

No risk factors

### **Interpreting TST Results in HCWs:**

TST result interpretation depends on two factors:

1) Measured TST induration in millimeters and

2) The person's risk for being infected with *M. tuberculosis* and risk for progression to TB disease if infected.

The purpose of the test should be used to determine whether the TST result should be classified as positive or negative. A TST result with no induration (0 mm) or a measured induration below the defined cut point for each category is considered to signify absence of infection with *M. tuberculosis*.

#### **A. Interpreting the TST Result for Infection Control and Surveillance:**

- On baseline TST testing, a TST result of  $\geq 10$  mm is considered positive for the majority of HCWs, and a TST result of  $\geq 5$  mm is considered positive for HCWs who are infected with HIV or who have other immunocompromising conditions. All HCWs with positive baseline, TST results should be referred for medical and diagnostic evaluation; additional skin testing does not need to be performed.
- On serial screening for the purposes of infection control surveillance, TST results indicating an increase of  $\geq 10$  mm within 2 years should be interpreted and recorded as a TST conversion. For the purposes of assessing and monitoring infection control, TST conversion rates should be regularly determined. Any HCW with a positive TST result from serial TB screening should be referred to a medical provider for an evaluation and to determine the need for treatment of LTBI based on individual risk

- After a known exposure in a health-care setting, close HCW contacts who have TST results of  $\geq 5$  mm should be considered to have positive TST results, which should be interpreted as new infections only in HCWs whose previous TST result is 0 mm. However, HCWs with a baseline or follow-up TST result of  $>0$  mm but  $<10$  mm with a health-care--associated exposure to *M. tuberculosis* and who then have an increase of  $\geq 10$  mm should be considered to have a TST conversion because of a new infection. In a contact investigation, a follow-up TST should be administered 8-10 weeks after the end of exposure (rather than 1-3 weeks later, as in two-step testing). In this instance, a change from a negative TST result to a positive TST result should not be interpreted as a boosted reaction. The change in the TST result indicates a TST conversion, recent exposure, transmission and infection.
- After an HCW has met criteria for a positive TST result, including HCWs who will not receive treatment for LTBI, repeat TSTs are not necessary because the results would not provide any additional information. For future TB screening in settings that are medium risk, instead of participating in serial skin testing, the HCW should receive a medical evaluation and a symptom screen annually.

#### **B. Interpreting the TST Result for Medical and Diagnostic Referral and Evaluation**

- HCWs who have positive TST results and who meet the criteria for referral should have a medical and diagnostic evaluation. For HCWs who are at low risk (e.g., those from low-incidence settings), a baseline result of  $\geq 15$  mm of induration (instead of  $\geq 10$  mm) might possibly be the cut point.
- When making decisions for the diagnosis and treatment of LTBI, setting-based risk factors (e.g., the prevalence of TB disease and personal risk factors such as having an immunocompromising condition or known contact with a TB case) should be assessed when choosing the cut point for a positive TST result.
- HCWs with negative baseline two-step TST results who are referred for medical evaluation for an increase of  $\geq 10$  mm induration on follow-up TST screening, including those who are otherwise at low risk for TB disease, probably acquired *M. tuberculosis* infection since receiving the previous TST and should be evaluated for TB disease. If disease is excluded, the HCW should be offered treatment for LTBI if they have no contraindication to treatment.

## **Special Considerations in TST**

- **Anergy.** The absence of a reaction to a TST does not exclude a diagnosis of TB disease or infection with *M. tuberculosis*. In immunocompromised persons, delayed-type hypersensitivity (DTH) responses (e.g., tuberculin reactions) can decrease or disappear more rapidly, and a limited number of otherwise healthy persons apparently are incapable of reacting to tuberculin even after diagnosed infection with *M. tuberculosis*. This condition, called anergy, can be caused by multiple factors (e.g., advanced HIV infection, measles infection, sarcoidosis, poor nutrition, certain medications, vaccinations, TB disease itself, and other factors)
- **Pregnancy.** Tens of thousands of pregnant women have received TST since the test was developed, and no documented episodes of TST-related fetal harm have been reported. No evidence exists that the TST has adverse effects on the pregnant mother or fetus. Pregnant HCWs should be included in serial skin testing as part of an infection control program or a contact investigation because no contraindication for skin testing exists.
- **BCG vaccination.** A positive TST reaction as a result of BCG wanes after 5 years. Therefore, HCWs with previous BCG vaccination will frequently have a negative TST result. Because HCWs with a history of BCG are frequently from high TB prevalence countries, positive test results for *M. tuberculosis* infection in HCWs with previous BCG vaccination should be interpreted as representing infection with *M. tuberculosis*. Although BCG reduces the occurrence of severe forms of TB disease in children and overall might reduce the risk for progression from LTBI to TB disease, BCG is not thought to prevent *M. tuberculosis* infection. Test results for *M. tuberculosis* infection for HCWs with a history of BCG should be interpreted by using the same diagnostic cut points used for HCWs without a history of BCG vaccination.

Previous BCG vaccination is not a contraindication to having a TST or two-step skin testing administered. HCWs with previous BCG vaccination should receive baseline and serial skin testing in the same manner as those without BCG vaccination.



## **FACTORS CAUSING FALSE-NEGATIVE TUBERCULIN SKIN TESTS**

### **Factors related to the person being tested:**

- Infections
  - Viral (measles, mumps, chicken pox, HIV)
  - Bacterial (typhoid fever, brucellosis, typhus, leprosy, pertussis, overwhelming tuberculosis, tuberculous pleurisy)
  - Fungal (South American blastomycosis)
- Live virus vaccinations (measles, mumps, polio, varicella)
- Metabolic derangements (chronic renal failure)
- Low protein states (severe protein depletion, afibrinogenemia)
- Diseases affecting lymphoid organs (Hodgkin's disease, lymphoma, chronic leukemia, sarcoidosis)
- Drugs (corticosteroids and many other immunosuppressive agents)
- Age (newborns, elderly patients with "waned" sensitivity)
- Stress (surgery, burns, mental illness, graft-versus-host reactions)

### **Factors related to the tuberculin used**

- Improper storage (exposure to light and heat)
- Improper dilutions
- Chemical denaturation
- Contamination
- Adsorption (partially controlled by adding Tween 80)

### **Factors related to the method of administration**

- Injection of too little antigen
- Subcutaneous injection
- Delayed administration after drawing into syringe
- Injection too close to other skin tests

### **Factors related to reading the test and recording results**

- Inexperienced reader
- Conscious or unconscious bias
- Error in recording

## 2. Blood assay for *M. tuberculosis*:

In vitro cytokine-based immunoassays for the detection of *M. tuberculosis* infection have been the focus of intense research and development. One such blood assay for *M. tuberculosis* (or BAMT) is an interferon gamma release assay (IGRA), the QuantiFERON<sup>®</sup>TB test (QFT), and the subsequently developed version, QFTG. The QFTG measures cell-mediated immune responses to peptides from two *M. tuberculosis* proteins those are not present in any Bacille Calmette-Guérin (BCG) vaccine strain and that are absent from the majority of nontuberculous mycobacteria (NTM), also known as mycobacteria other than TB (MOTT).

**Table- 3. Interpretations of tuberculin skin test (TST) and QuantiFERON<sup>(R)</sup>- TB test (QFT) results according to the purpose of testing for Mycobacterium tuberculosis infection in a health-care setting.**

Purpose of testing	TST	QFT
1. Base line	1. $\geq 10$ mm is considered a positive result (either first- or second- step)	1. Positive (only one- step)
2. Serial testing without known exposure	2. Increase of $> 10$ mm is considered a positive result (TST conversion)	2. Change from negative to positive (QFT conversion)
3. Known exposure (close contact)	3. $\geq 5$ mm is considered a positive result in persons who have a baseline TST result of 0mm; an increase of $\geq 10$ mm is considered a positive result in persons with a negative baseline TST result or previous follow up screening TST result of $\geq 0$ mm	3. Change to positive.

QFTG was approved by FDA in 2005 and is an available option for detecting *M. tuberculosis* infection. Additional cytokine-based immunoassays are under development and might be useful in the diagnosis of *M. tuberculosis* infection. Future FDA-licensed products in combination with CDC-issued recommendations might provide additional diagnostic alternatives

## 3. Chest radiography:

In persons with LTBI, the chest radiograph is usually normal, although it might demonstrate abnormalities consistent with previous healed TB disease or other pulmonary conditions. Previous,

healed TB disease can produce radiographic findings that might differ from those associated with current TB disease, although a substantial overlap might exist. These findings include nodules, fibrotic scars, calcified granulomas, or basal pleural thickening. Nodules and fibrotic scars might contain slowly multiplying tubercle bacilli and pose a high risk for progression to TB disease. Calcified nodular lesions (calcified granulomas) and apical pleural thickening pose a lower risk for progression to TB disease.

## **B. diagnosis of TB disease:**

### **1. Clinical presentations:**

TB disease should be considered for any patient who has symptoms or signs of disease, including coughing for >3 weeks, loss of appetite, unexplained weight loss, night sweats, bloody sputum or hemoptysis, hoarseness, fever, fatigue, or chest pain. The index of suspicion for TB disease will vary by individual risk factors, geographic area, and prevalence of TB disease in the population served by the health-care setting.

#### ***Extra pulmonary TB***

Extrapulmonary tuberculosis usually presents more of a diagnostic problem than pulmonary tuberculosis. In part this relates to its being less common and, therefore, less familiar to most

clinicians. In addition, extrapulmonary tuberculosis involves relatively inaccessible sites and, because of the nature of the sites involved, fewer bacilli can cause much greater damage. The combination of small numbers of bacilli and inaccessible sites causes bacteriologic confirmation of a diagnosis to be more difficult, and invasive procedures are frequently required to establish a diagnosis.

#### ***Disseminated tuberculosis***

Disseminated tuberculosis occurs because of the inadequacy of host defenses in containing tuberculous infection. This failure of containment may occur in either latent or recently acquired tuberculous infection. Because of HIV or other causes of immunosuppression, the organism proliferates and disseminates throughout the body. Multiorgan involvement is probably much more common than is recognized because, generally, once *M. tuberculosis* is identified in any specimen, other sites are not evaluated. Because of the multisystem involvement in disseminated tuberculosis, the clinical manifestations are protean. The presenting symptoms and signs are generally nonspecific and are dominated by systemic effects, particularly fever, weight loss, night-sweats, anorexia, and weakness. Other symptoms depend on the relative severity of disease in the organs involved. A productive cough is common because most patients with disseminated disease also have pulmonary involvement. (For more details see appendix A for extrapulmonary)

## **2. Chest radiograph:**

Chest radiographic abnormalities can suggest pulmonary TB disease. Radiographic abnormalities that are consistent with pulmonary TB disease include upper-lobe infiltration, cavitation, and effusion. Infiltrates can be patchy or nodular and observed in the apical (in the top part of the lungs) or subapical posterior upper lobes or superior segment of the lower lobes in the lungs.

HCWs who have positive test results for *M. tuberculosis* infection or symptoms or signs of TB disease, regardless of test results for *M. tuberculosis* infection, should have a chest radiograph performed to exclude a diagnosis of TB disease. However, a chest radiograph is not a substitute for tests for *M. tuberculosis* infection in a serial TB screening program for HCWs.

Persons who have LTBI or cured TB disease should not have repeat chest radiographs performed routinely. Repeat radiographs are not needed unless symptoms or signs of TB disease develop or a clinician recommends a repeat chest radiograph..

## **3. Imaging technique:**

Computed tomography (CT) is more sensitive than chest radiography for detection of cavities, lymphadenopathy, miliary disease, bronchiectasis, bronchial stenosis, bronchopleural fistula, and pleural effusion. The increased sensitivity of CT also is valuable when findings on chest films are absent or inconsistent and for guiding diagnostic evaluations, such as bronchoscopy. High-resolution CT may reveal occult abscesses, cavities, and the extent of pleural disease. CT is also useful in patients with extensive fibrosis, scarring, or postsurgical changes. Magnetic resonance imaging is preferred for diagnosis of extrapulmonary disease, such as skeletal and intracranial TB.

## **4. Laboratory diagnosis:**

### **A. Sample collection:**

#### **• Sputum:**

Persons requiring sputum collection for smear and culture should have at least three consecutive sputum specimens obtained, each collected in 8-24-hour intervals, with at least one being an early morning specimen. Specimens should be collected in a sputum induction booth or in an AII room. In resource-limited settings without environmental containment or when an AII room is not available, sputum collection can be performed safely outside of a building, away from other persons, windows, and ventilation intake. For patients who are unable to produce an adequate sputum specimen, expectoration can be induced by inhalation of an aerosol of warm, hypertonic saline. For AFB smear and specimen, and induced specimens have better yield than specimens obtained without induction. Sputum induction is well-tolerated even in children, and sputum specimens (either spontaneous or induced) should be obtained in all cases before a bronchoscopy

For optimal results, sputum should be collected and processed in the same container. Commercially available sputum collection devices using a 50-ml plastic, single-use, disposable centrifuge tube is

recommended. Alternatively, a sterile, wide-mouth container with a tightly fitting screw top lid is adequate. Three sputum samples have an increased yield compared with a single specimen.

- **Bronchial washings, bronchoalveolar lavage, transbronchial biopsy:**

For patients in whom a diagnosis of tuberculosis has not been established from sputum, fiberoptic bronchoscopy performed with appropriate infection control precautions may be needed with bronchoalveolar lavage, and/or transbronchial biopsy. If possible, bronchoscopy should be avoided in patients with a clinical syndrome consistent with pulmonary or laryngeal TB disease because bronchoscopy substantially increases the risk for transmission either through an airborne route or a contaminated bronchoscope, including in persons with negative AFB sputum smear results. Even in the presence of significant pulmonary disease, the smears of bronchoalveolar lavage fluid may be negative. The topical agents used to anesthetize the airway mucosa may be lethal to *M. tuberculosis*, so these agents should be used judiciously. Patients should be placed in a room with appropriate infection controls during and after the procedure. Patient's sputum produced after bronchoscopy (during the recovery phase and the next morning) should also be collected and examined. The procedure may cause the patient to continue producing sputum for several days. These later specimens should also be collected and examined.

- **Gastric aspiration**

Gastric aspiration may be necessary for those patients, particularly children, who cannot produce sputum even with aerosol inhalation. In children, *M. tuberculosis* can be recovered from gastric aspirates in about 40% of those with radiographic evidence of significant pulmonary disease.

- **Urine**

The first morning-voided midstream specimen is preferred. Multiple specimens are advised to demonstrate the presence of mycobacteria. Smears of urine are usually negative and therefore may not be cost-effective to perform. It is preferable that the patient not be receiving broad-spectrum antibiotics at the time of collection because the antibiotics may inhibit the growth of mycobacteria from urine.

- **Cerebrospinal fluid**

Cerebrospinal fluid should be analyzed for protein and glucose (compared with simultaneous serum total protein and glucose). Total white blood cell and differential counts should also be obtained. A high protein (>50% of the serum protein concentration), lymphocytosis, and low glucose are typical of tuberculous meningitis. A minimum of 5 ml should be submitted to the laboratory in a sterile container for mycobacterial culture. The AFB smear of cerebrospinal fluid is usually negative; however, the culture may be positive. If the laboratory concentrates the fluid before smear and

culture, a greater volume (10 ml) can lead to increased yield, but may also increase complications of the procedure.

- **Tissue and other body fluids**

Under a variety of circumstances, when noninvasive techniques have not provided a diagnosis, tissue or other body fluids should be obtained for histologic evaluation and culture. Pleural, peritoneal, and pericardial fluids may be analyzed for protein and glucose (compared with simultaneous serum total protein and glucose). Cell and differential counts should be obtained. A high protein (. 50% of the serum protein concentration), lymphocytosis, and a low glucose are usually found in tuberculous infections, but neither their presence nor their absence is diagnostic. In the pleural fluid from most cases of tuberculous pleuritis is relatively low, with positive cultures found in less than 25% of cases. Pleural biopsy shows granulomatous inflammation in approximately 60% of patients. However, when culture of three biopsy specimens is combined with microscopic examination, the diagnosis can be made in up to 90% of cases. Pleuroscopy-guided biopsies increase the yield in pleural sampling. Peritoneal biopsies are best obtained via laparoscopy.

- **Tissue biopsy.**

Invasive procedures to obtain specimens from the lung, pericardium, lymph nodes, bones and joints, bowel, salpinges, and epididymis should be considered when noninvasive techniques do not provide a diagnosis. Many of these areas are amenable to closed techniques such as percutaneous needle biopsy or aspiration, transbronchial biopsy, or brushing, precluding a need for formal surgical procedures. In patients with hematogenous or disseminated disease, bone marrow biopsy, lung biopsy, and liver biopsy for histologic examination and culture should be considered. Appropriate measures must be taken when collecting these specimens to minimize aerosolation of *M. tuberculosis* organisms and prevent transmission of infection to persons.

### **B. Microscopic examination of samples:**

Detection of AFB in stained smears by microscopy can provide the first bacteriologic indication of TB disease. Laboratories should report any positive smear results within 24 hours of receipt of the specimen. A positive result for AFB in a sputum smear is predictive of increased infectiousness. Smears allow presumptive detection of mycobacteria, but definitive identification, strain typing, and drug-susceptibility testing of *M. tuberculosis* require that a culture be performed. Negative AFB sputum smear results do not exclude a diagnosis of TB disease, especially if clinical suspicion of disease is high.

Two procedures are commonly used for demonstration of mycobacteria:

- Acid fast staining (Ziehl-Neelsen carbolfuchsin or Kinyoun carbolfuchsin) , the acid-fast smear is a rapid and inexpensive test that can be performed with a minimum of equipment and is very specific for mycobacteria

- Fluorochrome procedures: The stains most commonly used are auramine-rhodamine or auramine O), examined by fluorescence microscopy under lower magnifications (x150 and x450). Mycobacteria are most easily detected by fluorochrome stains, with which the bacilli fluoresce a bright yellow-green orange-yellow (depending on the stain) against a black background. Because of the increased sensitivity and shorter time required for screening, fluorochrome stains, are preferred.

### **C. Culture techniques:**

All clinical specimens suspected of containing mycobacteria should be inoculated (after appropriate digestion and decontamination, if required) onto culture media for four reasons:

- (1) Culture is much more sensitive than microscopy, being able to detect as few as 10 bacteria/ml of material
- (2) Growth of the organisms is necessary for precise species identification
- (3) Drug susceptibility testing requires culture of the organisms;and
- (4) Genotyping of cultured organisms may be useful to identify epidemiological links between patients or to detect laboratory cross-contamination.

In general, the sensitivity of culture is 80–85% with a specificity of approximately 98%.

Three different types of traditional culture media are available:

1. Egg based (Löwenstein–Jensen),
  2. Agar based (Middlebrook 7H10 or 7H11 medium), and liquid (Middlebrook 7H12 and other commercially available broths), and each can be made into selective media by adding antibiotics.
- Growth in liquid media is faster than growth on solid media. A major improvement in mycobacteriology has been the development of commercial automated broth systems for mycobacterial growth detection. (radiometric or colorimetric systems). Liquid systems allow for rapid growth [detection of mycobacterial growth within 1–3 wk compared with solid media, where growth takes 3–8 wk, whereas agar media provide an opportunity to examine colony morphology and detect mixed cultures.

### **4. Identification of Mycobacteria directly from clinical Specimens**

A dramatic improvement in the direct detection and identification of *M. tuberculosis* has resulted from methods using nucleic acid amplification techniques (NAA). These technologies allow for the amplification of specific target sequences of nucleic acids that can then be detected through the use of a nucleic acid probe.

Nucleic acid amplification methods can be applied to clinical specimens within hours Nucleic acid amplification methods do not replace the need for routine AFB smear and culture, especially when drug susceptibility tests are to be performed. However, these tests can greatly increase confidence in the clinical diagnosis pending culture results. Also, nucleic acid amplification procedures can detect nucleic acids from dead as well as live *M. tuberculosis* and, therefore, can remain positive for long

periods in patients who have completed tuberculosis therapy. Thus, this method should be used only for initial diagnosis and not follow-up evaluations of patients who are receiving antimycobacterial drugs.

It is generally accepted that clinical TB eventually occurs in about 10% of persons infected with *M tuberculosis*. Half of these clinical cases occur in the first 2 years after infection and the other half occur later. Progression from TB infection to disease is related to such host factors as genetics, nutritional status, and immunocompetence. In addition, other diseases (eg, diabetes, cancer, malnutrition, alcoholism, IV drug abuse, renal insufficiency, HIV) and use of immunosuppressive drugs may compromise the integrity of the immune system. While immunocompetent patients have a 10% lifetime risk for active disease after TB infection, the risk is 8% to 10% *per year* in HIV-infected patients.

### **VIII. Treatment regimens for Tuberculosis**

#### **Pretreatment Evaluation and Monitoring of Treatment**

The pretreatment evaluation of persons who are targeted for treatment of LTBI provides an opportunity for healthcare providers to:

- 1) Establish rapport with patients.
- 2) Discuss details of the patient's risk for progression from LTBI to TB disease.
- 3) Explain the benefits of treatment and the importance of adhering to the drug regimen.
- 4) Review possible adverse effects of the regimen, including interactions with other medications.
- 5) Establish an optimal follow-up plan.

Monitoring for adverse effects of antituberculosis medications must be individualized. Persons receiving treatment for LTBI should be specifically instructed to look for symptoms associated with the most common reactions to the medications they are taking. Laboratory testing should be performed to evaluate possible adverse effects. Routine laboratory monitoring during treatment of LTBI is indicated for patients with abnormal baseline test results and for persons with a risk for hepatic disease. Baseline laboratory testing is indicated for persons infected with HIV, pregnant women, women in the immediate postpartum period (usually within 3 months of delivery), persons with a history of liver disease, persons who use alcohol regularly, and those who have or are at risk for chronic liver disease. All patients being treated for LTBI should be clinically monitored at least monthly, including a brief clinical assessment conducted in the person's primary language for signs of hepatitis (e.g., nausea, vomiting, abdominal pain, jaundice, and yellow or brown urine). Patients receiving treatment for LTBI should be advised about the adverse effects of the drugs and the need for prompt cessation of treatment and clinical evaluation if adverse effects occur. Because of the risk for serious hepatic toxicity and death, the use of the combination of RZ for the treatment of LTBI generally should not be offered.



## **Treatment Procedures for LTBI and TB Disease**

### **• Treatment for LTBI**

Treatment for LTBI is essential to control and eliminate TB disease in the United States because it substantially reduces the risk that infection with *M. tuberculosis* will progress to TB disease. Before beginning treatment of LTBI, a diagnosis of TB disease should be excluded by history, medical examination, chest radiography, and, when indicated, bacteriologic studies. In addition, before offering treatment of LTBI, ensure that the patient has not experienced adverse reactions with previous isoniazid (INH) treatment.

### **• Candidates for Treatment of LTBI**

Persons in the following groups at high risk should be administered treatment for LTBI if their TST result is >5 mm, regardless of age.

- Persons infected with HIV,
- Recent contacts with a person with TB disease,
- Persons with fibrotic changes on chest radiograph consistent with previous TB disease,
- Organ transplant recipients, and
- Other immunosuppressed persons (e.g., persons receiving >15 mg/day of prednisone for >1 month).

Persons in the following groups at high risk should be considered for treatment of LTBI if their TST result is >10 mm, or if the BAMT result is positive:

- Persons with TST or BAMT conversions;
- Persons born or who have lived in developing countries or countries with a high-incidence of TB disease;
- Persons who inject illicit drugs;
- Residents and employees in congregate settings that are at high risk (i.e., correctional facilities and LTCFs [e.g., hospices and skilled nursing facilities]), hospitals and other health-care facilities, residential settings for persons with HIV/AIDS or other immunocompromising conditions, and homeless shelters;
- Personnel from mycobacteriology laboratories;

• Persons with any of the following clinical conditions or other immunocompromising conditions that place them at high risk for TB disease:

- silicosis,
- diabetes mellitus,
- chronic renal failure,

- certain hematologic disorders (e.g., leukemias and lymphomas),
- other specific malignancies (e.g., carcinoma of the head, neck, or lung),
- unexplained weight loss of >10% of ideal body weight,
- gastrectomy, or
- jejunoileal bypass;
- Persons living in areas with high incidence of TB disease;
- Children aged <4 years; and
- Infants, children, and adolescents exposed to adults at high risk for developing TB disease.

Persons with no known risk factors for TB disease can be considered for treatment of LTBI if their TST result is >15 mm. However, programs to screen HCWs for infection with *M. tuberculosis* should only be conducted among groups at high risk. All testing activities should be accompanied by a plan for follow-up care for persons with LTBI or, if it is found, TB disease. A decision to test for infection with *M. tuberculosis* should be based on a commitment to treat LTBI after a medical examination.

Persons who might not be good candidates for treatment of LTBI include:

Those with a previous history of liver injury or a history of excessive alcohol consumption. Active hepatitis and ESLD are relative contraindications to the use of INH for treatment of LTBI. If the decision is made to treat such patients, baseline and follow-up monitoring of serum amino transaminases should be considered.

For persons who have previous positive TST or BAMT results and who completed treatment for LTBI previously, treating them again is not necessary. Documentation of completed therapy for LTBI is critical. Instead of participating in serial skin testing, the HCW should receive a medical evaluation and a symptom screen annually.

Screening HCWs for infection with *M. tuberculosis* is an essential administrative measure for the control of transmission of *M. tuberculosis* in health-care settings. By conducting TB screening, ongoing transmission of *M. tuberculosis* can be detected, and future transmission can be prevented by identifying lapses in infection control and identifying persons infected with *M. tuberculosis* and TB disease. The majority of individual HCWs, however, do not have the risk factors for progression to disease that serve as the basis for the current recommendations for targeted testing and treatment of LTBI. The majority of HCWs in the United States do not provide care in areas in which the prevalence of TB is high. Therefore, HCWs should be tested, as determined by risk classification for the health-care setting, and can be categorized as having a positive test result or conversion for *M. tuberculosis* infection. HCWS can be categorized as part of the TB infection-control program for the

purpose of surveillance and referral, but they might not necessarily be a candidate for treatment of LTBI.

In the context of TST screening as part of an infection control program, the interpretation of TST results in HCWs occurs in multiple steps. HCWs should receive baseline two step TST testing Diagnostic Procedures. In the context of BAMT screening, HCWs should receive only one baseline test.

To determine whether treatment for LTBI should be indicated, HCWs should be referred for medical and diagnostic evaluation according to the TST result criteria. In conjunction with a medical and diagnostic evaluation, HCWs with positive test results for *M. tuberculosis* should be considered for treatment of LTBI after TB disease has been excluded by further medical evaluation. HCWs cannot be compelled to take treatment for LTBI, but they should be encouraged to do so if they are eligible for treatment.

HCWs' TST or BAMT results might be considered positive as part of the TB infection-control program for the purposes of surveillance and referral (i.e., meet the criterion for a conversion), and this occurrence is important to note. However, not all of these HCWs may be considered candidates for treatment of LTBI, according to the individual medical and diagnostic evaluation. After an HCW has been classified as having a positive result or conversion for *M. tuberculosis* infection, additional testing is not necessary.

Table 4

TABLE 3. Doses\* of antituberculosis drugs for adults and children†

Drug	Preparation	Adults/children	Doses			
			Daily	1x/wk	2x/wk	3x/wk
<b>First-line drugs</b>						
Isoniazid	Tablets (50 mg, 100 mg, 300 mg); elixir (50 mg/5 ml); aqueous solution (100 mg/ml) for intravenous or intramuscular injection	Adults (max.) Children (max.)	5 mg/kg (300 mg) 10–15 mg/kg (300 mg)	15 mg/kg (900 mg) —	15 mg/kg (900 mg) 20–30 mg/kg (900 mg)	15 mg/kg (900 mg) —
Rifampin	Capsule (150 mg, 300 mg); powder may be suspended for oral administration; aqueous solution for intravenous injection	Adults‡ (max.) Children (max.)	10 mg/kg (600 mg) 10–20 mg/kg (600 mg)	— —	10 mg/kg (600 mg) 10–20 mg/kg (600 mg)	10 mg/kg (600 mg) —
Rifabutin	Capsule (150 mg)	Adults‡ (max.) Children	5 mg/kg (300 mg) Appropriate dosing for children is unknown	— Appropriate dosing for children is unknown	5 mg/kg (300 mg) Appropriate dosing for children is unknown	5 mg/kg (300 mg) Appropriate dosing for children is unknown
Rifapentine	Tablet (150 mg, film coated)	Adults Children	— The drug is not approved for use in children	10 mg/kg (continuation phase) (600 mg) The drug is not approved for use in children	— The drug is not approved for use in children	— The drug is not approved for use in children
Pyrazinamide	Tablet (500 mg, scored)	Adults Children (max.)	See Table 4 15–30 mg/kg (2.0 g)	— —	See Table 4 50 mg/kg (2 g)	See Table 4 —
Ethambutol	Tablet (100 mg, 400 mg)	Adults Children§ (max.)	See Table 5 15–20 mg/kg daily (1.0 g)	— —	See Table 5 50 mg/kg (2.5 g)	See Table 5 —
<b>Second-line drugs</b>						
Cycloserine	Capsule (250 mg)	Adults (max.) Children (max.)	10–15 mg/kg/d (1.0 g in two doses), usually 500–750 mg/d in two doses¶ 10–15 mg/kg/d (1.0 g/d)	There are no data to support intermittent administration —	There are no data to support intermittent administration —	There are no data to support intermittent administration —
Ethionamide	Tablet (250 mg)	Adults* (max.) Children (max.)	15–20 mg/kg/d (1.0 g/d), usually 500–750 mg/d in a single daily dose or two divided doses* 15–20 mg/kg/d (1.0 g/d)	There are no data to support intermittent administration There are no data to support intermittent administration	There are no data to support intermittent administration There are no data to support intermittent administration	There are no data to support intermittent administration There are no data to support intermittent administration
Streptomycin	Aqueous solution (1-g vials) for intravenous or intramuscular administration	Adults (max.) Children (max.)	** 20–40 mg/kg/d (1 g)	** —	** 20 mg/kg	** —
Amikacin/ kanamycin	Aqueous solution (500-mg and 1-g vials) for intravenous or intramuscular administration	Adults (max.) Children (max.)	** 15–30 mg/kg/d (1 g) intravenous or intramuscular as a single daily dose	** —	** 15–30 mg/kg	** —
Capreomycin	Aqueous solution (1-g vials) for intravenous or intramuscular administration	Adults (max.) Children (max.)	** 15–30 mg/kg/d (1 g) as a single daily dose	** —	** 15–30 mg/kg	** —
p-Aminosalicylic acid (PAS)	Granules (4-g packets) can be mixed with food; tablets (500 mg) are still available in some countries, but not in the United States; a solution for intravenous administration is available in Europe	Adults Children	8–12 g/d in two or three doses 200–300 mg/kg/d in two to four divided doses (10 g)	There are no data to support intermittent administration There are no data to support intermittent administration	There are no data to support intermittent administration There are no data to support intermittent administration	There are no data to support intermittent administration There are no data to support intermittent administration
Levofloxacin	Tablets (250 mg, 500 mg, 750 mg); aqueous solution (500-mg vials) for intravenous injection	Adults Children	500–1,000 mg daily ††	There are no data to support intermittent administration ††	There are no data to support intermittent administration ††	There are no data to support intermittent administration ††

- **Treatment Regimens for LTBI**

For persons suspected of having LTBI, treatment of LTBI should not begin until TB disease has been excluded. Persons highly suspected of having TB disease should receive the standard multidrug antituberculosis treatment regimen for TB disease until the diagnosis is confirmed or excluded. Standard regimens for the treatment of LTBI have been presented (Table ); however, modifications to those regimens should be considered under certain circumstances, including HIV infection, suspected drug resistance, and pregnancy.

**Table- 5. Standard drug regimens for treatment of latent TB infection (LTBI)\***

<b>Drugs</b>	<b>Months of duration</b>	<b>Interval</b>	<b>Minimum no. of standard doses*</b>
Isoniazid (INH)	9†	Daily Twice weekly	270 76
INH	6	Daily Twice weekly	180 52
Rifampin (RIF)	4	Daily	120
Rifampin/Pyrazinamide (RIF/PZA or RZ)	§	§	§

\* **SOURCE:** American Thoracic Society, CDC. Targeted tuberculin testing and treatment of latent tuberculosis infection. MMWR 2000;49(No. RR-6).

† Nine months of INH is preferred, but 6 months of INH or 4 months of rifampin are acceptable alternatives.

§ Generally should not be offered for treatment of LTBI. **SOURCE:** CDC.

Update: adverse event data and revised American Thoracic Society/CDC recommendations against the use of rifampin and pyrazinamide for treatment of latent tuberculosis infection—United States, 2003. MMWR 2003;52:735–9.

Reports of severe liver injury and death associated with the combination of rifampin and pyrazinamide (RZ) for treatment of LTBI prompted the American Thoracic Society and CDC to revise previous recommendations to indicate that RZ generally should not be offered for the treatment of LTBI. If the potential benefits substantially outweigh the demonstrated risk for severe liver injury and death associated with this regimen and the patient has no contraindications, a physician with experience treating LTBI and TB disease should be consulted before using this regimen. Clinicians should continue the appropriate use of rifampin and pyrazinamide in standard multidrug antituberculosis treatment regimens for the treatment of TB disease.

For all regimens for treatment of LTBI, non adherence to intermittent dosing (i.e., once or twice weekly) results in a larger proportion of total doses missed than daily dosing. DOT should be used for all doses during the course of treatment of LTBI whenever feasible. Collaborate with the local or state health department on decisions regarding DOT arrangements.

### **Contacts of patients with drug-susceptible TB disease.**

Persons with a previously negative TST or BAMT result who are contacts of patients with drug-susceptible TB disease and who subsequently have a positive TST result (>5 mm) or positive BAMT result should be evaluated for treatment of LTBI, regardless of age. The majority of persons who are infected with

*M. tuberculosis* will have a positive TST result within 6 weeks of exposure. Therefore, contacts of patients with drug-susceptible TB disease with negative TST (or BAMT) results should be retested 8–10 weeks after the end of exposure to a patient with suspected or confirmed TB disease.

Persons infected with *M. tuberculosis* should be advised that they possibly can be reinfected with *M. tuberculosis* if re-exposed. Persons infected with HIV, persons receiving immunosuppressive therapy, regardless of TST result, and persons with a previous positive TST or BAMT result who are close contacts of a person with suspected or confirmed TB disease should be considered for treatment of LTBI.

The interpretation of TST results is more complicated in a contact investigation among HCWs who have negative baseline TST results from two-step testing but where the induration was >0 mm on the baseline TST or subsequent serial testing. Differences in the TST results between the contact investigation and previous baseline and serial TST could be a result of 1) inter-test variability in reaction size; 2) intervening exposure to NTM, BCG, or *M. tuberculosis*; and 3) reversion. In practice, TST, only inter-test variability and exposure to or infection with NTM or *M. tuberculosis* are likely.

Treatment of LTBI should not be started until a diagnosis of TB disease has been excluded. If uncertainty exists concerning the presence of TB disease because of an ambiguous chest radiograph, a standard multidrug antituberculosis treatment regimen can be started and adjusted as necessary based on the results of sputum cultures and the patient's clinical response. If cultures are obtained without initiating therapy, treatment for LTBI should not be initiated until all culture results are reported as negative.

### **Contacts of patients with drug-resistant TB disease.**

Treatment for LTBI caused by drug-resistant or MDR TB disease is complex and should be conducted in consultation with the local or state health department's infection-control program and experts in the medical management of drug-resistant TB. In certain instances, medical decision making for the person with LTBI will benefit from the results of drug susceptibility testing of the isolate of the index TB case. Treatment should be guided by susceptibility test results from the isolate to which the patient was exposed and presumed to be infected.

## Treatment for TB Disease

Suspected or confirmed TB cases must be reported to the local or state health department in accordance with laws and regulations. Case management for TB disease should be coordinated with officials of the local or state health department. Regimens for treatment of TB disease must contain multiple drugs to which the organisms are susceptible. For persons with TB disease, treatment with a single drug can lead to the development of mycobacterial resistance to that drug. Similarly, adding a single drug to a failing antituberculosis treatment regimen can lead to resistance to the added drug.

For the majority of patients, the preferred regimen for treating TB disease consists of:

1. An initiation 2-month phase of four drugs (INH, rifampin, pyrazinamide, and ethambutol) and
2. At least a 4-month continuation phase of INH and rifampin (for a minimum total treatment of 6 months).
3. Ethambutol may be discontinued if supporting drug susceptibility results are available.
4. Completion of therapy is based on the number of doses taken within a maximal period and not simply 6 months.
5. Persons with cavitary pulmonary TB disease and positive culture results of sputum specimens at the completion of 2 months of therapy should receive a longer (7-month continuation) phase because of the significantly higher rate of relapse.

TB treatment regimens might need to be altered for persons infected with HIV who are on ART. Whenever feasible, the care of persons with both TB disease and HIV infection should be provided by or in consultation with experts in the management of both TB and HIV-related disease. To prevent the emergence of rifampin-resistant organisms, persons with TB disease, HIV infection, and CD4 cell counts of <100 cells/mm<sup>3</sup> should not be treated with highly intermittent (i.e., once or twice weekly) regimens. These patients should receive daily treatment during the intensive phase by DOT (if feasible) and daily or three times weekly by DOT during the continuation phase.

Drug-susceptibility testing should be performed on all initial isolates from patients with TB disease. When results from drug susceptibility tests become available, the antituberculosis treatment regimen should be reassessed, and the drugs used in combination should be adjusted accordingly.

The major determinant of the outcome of treatment is adherence to the drug regimen. Therefore, careful attention should be paid to measures designed to enable and foster adherence. **DOT** is an adherence-enhancing strategy in which a trained HCW or other specially trained person watches a patient swallow each dose of medication and records the dates that the **DOT** was observed. **DOT** is the standard of care for all patients with TB disease and should be used for all doses during the

course of therapy for TB disease and for LTBI, whenever feasible. Plans for **DOT** should be coordinated with concerned department.

### **Reporting Serious Adverse Events**

HCWs should report serious adverse events associated with the administration of tuberculin antigen or treatment of LTBI or TB disease.

### **Extrapulmonary TB**

The treatment regimen for extra pulmonary TB is similar to that for pulmonary TB. In selected cases (eg, bone or joint TB, tuberculous meningitis, children with miliary TB), the recommended duration of treatment is 12 months. Use of adjunctive methods (eg, addition of corticosteroids in initial management, surgery) has proved to be beneficial in decreasing morbidity and mortality.

## **IX. Recommendations of preventing transmission of *M. tuberculosis* in health-care settings**

All health-care settings need a Tb infection –control program designed to ensure prompt detection, airborne precautions , and treatment of persons who have suspected or confirmed TB disease (or prompt referral of persons who have suspected TB disease for settings in which persons either TB disease are not expected to be encountered). Such a program is based on a three-level hierarchy or controls, including

### **I. Administrative**

### **II. Environment**

### **III. Respiratory protection.**

Due to the lack of incidence data in Kuwait and according to our experience, most of the general hospitals can be classified as medium risk and some times potential ongoing transmission.

TB center is not properly designed to accept all TB cases, so additional infection control requirements including construction of ICU should be available to the center to manage the confirmed and suspected cases.

### **I. Administrative Controls**

- 1. Supervisory TB infection control committee.**
- 2. TB risk assessment of the setting**
- 3. Infection Control Plan**
- 4. Processing and reporting of lab results**



5. **Managing Patients Who Have Suspected or Confirmed TB Disease:**
6. **Cleaning, Disinfection and sterilizing patient-care Equipment and Rooms**
7. **Training and educating HCWs**
8. **Infection control surveillance**
9. **Problem Evaluation**
10. **Patient Education**
11. **National TB Control Committee**

The first and most important level of TB controls is the use of administrative measures to reduce the risk for exposure to persons who might have TB disease. Administrative control consists of the following activities:

**1. Supervisory TB infection control committee.**

Assign supervisory responsibility for the T.B infection control program, to a committee chaired by the hospital director and members including infection control doctor as co-ordinator, microbiologist, preventive medicine doctors, quality assurance doctor, respirologist and pharmacist, representatives from emergency department, nursing director, and engineering department.

The committee is authorized to conduct TB risk assessment, implement, and enforce T.B infection control policies and ensure recommended training and education of HCWs.

**2. TB risk assessment of the setting**

Risk assessment is defined as an initial and ongoing evaluation of the risk for transmission of M.tuberculosis in a particular health-care settings. To perform a risk assessment, the following factors should be considered: the community rate of TB, number of TB patients encountered in the settings, and the speed with which patients with TB disease are suspected, isolated, and evaluated.

The TB risk assessment determines the types of administrative, environmental, and respiratory-protection controls needed for a setting and serves as an ongoing evaluation tool of the quality of TB infection control and for the identification of needed improvements in infection-control measures. Part of the risk assessment is similar to a program. The TB risk Assessment Worksheet can be used as a guide for conducting a risk assessment. (see appendix- B)

The initial and ongoing risk assessment for health-care settings should consider of the following steps:

1. Review the community profile of TB disease in collaboration with the TB center.
2. Consult the TB center program to obtain epidemiologic surveillance data necessary to conduct a TB risk assessment for the health-care settings.
3. Review the number of patients with suspected or confirmed TB disease who have been encountered in the setting during at least the previous 5 years.
4. Determines if persons with unrecognized TB disease have been admitted to or were encountered in the setting during the previous 5 years.
5. Determine which HCWs need to be included in a TB screening program and the frequency of screening (based on risk classification) (See table 6)
6. Ensure the prompt recognition and evaluation of suspected episodes of health-care associated transmission of *M.tuberculosis*.
7. Identify areas in the setting with an increased risk for health-care associated transmission of *M.tuberculosis*, and target them for improved TB infection controls.
8. Assess the number of AII room needed for the settings. The risk classification for the settings should help to make this determination, depending on the number of TB patients examined. At least one AII rooms is needed for settings in which TB patients stay while they are being treated , and additional AII rooms might be needed, depending on the magnitude of patient-days of cases of suspected or confirmed TB disease. Additional AII rooms might be considered if options are limited for transferring patients with suspected or confirmed TB disease to other settings with AII rooms.
9. Determine the types of environmental controls needed other than AII rooms.
10. Determine which HCWs needed to be included in the respiratory –protection program.
11. Conduct periodic reassessments (annually, if possible) to ensure
  - proper implementation of the TB infection control plan,
  - prompt detection and evaluation of suspected TB cases,
  - prompt initiation of airborne precautions of suspected infectious TB cases,
  - recommended medical management of patients with suspected or confirmed TB disease,
  - functional environmental controls,
  - implementations of the respiratory protection program, and
  - ongoing HCW training and education regarding TB.
12. Recognize and correct lapse in infection control.

### **3. Infection Control Plan**

Developing and instituting a written TB infection control plan to ensure prompt detection, airborne precautions and treatment of persons who have suspected or confirmed TB disease.

The supervisory TB control committee will be responsible for writing and obtaining approval as well as implementing and monitoring the infection control plan. In general, the infection control plan should include:

- Identification of risk areas.
- Assessment of TB among HCWs (where feasible).
- Assessment of HIV prevalence in the patient population (where feasible).
- Assessment of HCW training needs.
- Area-specific infection control recommendations.
- Time –line and budget (e.g., material and personnel costs).

#### **4. Processing and reporting of lab results**

To ensure prompt laboratory evaluation, efforts should be made to make sure that the patient's sputum specimen reaches the laboratory in a timely fashion and results are returned promptly. The laboratory performing acid fast bacilli (AFB) smears should be proficient at:

- Methods of sputum specimen processing
- The administrative aspects of specimen processing (e.g., record keeping, notification)
- Maintaining quality control of diagnostic procedures (e.g., AFB sputum smears)
- Ensuring adequate supplies for processing sputum samples.

It is essential that sputum collection and delivery to the laboratory be done in a timely manner. Ideally, laboratory staff should be available seven days a week, so that AFB sputum smears can be performed and read in a timely manner, and results can be available within 24hours of specimen collection. If seven day laboratory coverage is not possible, at least six days should be ensured.

#### **5. Managing Patients Who Have Suspected or Confirmed TB Disease:**

- **General Recommendations**

The primary TB risk to HCWs is the undiagnosed or unsuspected patient with infectious TB disease. A high index of suspicion for TB disease and rapid implementation of precautions are essential to prevent and interrupt transmission. Specific precautions will vary depending on the settings.

- **Prompt Triage**

Within health-care settings, protocols should be implemented and enforced to promptly identify, separate from others, and either transfer or manage persons who have suspected or confirmed infectious TB disease. When patients medical histories are taken, all patients should be routinely asked about 1) a history of TB exposure, infection, or disease; 2) symptoms or signs of TB disease; and 3) medical conditions that increase their risk for TB disease.

- **TB Airborne Precautions**

Within health-care settings, TB airborne precautions should be initiated for any patient who has symptoms or signs of TB disease, or who has documented infectious TB disease and has not completed anti-tuberculosis treatment. For patients placed in AII rooms because of suspected infectious TB disease of the lungs, airway, or larynx, airborne precautions may be discontinued when infectious TB disease is considered unlikely and either 1) another diagnosis is made that explains the clinical syndrome or 2) the patient has three consecutive, negative AFB sputum smear results . Each of the three sputum specimens should be collected in 8 -24 hour intervals, and at least one specimen should be an early morning specimen because respiratory secretions pool overnight. Generally this method will allow patients with negative sputum smear result to be released from airborne precautions in 2 days.

The classification of the risk assessment of the health-care setting is used to determine how many AII rooms each setting needs, depending on the number of TB patients examined. According to current situation in Kuwait general hospital the recommended number of AII rooms as follows:

- ◆ Emergency rooms            1 room
- ◆ Medical Department        1 room / ward
- ◆ Surgical Department        1 room/ 2 wards
- ◆ Pediatric Department       1 room/ 2 wards
- ◆ Maternity Department      1 room
- ◆ ICU                              1 room
- ◆ Bronchoscopy suits         1 room
- ◆ Operation theatre          1 room
- ◆ In tertiary care hospital the recommended AII room is according to risk classification.

Additional rooms might be considered if options are limited for transferring patients with suspected or confirmed TB disease to other settings with AII rooms. For example, for a hospital

with 120beds, a minimum of one AII room is needed, possibly more, depending on how many TB patients are examined in 1 year.

**TB Airborne Precautions for Settings in which patients with Suspected or Confirmed TB disease are expected to be encountered.**

Settings that plan to evaluate and manage patients with TB disease should have at least one AII room or enclosure that meets AII requirements. These settings should develop written policies that specify 1) Indications for air borne precautions, 2) persons authorized to initiate and discontinue airborne precautions, 3) specific airborne precautions, 4) AII rooms-monitoring procedures, 5) procedures for managing patients who do not adhere to airborne precautions, and 6) criteria for discontinuing airborne precautions.

**AII Room Practices**

AII rooms should be single-patient rooms in which environmental factors and entry of visitors and HCWs are controlled to minimize the transmission of *M.tuberculosis*. All HCWs who enter an AII room should wear at least N95 disposable respirators (see respiratory protection). Visitors may be offered respiratory protection (i.e., N95) and should be instructed by HCWs on the use of the respirator before entering an AII room. AII rooms must have specific requirements for controlled ventilation, negative pressure, and air filtration. Each inpatient AII room should have a private bathroom.

**Diagnostic procedures**

Diagnostic procedures should be performed in setting health appropriate infection control capabilities.

**Initiation of treatment**

For patients who have confirmed TB disease or who are considered highly probable to have TB disease, promptly start anti-tuberculosis treatment in accordance with current guide.

**Managing Patients Who Have Suspected or Confirmed TB Disease:**

**Considerations for Special Circumstances and Settings**

The recommendations for preventing transmission of *M. tuberculosis* are applicable to all health-care settings, including those that have been described (Appendix B). These settings should each have independent risk assessment if they are stand-alone setting should have a detailed section written as part of the risk assessment for the overall setting.

## **6. Cleaning, Disinfection and sterilizing patient-care Equipment and Rooms**

### **General**

The rationale for cleaning, disinfection, or sterilizing patient-care instruments and equipment can be understood more readily if medical devices, equipment, and surgical materials are divided into three general categories. The categories are critical, semi-critical, and non-critical and are based to the potential risk for infection if an item remains contaminated at the time of use.

### **Critical Medical Instruments**

Instruments that are introduced directly into the blood-stream or other normally sterile areas of the body (e.g., needles, surgical instruments, cardiac catheters, and implants) are critical medical instruments. These items should be sterile at the time of use.

### **Semi-critical Medical Instruments**

Instruments that might come into contact with mucous membranes but do not ordinarily penetrate body surfaces (e.g., noninvasive flexible and rigid fiberoptic endoscopes or bronchoscopes, endotracheal tubes, and anesthesia breathing circuits) are semi critical medical instruments. Although sterilization is preferred for these instruments, high-level disinfection that destroy vegetative microorganisms, the majority of fungal spores, mycobacterium (including tubercle bacilli), and small nonlipid viruses can be used. Meticulous cleaning of such items before sterilization or high level disinfection is essential. When an automated washer is used to clean endoscopes and bronchoscope, the washer must be compatible with the instruments to be cleaned.

High level disinfection can be accomplished with either manual procedures alone or use of an automated endoscope reprocessor with manual cleaning. In all cases, manual cleaning is an essential first-step in the process to remove debris from the instruments.

### **Non-critical Medical Instruments or Devices**

Instruments or devices that either do not ordinary touch the patient or touch only the patient's intact skin (e.g., crutches, bed boards, and blood pressure cuffs) are non-critical medical instruments. These items are not associated with transmission of *M.tuberculosis*. When noncritical instruments or equipments are contaminated with blood or body substances, they should be cleaned and then disinfected with a hospital –grade, Environmental protection Agency (EPA)- registered germicide disinfectant with a label claim for tuberculocidal activity (i.e., an intermediate-level disinfectant). Tuberculocidal activity is not necessary for cleaning agents or low-level disinfectants that are used to clean or disinfectant minimally soiled noncritical items

and environmental surfaces (e.g., floors, walls, tabletops, and surfaces with minimal hand contact).

The same cleaning procedures used in other rooms in the health-care setting should be used to clean AII rooms. However, personnel should follow airborne precautions while cleaning these rooms when they are still in use. Personnel protective equipment is not necessary during the final cleaning of an AII room after a patient has been discharged if the room has been ventilated for the appropriate amount of time.

## **7. Training and educating HCWs**

HCW training and education regarding infection with *M.tuberculosis* and TB disease is an essential part of administrative controls in a TB surveillance or infection-control program. HCW training and education can increase adherence to TB infection-control measures. Training and education should emphasize the increased risks posed by an undiagnosed person with TB disease in health-care setting and the specific measures to reduce this risk.

### **Initial TB training and Education**

The setting should document that all HCWs, including physicians, have received initial TB training relevant to their work settings and additional occupation –specific education. The level and detail of baseline training will vary according to the responsibilities of the HCW and the risk classification of the settings.

The component of an initial TB training education program for HCWs include

- ◆ Adequate basic clinical information
- ◆ Epidemiology of TB
- ◆ Infection control practice to prevent and detect *M.Tuberculosis* transmission in healthcare settings.
- ◆ TB and immunocompromising condition
- ◆ TB and public health

## **Follow-up TB Training and Education**

All settings should conduct an annual evaluation of the need for follow up training and education for HCWs based on the number of untrained and new HCWs, changes in the organization and services of the setting, and availability of new TB infection control information.

If potential or known exposure to *M.tuberculosis* occurs in the setting, prevention and control measures should include retraining HCWs in the infection control procedures established to prevent the recurrence of exposure.

If a potential or known exposure result in a newly recognized positive TST or BAMT result, test conversion, or diagnosis of TB disease, education should include information on

- 1) Transmission of *M.tuberculosis*,
- 2) Non-infectiousness of HCWs with LTBI and
- 3) Potential infectiousness of HCWs with TB disease.

HCWs in settings with a classification of potential ongoing transmission should receive additional training and education on

- 1) Symptoms and signs of TB disease,
- 2) *M. tuberculosis* transmission
- 3) Infection control policies,
- 4) Importance of TB screening for HCWs, and
- 5) Responsibilities of employers and employees regarding *M.tuberculosis* infection test conversion and diagnosis and diagnosis of TB disease.

## **8. Infection control surveillance**

### **HCW screening program for TB support Surveillance and Clinical Care**

The screening program consist of four major components:

- 1) Baseline testing for *M.tuberculosis* infection ,
- 2) Serial testing for *M.tuberculosis* infection,



3) Serial screening for symptoms or signs of TB disease, and 4) TB training and education.

**HCWs who should be included in a TB surveillance program**

HCWs refer to all paid and unpaid persons working in healthcare settings who have the potential for exposure to M.tuberculosis through air space shared with persons with infectious TB disease. Part time, temporary, contact, and full time HCWs should be included in TB screening programs. All HCWs who have duties that involve face-to-face contact with patients with suspected or confirmed TB disease (including transport staff) should be included in a TB screening program.

The following are HCWs who should be included in a TB screening program:

- ◆ Administrator or managers
- ◆ Bronchoscopy staff
- ◆ Chaplains
- ◆ Clerical staff
- ◆ Computer programmers
- ◆ Construction staff
- ◆ Correctional officers
- ◆ Craft or repair staff
- ◆ Dental staff
- ◆ Dietician or dietary staff
- ◆ Emergency department staff
- ◆ Engineers
- ◆ Food service staff
- ◆ Health aides
- ◆ Health and safety staff
- ◆ Housekeeping or custodial staff
- ◆ Infection control staff
- ◆ ICU staff
- ◆ Janitorial staff
- ◆ Laboratory staff
- ◆ Maintenance staff
- ◆ Morgue staff
- ◆ Nurses
- ◆ Pathology laboratory staff
- ◆ Patient transport staff, including EMS

- ◆ Pediatric staff
- ◆ Pharmacists
- ◆ Phlebotomists
- ◆ Physical and occupational therapists
- ◆ Physicians (assistant, fellow, resident or intern) including
  - Anesthesiologists
  - Pathologists
  - Psychiatrists- Psychologists
- ◆ Public health staff
- ◆ Public safety staff
- ◆ Respiratory therapists
- ◆ Visiting scientists
- ◆ Social workers
- ◆ Students (e.g., medical , nursing, technicians and allied health)
- ◆ Technicians (e.g., health, laboratory, radiology, and animal)
- ◆ Veterinarians
- ◆ Volunteers

In addition, HCWs who perform any of the following activities should also be included in the TB screening program.

- ◆ Entering patient rooms or treatment rooms whether or not a patient is present,
- ◆ Participating in aerosols –generating or aerosol –producing procedures (e.g., bronchoscopy, sputum induction, and administration of aerosolized medications)
- ◆ Participating in suspected or confirmed *M.tuberculosis* specimen processing; or
- ◆ Installing, maintaining, or replacing environmental controls in areas in which persons with TB disease are encountered.

Test to screen for *M.tuberculosis* infection should be administered, interpreted, and recorded. Protection of privacy and maintenance of confidentiality of HCW test results should be ensured.

### **Baseline Testing for *M. tuberculosis* Infection**

Baseline testing for *M. tuberculosis* infection is recommended for all newly hired HCWs, regardless of the risk classification of the setting and can be conducted with the TST or BAMT. Certain settings, with the support of the infection control committee, might choose not to perform baseline or serial TB screening for HCWs who will never be in contact with or have shared air space with patients who have TB disease (e.g., telephone operators who work in a separate building from patients) or who will never be in contact with clinical specimens that might contain *M. tuberculosis*.

### Baseline test results

- 1) Provide a basis for comparison in the event of a potential or known exposure to *M. tuberculosis*
- 2) Facilitate the detection and treatment of LTBI or TB disease in an HCW before employment begins and reduces the risk to patients and other HCWs.

### Baseline Testing for *M. tuberculosis* Infection After TST Within the Previous 12 Months

A second TST is not needed if the HCW has a documented TST result from any time during the previous 12 months. If a newly employed HCW has had a documented negative TST result within the previous 12 months, a single TST can be administered in the new setting. This additional TST represents the second stage of two-step testing. The second test decreases the possibility that boosting on later testing will lead to incorrect suspicion of transmission of *M. tuberculosis* in the setting.

### Baseline Documentation of a History of TB Disease, a Previously Positive Test Result for *M. tuberculosis* Infection, or Completion of Treatment for LTBI or TB Disease

Additional tests for *M. tuberculosis* infection do not need to be performed for HCWs with a documented history of TB disease, documented previously positive test result for *M. tuberculosis* infection, or documented completion of treatment for LTBI or TB disease

### Serial Follow-Up of TB Screening and Testing for *M. tuberculosis* Infection

The need for serial follow-up screening for groups of HCWs with negative test results for *M. tuberculosis* infection is an institutional decision that is based on the setting's risk classification.

**Table- 6. Risk classification for health-care settings that serve communities with high incidence of tuberculosis recommended frequency of screening for Mycobacterium tuberculosis infection among health-care workers (HCWs)\***

Setting	Risk classification+		
	Low risk	Medium risk	Potential ongoing transmission§
Inpatient <200 beds	< 3 TB patients / year	≥ 3TB patients / year	Evidence of ongoing <i>M.tuberculosis</i> transmission, regardless of setting from patients to patients
Inpatient ≥200 beds Outpatient; and nontraditional facility based	< 6 TB patients / year < 3 TB patients / year	≥ 6TB patients / year ≥ 3TB patients / year	
Laboratories	Laboratories in which clinical specimens that might contain <i>M.tuberculosis</i> are not manipulated.	Laboratories in which clinical specimens that might contain <i>M.tuberculosis</i> are manipulated.	

\*Health-care workers (HCWs) refers to all paid and unpaid persons working in health-care setting who have the potential for exposure to *M.tuberculosis* through air space shared with persons with TB disease.

+settings that serve communities with a high incidence of TB disease or that treat populations at high risk (e.g., those with human immunodeficiency virus infection or other immunocompromising conditions) or that treat patients with drug-resistant TB disease might need to be classified as medium risk, even if they meet the low-risk criteria.

§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 had ceased. The setting should be reclassified as medium risk and the recommended timeframe for this medium risk classification is at least 1 year.

## Use of Risk Classification to Determine Need for TB Screening and Frequency of Screening HCWs

Risk classification should be used as part of the risk assessment to determine the need for a TB screening program for HCWs and the frequency of screening (Table -7.)

### Recommendations for Screening Frequency

<u>Setting</u>	<u>Low risk</u>	<u>Medium risk</u>	<u>Potential ongoing transmission§</u>
Baseline two-step TST or one BAMT¶	Yes, for all HCWs upon hire	Yes, for all HCWs upon hire	Yes, for all HCWs upon hire
Serial TST or BAMT screening of HCWs	No**	Every 12 months††	As needed in the investigation of potential ongoing transmission§§
TST or BAMT for HCWs upon unprotected exposure to <i>M. tuberculosis</i>	Perform a contact investigation (i.e., administer one TST as soon as possible at the time of exposure, and, if the TST result is negative, place another TST 8–10 weeks after the end of exposure to <i>M. tuberculosis</i> )¶¶		

¶ All HCWs should have a baseline two-step tuberculin skin test (TST) or one blood assay for *M. tuberculosis* (BAMT) result at each new health-care setting. Even if the setting is determined to be low risk. In certain settings, a choice might be made to not perform baseline TB screening or serial TB screening for HCWs who 1) will never be in contact with or have shared air space with patients who have TB disease (e.g., telephone operators who work in a separate building from patients) or 2) will never be in contact with clinical specimens that might contain *M. tuberculosis*. Establishment of a reliable baseline result can be beneficial if subsequent screening is needed after an unexpected exposure to *M. tuberculosis*.

\*\* HCWs whose duties do not include contact with patients or TB specimens do not need to be included in the serial TB screening program.

†† The frequency of testing for infection with *M. tuberculosis* will be determined by the risk assessment for the setting.

§§ During an investigation of potential ongoing transmission of *M. tuberculosis*, testing for *M. tuberculosis* infection should be performed every 8–10 weeks until lapses in infection controls have been corrected and no further evidence of ongoing transmission is apparent.

¶¶ Procedures for contact investigations should not be confused with two-step TST, which is used for newly hired HCWs.

### TB Screening Procedures for Settings (or HCWs) Classified as Low Risk

- All HCWs should receive baseline TB screening upon hire, using two-step TST or a single BAMT to test for infection with *M. tuberculosis*.
- After baseline testing for infection with *M. tuberculosis*, additional TB screening is not necessary unless an exposure to *M. tuberculosis* occurs.
- HCWs with a baseline positive or newly positive test result for *M. tuberculosis* infection (i.e., TST or BAMT) or documentation of treatment for LTBI or TB disease should receive one chest radiograph result to exclude TB disease (or an interpretable copy within a reasonable time frame, such as 6 months). Repeat radiographs are not needed unless symptoms or signs of TB disease develop or unless recommended by a clinician.

### **TB Screening Procedures for Settings (or HCWs) Classified as Medium Risk**

- All HCWs should receive baseline TB screening upon hire, using two-step TST or a single BAMT to test for infection with *M. tuberculosis*.
- After baseline testing for infection with *M. tuberculosis*, HCWs should receive TB screening annually (i.e., symptom screen for all HCWs and testing for infection with *M. tuberculosis* for HCWs with baseline negative test results).
- HCWs with a baseline positive or newly positive test result for *M. tuberculosis* infection or documentation of previous treatment for LTBI or TB disease should receive one chest radiograph result to exclude TB disease. Instead of participating in serial testing, HCWs should receive a symptom screen annually. This screen should be accomplished by educating the HCW about symptoms of TB disease and instructing the HCW to report any such symptoms immediately to the occupational health unit. Treatment for LTBI should be considered in accordance with CDC guidelines.

### **TB Screening Procedures for Settings (or HCWs) Classified as Potential Ongoing Transmission**

- Testing for infection with *M. tuberculosis* might need to be performed every 8--10 weeks until lapses in infection control have been corrected, and no additional evidence of ongoing transmission is apparent.
- The classification of potential ongoing transmission should be used as a temporary classification only. It warrants immediate investigation and corrective steps. After a determination that ongoing transmission has ceased, the setting should be reclassified as medium risk. Maintaining the classification of medium risk for at least 1 year is recommended.

### **HCWs with a Newly Recognized Positive Test Result for *M. tuberculosis* Infection or Symptoms or Signs of TB Disease**

#### **Clinical Evaluation**

Any HCW with a newly recognized positive test result for *M. tuberculosis* infection, test conversion, or symptoms or signs of TB disease should be promptly evaluated.

#### **Workplace Restrictions**

**1.** HCWs with a baseline positive or newly positive test result for *M. tuberculosis* infection should receive one chest radiograph result to exclude TB disease (or an interpretable copy within a reasonable time frame, such as 6 months). HCWs with confirmed infectious pulmonary, laryngeal, endobroncheal, or tracheal TB disease, or a draining TB skin lesion pose a risk to patients, HCWs,

and others. Such HCWs should be excluded from the workplace and should be allowed to return to work when the following criteria have been met:

A) Three consecutive sputum samples collected in 8–24-hour intervals that are negative, with at least one sample from an early morning specimen (because respiratory secretions pool overnight);

B) The person has responded to antituberculosis treatment that will probably be effective (can be based on susceptibility results); and

C) The person is determined to be noninfectious by a physician knowledgeable and experienced in managing TB disease.

2. HCWs with extra pulmonary TB disease usually do not need to be excluded from the workplace as long as no involvement of the respiratory tract has occurred. They can be confirmed as noninfectious and can continue to work if documented evidence is available that indicates that concurrent pulmonary TB disease has been excluded.

3. HCWs receiving treatment for LTBI can return to work immediately. They should be counseled regarding the risk for developing TB disease and instructed to report any TB symptoms immediately to the supervisory TB infection control committee

4. HCWs who have a documented positive TST or BAMT result and who leave employment should be counseled again, if possible, regarding the risk for developing TB disease and instructed to seek prompt evaluation with the TB control unit or their primary care physician if symptoms of TB disease develop.

### **Identification of Source Cases and Recording of Drug-Susceptibility Patterns**

If an HCW experiences a conversion in a test result for *M. tuberculosis* infection, evaluate the HCW for a history of suspected or known exposure to *M. tuberculosis* to determine the potential source. When the source case is identified, also identify the drug susceptibility pattern of the *M. tuberculosis* isolate from the source. The drug-susceptibility pattern should be recorded in the HCW's medical or employee health record to guide the treatment of LTBI or TB disease, if indicated.

### **HCWs with Medical Conditions Associated with Increased Risk for Progression to TB Disease**

Immuno-compromised HCWs should have the option of an assignment in an area or activity where the risk for exposure to *M. tuberculosis* is low. Health-care settings should provide education and follow infection-control recommendations.

## **9. Problem Evaluation:**

Epidemiologic investigations may be indicated for several situations. These include, but are not limited to

a) The occurrence of TST conversions or TB disease in HCWs;

b) The occurrence of possible person-to-person transmission of *M. tuberculosis*; and

- c) Situations in which patients or HCWs with TB disease are not promptly identified and isolated, thus exposing other persons in the facility to *M. tuberculosis*.
- d) Diagnosis of TB disease in HCWs.
- e) Possible TB outbreaks identified using automated lab system.

**The general objectives of the epidemiologic investigations in these situations are as follows:**

- 1) To determine the likelihood that transmission of and infection with *M. tuberculosis* has occurred in the facility;
- 2) To determine the extent to which *M. tuberculosis* has been transmitted;
- 3) To identify those persons who have been exposed and infected, enabling them to receive appropriate clinical management;
- 4) To identify factors that could have contributed to transmission and infection
- 5) To implement appropriate interventions.
- 6) To evaluate the effectiveness of any interventions those are implemented.
- 7) To ensure that exposure to and transmission of *M. tuberculosis* have been terminated.

**General guidance for conducting these investigations.**

**1. Investigating TST conversions and TB disease in HCWs**

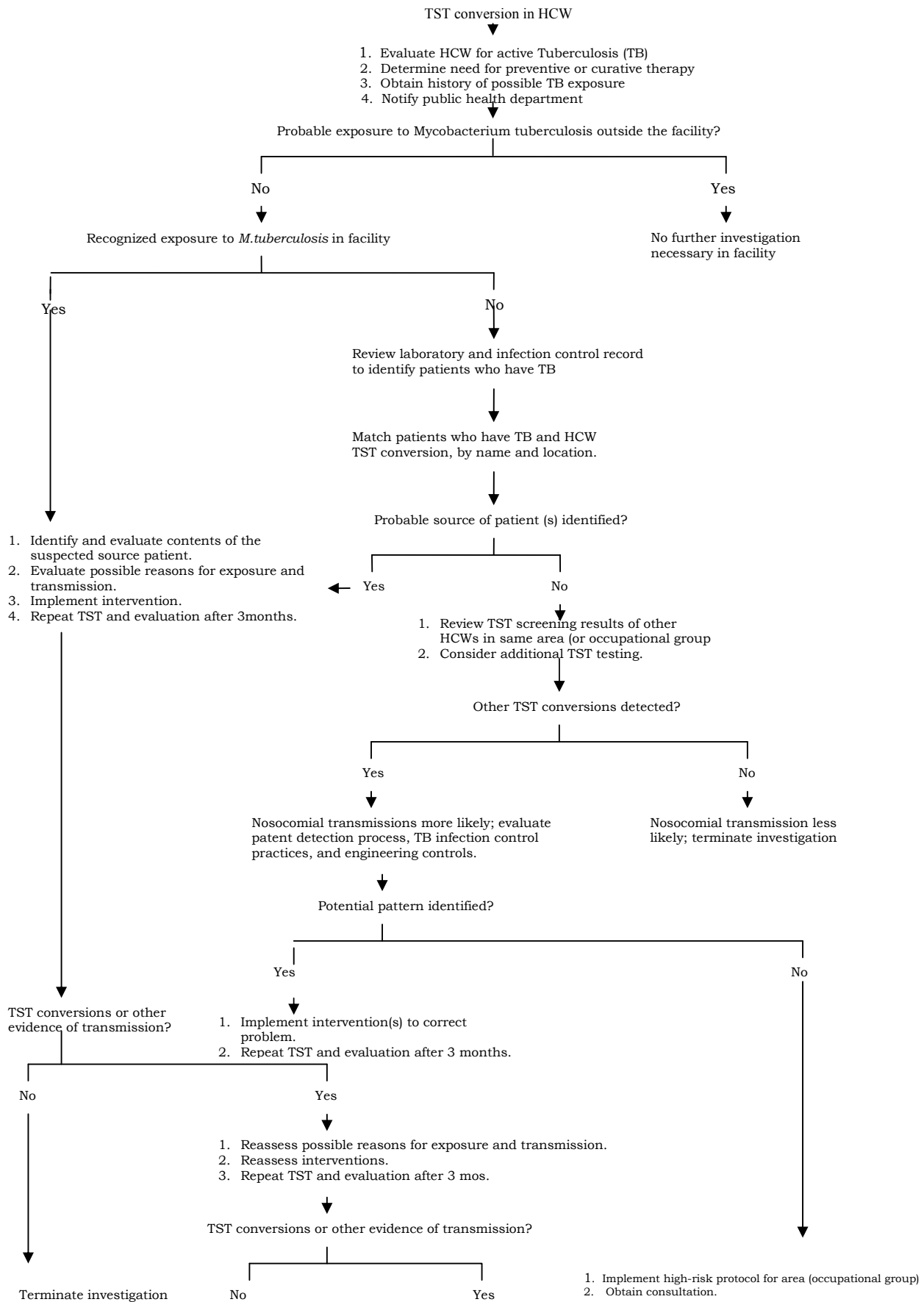
**a. Investigating TST conversions in HCWs**

TST conversions may be detected in HCWs as a result of:

- a contact investigation, in which case the probable source of exposure and transmission is already known ,
- Or as a result of routine screening, in which case the probable source of exposure and infection is not already known and may not be immediately apparent.

If a skin-test conversion in an HCW is identified as part of routine screening, the following steps should be considered:

**Figure 1. Protocol for investigating purified protein derivative (PPD) – tuberculin skin-test conversions in health-care workers (HCWs)**







## **b) Investigating cases of TB disease in HCWs**

If an HCW develops active TB, the following steps should be taken:

1. The case should be evaluated epidemiologically, in a manner similar to TST conversions in HCWs.
2. Contacts of the HCW (e.g., other HCWs, patients, visitors, and others who have had intense exposure to the HCW) should be identified and evaluated for TB infection and disease. The public health department should be notified immediately for consultation and to allow for investigation of community contacts that were not exposed in the health-care facility.
3. The public health department should notify facilities when HCWs with TB are reported by physicians. Notification should be in accordance with local laws to protect the confidentiality of the HCW.

### **2. Investigating possible patient-to-patient transmission of M. tuberculosis**

#### **When to suspect the possibility of patient- to- patient transmission?**

- A high proportion of TB patients had prior admissions during the year preceding onset of their TB.
- The number of patients with drug-resistant TB increased suddenly.
- Isolates obtained from multiple patients had identical and characteristic drug-susceptibility or DNA fingerprint patterns).

#### **Steps:**

1. Review the HCW TST results and patient surveillance data for the suspected areas to detect additional patients or HCWs with TST conversions or active disease.
2. Look for possible exposures that patients with newly diagnosed TB could have had to other TB patients during previous admissions. For example, were the patients admitted to the same room or area, or did they receive the same procedure or go to the same treatment area on the same day?

#### **If the evaluation thus far suggests transmission has occurred, the following steps should be taken:**

1. Evaluate possible causes of the transmission (e.g., problem with patient detection, institutional barriers to implementing appropriate isolation practices, or inadequate engineering controls).
2. Ascertain whether other patients or HCWs could have been exposed; if so, evaluate these persons for TB infection and disease.
3. Notify the public health department so they can begin a community contact investigation if necessary.

### **3-Investigating contacts of patients and HCWs who have infectious TB.**

#### **-Indications for contact investigation:**

-If a patient who has TB disease is examined in a health-care facility and the illness is not diagnosed correctly, resulting in failure to apply appropriate precautions

- If an HCW develops active TB and exposes other persons in the facility.

#### **-Steps for contacts investigations:**

- To identify other patients and HCWs who were exposed to the source patient before isolation procedures were begun.
- Interview the source patient and all applicable personnel and review that patient's medical record.
- Determine the areas of the facility in which the source patient was hospitalized, visited, or worked before being placed in isolation and the HCWs who may have been exposed during that time.
- Administer TST to the most intensely exposed HCWs and patients as soon as possible after the exposure has occurred. Then those persons with whom the patient had less contact should be evaluated. If the initial TST result is negative, a second test should be administered 8-10 weeks after the exposure was terminated.
- Prompt clinical evaluation and, if indicated, chest radiographs and bacteriologic studies should be performed for persons who were exposed to *M. tuberculosis* who have either a TST conversion or symptoms suggestive of TB.
- Preventive or curative therapy for persons who have evidence of newly acquired infection or active disease.

### **10. Patient Education**

Patients should be educated about *M.tuberculosis* transmission and the importance of cough etiquette, i.e., to minimize the generation of infectious droplet nuclei, coughing patients should be instructed to turn their heads and cover their mouth and nose with their hands and preferably with a cloth or tissue when coughing. If patients do not have a cloth or tissue, these should be provided by the institution. Posters emphasizing cough etiquette should be placed in the waiting areas.

### **11. National TB Control Committee**

For assistance with the planning and implementation of TB control activities in the health-care setting and for names of experts to help with policies, procedures, and program evaluation, settings should co-ordinate with local TB control program. The local health department must be notified when TB disease is suspected or confirmed in a patient or HCW so that follow up can be arranged

and a community contact investigation can be conducted. The local health department should be notified as early as possible before the patient is discharged or facilitate follow up and continuation of therapy by DOT. For inpatient settings, coordinate a discharge plan with the patient (including a patient who is an HCW with TB disease) and the TB-control program of the local health department.

## **II. Environmental Controls**

The second level of the hierarchy is the use of environmental controls to prevent the spread and reduce the concentration of infectious droplet nuclei in ambient air.

Primary environmental controls consist of controlling the source of infection by using local exhaust ventilation (e.g., hoods, tents, or booths) and diluting and removing contaminated air by using general ventilation.

Secondary environmental controls consists of controlling the airflow to prevent contamination of air in areas adjacent to the source (AII rooms) and cleaning the air by using high efficiency particulate air (HEPA), filtration or UVGI.

### **Local Exhaust Ventilation**

Local exhaust ventilation is a source-control technique used for capturing airborne contaminants (e.g., infectious droplet nuclei or other infectious particles) before they are dispersed into the general environment. In local exhaust ventilation methods, external hoods, enclosing booths, and tents are used. Local exhaust ventilation (e.g., enclosed ventilated booth) should be used for cough-inducing and aerosol-generating procedures. When local exhaust is not feasible, perform cough inducing and aerosol-generating procedures in a room that meets the requirements for an AII room. For assistance with the planning and implementation of TB-control activities in the health-care setting and for names of experts to help with policies, procedures, and program evaluation, settings should coordinate with the local or state TB-control program. By law, the local health department must be notified when TB disease is suspected or confirmed in a patient or HCW so that follow up can be arranged and a community contact investigation can be conducted. The local health department should be notified as early as possible before the patient is discharged to facilitate followup and continuation of therapy by DOT .For inpatient settings, coordinate a discharge plan with the patient (including a patient who is an HCW with TB disease) and the TB-control program of the local health department.

### **General Ventilation**

General ventilation systems dilute and remove contaminated air and control airflow patterns in a room or setting. An engineer or other professional with expertise in ventilation should be included as part of the staff of the health-care setting or hire a consultant with expertise in ventilation engineering specific to health-care settings. Ventilation systems should be designed to meet the infection control requirements.

A single-pass ventilation system is the preferred choice in areas in which infectious airborne droplet nuclei might be present (e.g., AII rooms). Use HEPA filtration if recirculation of air is necessary.

AII rooms in existing health-care settings should have an airflow of >6 ACH. When feasible, the airflow should be increased to 12 ACH by 1) adjusting or modifying the ventilation system or 2) using air-cleaning methods (e.g., room-air recirculation units containing HEPA filters or UVGI systems that increase the equivalent ACH). New construction or renovation of health-care settings should be designed so that AII rooms achieve an airflow of >12 ACH. Negative pressure should be maintained > 0.01 inch of water gauge compared with adjacent areas.

Based on the risk assessment for the setting, the required number of AII rooms, other negative-pressure rooms, and local exhaust devices should be determined. The location of these rooms and devices will depend partially on where recommended ventilation conditions can be achieved. Grouping rooms in one area might facilitate the care of patients with TB disease and the installation and maintenance of optimal environmental controls.

AII rooms should be checked for negative pressure by using negative pressure monitoring before occupancy, and these rooms should be checked daily when occupied by a patient with suspected or confirmed TB disease.

Health-care settings serving populations with a high prevalence of TB disease might need to improve the existing general ventilation system or use air-cleaning technologies in general use areas (e.g., waiting rooms, EMS areas, and radiology suites).

Applicable approaches include 1) single-pass, non recirculating systems that exhaust air to the outside, 2) recirculation systems that pass air through HEPA filters before recirculating it to the general ventilation system, and 3) room-air recirculation units with HEPA filters and UVGI systems.

### **Air-Cleaning Methods**

#### **High-Efficiency Particulate Air (HEPA) Filters**

HEPA filters can be used to filter infectious droplet nuclei from the air and must be used 1) when discharging air from local exhaust ventilation booths or enclosures directly into the surrounding room or area and 2) when discharging air from an AII room (or other negative-pressure room) into the general ventilation system (e.g., in settings in which the ventilation system or building configuration makes venting the exhaust to the outside impossible).

## **UVGI**

UVGI is an air-cleaning technology that can be used in a room or corridor to irradiate the air in the upper portion of the room (upper-air irradiation) and is installed in a duct to irradiate air passing through the duct (duct irradiation) or incorporated into room air-recirculation units. UVGI can be used in ducts that recirculate air back into the same room or in ducts that exhaust air directly to the outside. However, UVGI should not be used in place of HEPA filters when discharging air from isolation booths or enclosures directly into the surrounding room or area or when discharging air from an AII room into the general ventilation system.

Effective use of UVGI ensures that UVGI tubes should be changed and cleaned according to the instructions of the manufacturer or when irradiance measurements indicate that output is reduced below effective levels. In settings that use UVGI systems, education of HCWs should include 1) basic principles of UVGI systems (mechanism and limitations), 2) potential hazardous effects of UVGI if overexposure occurs, 3) potential for photosensitivity associated with certain medical conditions or use of certain medications, and 4) the importance of maintenance procedures and record-keeping. In settings that use UVGI systems, patients and visitors should be informed of the purpose of UVGI systems and be warned about the potential hazards and safety precautions.

### **Maintenance of environmental control measures**

Ensure the optimal selection, installation, operation, and maintenance of environmental controls.

1. A written maintenance plan should be developed that outlines the responsibility and authority for maintenance of the environmental controls and addresses HCW training needs.
2. Standard operating procedures should include the notification of infection-control personnel before performing maintenance on ventilation systems servicing TB patient-care areas.
3. Personnel should schedule routine preventive maintenance for all components of the ventilation systems (e.g., fans, filters, ducts, supply diffusers, and exhaust grills) and air-cleaning devices.
4. Quality control (QC) checks should be conducted to verify that environmental controls are operating as designed and that records are current.
5. Provisions for emergency electrical power should be made so that the performance of essential environmental controls is not interrupted during a power failure.

### **III. Respiratory Protection**

The third level of the hierarchy is the use of respiratory protective equipment in situations that pose a high risk for exposure .

#### **Indications for Use**

Respiratory protection should be used by the following persons:

- All persons, including HCWs and visitors, entering rooms in which patients with suspected or confirmed infectious TB disease are being isolated;
- Persons present during cough-inducing or aerosol generating procedures performed on patients with suspected or confirmed infectious TB disease; and
- Persons in other settings in which administrative and environmental controls probably will not protect them from inhaling infectious airborne droplet nuclei. These persons might also include persons who transport patients with suspected or confirmed infectious TB disease in vehicles (e.g., EMS vehicles or, ideally, ambulances) and persons who provide urgent surgical or dental care to patients with suspected or confirmed infectious TB disease.

Laboratorians conducting aerosol-producing procedures might require respiratory protection.

#### **Types of Respiratory Protection for TB**

Respirators encompass a range of devices that vary in complexity from flexible masks covering only the nose and mouth, to units that cover the user’s head (e.g., loose-fitting or hooded PAPRs), and to those that have independent air supplies (e.g., airline respirators). Respirators must be selected from those approved by CDC/NIOSH .

**Non-powered air-purifying respirators.** Nine classes of non-powered, air-purifying, particulate-filter respirators are certified. These include N-, R-, and P-series respirators of 95%, 99%, and 100% (99.7%) filtration efficiency when challenged with 0.3 µm particles (filters are generally least efficient at this size). (Table 8). The N, R, and P classifications are based on the capacity of the filter to withstand exposure to oil. All of these respirators meet or exceed CDC’s filtration efficiency performance criteria during the service life of the filter.

**TABLE- 8. Non-powered air-purifying respirator filter classes certified**

Resistance to efficiency filter degradation	Filter efficiencies†		
	95 (95%)	99 (99%)	100 (99.97%)
N (Not resistant to oil)	N95	N99	N100
R (Resistant to oil)	R95	R99	R100

\* Code of Federal Regulations.

† The percentages in parenthesis indicate the minimum allowable laboratory Filter efficiency value when challenged with 0.3 µm particles.

All respirators should be replaced as needed,

1. Based on hygiene considerations
2. Increased breathing resistance
3. In the CDC/NIOSH approval guidelines.
4. And respirator damage, in accordance with manufacturer specifications.

### **III. Respirator protection against TB**

#### **Introduction**

Surgical masks are not respirators and are not certified as such; they do not protect the user adequately from exposure to TB. Disposable respirators (e.g., N-95s) are commonly used in TB isolation rooms, in transport of TB cases, or in other areas of the health care facility. However, when high-risk procedures such as bronchoscopy or autopsy are conducted, respiratory protection exceeding the CDC standard performance criteria may be needed. This protection includes full facepiece negative-pressure respirators, powered air-purifying respirators (PAPRs), or positive-pressure airline respirators equipped with a half-mask or full facepiece.

#### **N95 – Disposable Respirators**

N95 means N-series filter that is at least 95% efficient.

#### **When should an N95 respirator be changed?**

- ▶ N95 respirators are disposable and cannot be cleaned.
  - ▶ N 95 s can be reused if used in the care of a tuberculosis patient.
1. Check before putting on each time and replace if facepiece show any signs of damage, deterioration. (E.g. nicks, abrasions, cuts, or creases in the facepiece-to-face sealing material).
  2. Replace if facepiece is visibly dirty, splashed on, or becomes difficult to breathe through.
  3. Make sure that the metal nose clip (if capable) is in place and functions correctly.
  4. Make sure that the respirator is NIOSH approved (NIOSH approval will be marked on the filter, filter package, or respirator).
  5. Replace in accordance with your agency's infection control protocols.

### **How long can I use my respirator for TB exposures before I discard it?**

Disposable respirators can be functional for weeks to months and reused by the same HCW. Reuse is limited by hygiene, damage, and breathing resistance and manufacturer instructions should be considered.

### **What type of respiratory protection should be used in the operating room (OR) by HCWs with facial hair or other factors that preclude proper fitting of an N95 respirator?**

Will wearing a surgical or procedure mask underneath a PAPR solve this problem? HCWs with facial hair should not wear negative pressure respirators (e.g., N95 disposable respirators that require a tight face seal). In the OR, HCWs with facial hair who are caring for a person with suspected or confirmed infectious TB disease should consult their infection-control committee and respirator manufacturers regarding optimal respiratory protection and adequate infection-control measures. The HCW in this case might wear a surgical or procedure mask to protect the surgical field underneath a loose-fitting PAPR. However, the user cannot be assured of proper operation unless the PAPR's manufacturer tested the PAPR over a surgical or procedure mask or N95 respirator. All respiratory-protection equipment should be used in accordance with the manufacturer's instructions.

### **Respirator fitting**

Respirators are available in different sizes. It is recommended that HCWs be fit tested to ensure selection of the appropriate respirator. Fit testing of respirators should be performed to ensure that the appropriate respirator (size and shape) for each HCW is used. A QLFT test relies on the wearer's subjective response to taste, odor, or irritation. It involves the use of an aerosol which may be "tasted". 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 second time, a different size or brand respirator should be tested. A QNFT uses another means of detecting facepiece leakage and does not require the wearer's subjective response. Beards and facial hair do not allow proper sealing of respirators to the face. Any leak between the face and the mask is a potential entry point for infectious droplet nuclei. Should time and resources permit (financial and staff), respirator testing program should be incorporated into the IC plan. A user seal check is a method for determining whether a respirator has been put on and adjusted to fit properly and is performed every time a respirator is worn. A fit-test is a method used to select the respirator that provides an adequate and comfortable fit. Repetition of fit testing performed in accordance with federal, state, and local regulations. Additional fit testing should be used when 1) a new model of respirator is used, 2) a physical characteristic of the user changes, or 3) when the user or respiratory program administrator is uncertain that the HCW is obtaining an adequate fit.

### **Special circumstances in OT settings**



- **Loose Fitting PAPR**

This respirator consists of a hood or helmet, breathing tube, battery-operated blower, and HEPA filters. It meets CDC guidelines.

Advantages

1. More protective than a half-mask respirator.
2. The respirator is more comfortable because it is loose-fitting.
3. Provides a cooling effect in the hood or helmet.
4. The respirator is durable.
5. Breathing resistance is lower.
6. Vision may be better.
7. Can be worn with facial hair as long as facial hair does not interfere with valve or function of the respirator.

Disadvantages

1. The equipment cannot be used where a sterile field must be maintained because air exits around the hood or helmet.
2. HCWs in this case should wear surgical mask to protect the surgical field underneath a loose-fitting PAPR
3. Batteries must be charged and maintained.
4. The respirator must be inspected, cleaned, and repaired.
5. Communication may be difficult.
6. A PAPR may be bulky and noisy.

**Table -9 . (Administrative, environmental, and respiratory-protection controls for selected health-care settings**

Setting	Administrative controls*	Environmental controls†	Respiratory-protection controls§
<b>Inpatient Settings in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
Emergency departments (EDs)	<ul style="list-style-type: none"> <li>• Implement a written infection-control plan for triage of patients with suspected or confirmed TB disease. Update annually.</li> <li>• Patients with signs or symptoms of infectious TB disease should be moved to an AII room as soon as possible.</li> </ul>	<ul style="list-style-type: none"> <li>• In settings classified as medium risk or potential ongoing transmission, at least one room should meet requirements for an AII room to be used for patients with suspected or confirmed infectious TB disease.</li> <li>• Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs, visitors,¶ and others entering the AII room of a patient with suspected or confirmed TB disease, at least N95 disposable respirators should be worn.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, (e.g., if patient is not using a breathing circuit) during transport, in waiting areas, or when others are present.</li> </ul>
Intensive care units (ICUs)	<ul style="list-style-type: none"> <li>• Place patients with suspected or confirmed infectious TB disease in an AII room, separate from HCWs and other patients, if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• In settings with a high volume of patients with suspected or confirmed TB disease, at least one room should meet requirements for an AII room to be used for such patients .</li> <li>• Bacterial filters should be used routinely in breathing circuits of patients with suspected or confirmed TB disease and should filter particles 0.3 µm in size in unloaded and loaded situations with a filter efficiency of &gt;95%.</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs, visitors,¶ and others entering the AII room of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>• If the patient has signs or symptoms of infectious TB disease and is suspected of being contagious (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible (e.g., if patient is not using a breathing circuit) during transport, in waiting areas, or when others are present.</li> </ul>
Surgical suites	<ul style="list-style-type: none"> <li>• Schedule a patient with suspected or confirmed TB disease for surgery when a minimum number of HCWs and other patients are present, and as the last surgical case of the day to maximize the time available for removal of airborne contamination For postoperative recovery, place patients in a room that meets requirements for an AII room.</li> </ul>	<ul style="list-style-type: none"> <li>• If a surgical suite has an operating room (OR) with an anteroom, that room should be used for TB cases.</li> <li>• If surgery is needed, use a room or suite of rooms that meet requirements for AII rooms</li> <li>• If an AII or comparable room is not available for surgery or postoperative recovery, air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH .</li> <li>• If a surgical suite or an OR has an anteroom, the anteroom should be either 1) positive pressure compared with both the corridor and the suite or OR (with filtered supply air) or 2) negative pressure compared with both the corridor and the suite or OR. In the usual design in which an OR has no anteroom, keep the doors to the OR closed, and minimize traffic into and out of the room and in the corridor. Using additional air-cleaning technologies (e.g., UVGI) should be considered to increase the equivalent ACH. Air-cleaning systems can be placed in the room or in surrounding areas to minimize contamination of the surroundings after the procedure</li> <li>• Bacterial filters should be used routinely in breathing circuits of patients with suspected or confirmed TB disease and should</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs present during surgery of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators, unvalved, should be worn.</li> <li>• Standard surgical or procedure masks for HCWs might not have fitting or filtering capacity for adequate protection.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, before and after the procedure.</li> <li>• Valved or positive-pressure respirators should not be used because they do not protect the sterile surgical field.</li> </ul>

filter particles 0.3 µm in size in an unloaded and loaded situation with a filter efficiency of >95%.

**Table . (Continued) Administrative, environmental, and respiratory-protection controls for selected health-care settings**

Setting	Administrative controls*	Environmental controls†	Respiratory-protection controls§
<b>Inpatient Settings in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
Laboratories**	<ul style="list-style-type: none"> <li>• Conduct a laboratory-specific risk assessment.</li> <li>• In general, bio-safety level (BSL)-2 practices, procedures, containment equipment, and facilities are required for non aerosol-producing manipulations of clinical specimens. BSL-3 practices, procedures, and containment equipment might be necessary for certain aerosol generating or aerosol-producing manipulations.</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental controls should meet requirements for clinical microbiology laboratories in accordance with guidelines by Biosafety in Microbiological and Biomedical Laboratories (BMBL) and the AIA.</li> <li>• Perform all manipulation of clinical specimens that could result in aerosolization in a certified class I or II biosafety cabinet (BSC).</li> </ul>	<ul style="list-style-type: none"> <li>• For laboratory workers who manipulate clinical specimens (from patients with suspected or confirmed infectious TB disease) outside of a BSC, at least N95 disposable respirators should be worn.</li> </ul>
Bronchoscopy suites††	<ul style="list-style-type: none"> <li>• Use a dedicated room to perform bronchoscopy procedures.</li> <li>• If a patient with suspected or confirmed infectious TB disease must undergo bronchoscopy, schedule the procedure when a minimum number of HCWs and other patients are present, and schedule the patient at the end of the day.</li> <li>• Do not allow another procedure to be performed in the bronchoscopy suite until sufficient time has elapsed for adequate removal of M. tuberculosis–contaminated air 4 hrs at least.</li> </ul>	<ul style="list-style-type: none"> <li>• Bronchoscopy suites should meet requirements for an All room to be used for patients with suspected or confirmed infectious TB disease.</li> <li>• Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH.</li> <li>• Closing ventilatory circuitry and minimizing opening of such circuitry of intubated and mechanically ventilated patients might minimize exposure.</li> <li>• Keep patients with suspected or confirmed infectious TB disease in the bronchoscopy suite until coughing subsides.</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs present during bronchoscopic procedures of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn. Protection greater than an N95 (e.g., a full-facepiece elastomeric respirator or powered air-purifying respirator (PAPR) should be considered.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, before and after the procedure.</li> </ul>
Sputum induction and inhalation therapy rooms	<ul style="list-style-type: none"> <li>• Implement a written infection-control plan in the setting. Update annually.</li> <li>• Use a dedicated room to perform sputum induction and inhalation therapy.</li> <li>• Schedule sputum induction and inhalation therapy when a minimum number of HCWs and other patients are present, and schedule the patient at the end of the day.</li> <li>• Do not perform another procedure in a booth or room where sputum induction or inhalation therapy on a patient with suspected or confirmed infectious TB disease was performed until sufficient time has elapsed for adequate removal of M. tuberculosis-contaminated air.</li> </ul>	<ul style="list-style-type: none"> <li>• Perform sputum induction and inhalation therapy in booths with special ventilation, if possible. If booths are not available, sputum induction or inhalation therapy rooms should meet requirements for an All room to be used for patients with suspected or confirmed infectious TB disease.</li> <li>• Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH.</li> <li>• Keep patients with suspected or confirmed infectious TB disease in the sputum induction or inhalation therapy room after sputum collection or inhalation therapy until coughing subsides.</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs present during sputum induction and inhalation therapy of a patient with suspected or confirmed infectious TB disease, a respirator with a level of protection of at least N95 disposable respirators should be worn. Respiratory protection greater than an N95 (e.g., a fullfacepiece elastomeric respirator or PAPR) should be considered.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, before and after the procedure.</li> </ul>

Table . (Continued) Administrative, environmental, and respiratory-protection controls for selected health-care settings

Setting	Administrative controls*	Environmental controls†	Respiratory-protection controls§
<b>Inpatient Settings in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
Autopsy suites	<ul style="list-style-type: none"> <li>• Ensure proper coordination between attending physician(s) and pathologist(s) for proper infection control and specimen collection during autopsies performed on bodies with suspected or confirmed infectious TB disease.</li> <li>• Allow sufficient time to elapse for adequate removal of M. tuberculosis-contaminated air before performing another procedure.</li> </ul>	<ul style="list-style-type: none"> <li>• Autopsy suites should meet ACH requirements for an All room to be used for bodies with suspected or confirmed TB disease.</li> <li>• Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent.</li> <li>• Consider using local exhaust ventilation to reduce exposures to infectious aerosols and vapors from embalming fluids.</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs present during autopsy on bodies with suspected or confirmed infectious TB disease, a respirator with a level of protection of at least an N95 disposable respirator should be worn. Protection greater than an N95 (e.g., a full-facepiece elastomeric respirator or PAPR) should be considered, especially if aerosol generation is likely.</li> <li>• If another procedure cannot be delayed until sufficient time has elapsed for adequate removal of M. tuberculosis contaminated air, staff should continue wearing respiratory protection while in the room.</li> </ul>
Embalming rooms	<ul style="list-style-type: none"> <li>• Implement a written infection-control plan in the setting. Update annually.</li> </ul>	<ul style="list-style-type: none"> <li>• Embalming rooms should meet ACH requirements for an All room to be used for bodies with suspected or confirmed TB.</li> <li>• Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH.</li> </ul>	<ul style="list-style-type: none"> <li>• For staff present during embalming procedures on bodies with suspected or confirmed infectious TB disease, a respirator with a level of protection of at least N95 disposable respirators should be worn. Protection greater than an N95 (e.g., a full-facepiece elastomeric respirator or PAPR) should be considered, especially if aerosol generation is likely.</li> <li>• If another procedure cannot be delayed until sufficient time has elapsed for adequate removal of M. tuberculosis-contaminated air, staff should continue wearing respiratory protection while in the room.</li> </ul>
<b>Outpatient Settings§§ in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
	<ul style="list-style-type: none"> <li>• Perform an annual risk assessment for the setting.</li> <li>• Develop and implement a written infection-control plan for the setting and evaluate and update annually.</li> <li>• Provide TB training, education, and screening for HCWs as part of the infection-control plan.</li> <li>• Establish protocols for problem evaluation.</li> <li>• Collaborate with state or local health departments when appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental controls should be implemented based on the types of activities that are performed.</li> <li>• Patients with suspected or confirmed infectious TB disease requiring transport should be transported as discussed below under Emergency Medical Services (EMS).</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs, visitors,¶ and others entering an All room of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible (e.g., if patient is not using a breathing circuit), during transport, in waiting areas, or when others are present.</li> <li>• If risk assessment indicates that respiratory protection is needed, drivers or HCWs who are transporting patients with suspected or confirmed infectious TB disease in an enclosed vehicle should wear at least an N95 disposable respirator. The risk assessment should consider the potential for shared air.</li> </ul>

Table .. (Continued) Administrative, environmental, and respiratory-protection controls for selected health-care settings

Setting	Administrative controls*	Environmental controls†	Respiratory-protection controls§
<b>Inpatient Settings in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
<p>TB treatment facilities¶¶</p>	<ul style="list-style-type: none"> <li>Physically separate Immuno-suppressed patients from those with suspected or confirmed infectious TB.</li> <li>Schedule appointments to avoid exposing HIV-infected or other severely immuno-compromised persons to M. tuberculosis.</li> </ul>	<ul style="list-style-type: none"> <li>If patients with TB disease are treated in the clinic, at least one room should meet requirements for an All room.</li> <li>Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH.</li> <li>Perform all cough-inducing or aerosol-generating procedures by using environmental controls (e.g., booth) or in an All room.</li> <li>Keep patients in the booth or All room until coughing subsides.</li> <li>Do not allow another patient to enter the booth or All room until sufficient time has elapsed for adequate removal of M. tuberculosis contaminated Air.</li> </ul>	<ul style="list-style-type: none"> <li>For HCWs, visitors,¶ and others entering the All room of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present.</li> </ul>
<p>Medical offices and ambulatory-care settings</p>	<ul style="list-style-type: none"> <li>Implement a written infection-control plan in the setting. Update annually.</li> </ul>	<ul style="list-style-type: none"> <li>In medical offices or ambulatory care settings where patients with TB disease are treated, at least one room should meet requirements for an All room to be used for patients with suspected or confirmed infectious TB disease</li> </ul>	<ul style="list-style-type: none"> <li>For HCWs in medical offices or ambulatory care settings with patients with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present.</li> </ul>
<p>Dialysis units</p>	<ul style="list-style-type: none"> <li>Schedule dialysis for patients with TB disease when a minimum number of HCWs and other patients are present and at the end of the day to maximize the time available for removal of airborne contamination</li> </ul>	<ul style="list-style-type: none"> <li>Perform dialysis for patients with suspected or confirmed infectious TB disease in a room that meets requirements for an All room.</li> <li>Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent .</li> </ul>	<ul style="list-style-type: none"> <li>For HCWs, visitors,¶ and others entering the All room of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present.</li> <li>If risk assessment indicates the need for respiratory protection, drivers or HCWs who are transporting patients with suspected or confirmed infectious TB disease in an enclosed vehicle should wear at least an N95 disposable respirator. The risk assessment should consider the potential for shared air.</li> </ul>

Table . ( Continued) Administrative, environmental, and respiratory-protection controls for selected health-care settings

Setting	Administrative controls*	Environmental controls†	Respiratory-protection controls§
<b>Inpatient Settings in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
Dental-care settings	<ul style="list-style-type: none"> <li>• If possible, postpone dental procedures of patients with suspected or confirmed infectious TB disease until the patient is determined not to have TB disease or to be noninfectious.</li> </ul>	<ul style="list-style-type: none"> <li>• Treat patients with suspected or confirmed infectious TB disease in a room that meets requirements for an All room.</li> <li>• Air-cleaning technologies such as HEPA filtration and (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH .</li> </ul>	<ul style="list-style-type: none"> <li>• For dental staff performing procedures on a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> </ul>
<b>Nontraditional Facility-Based Settings</b>			
	<ul style="list-style-type: none"> <li>• Perform an annual risk assessment for the setting.</li> <li>• Develop and implement a written infection-control plan for the setting and evaluate and update annually.</li> <li>• Provide TB training, education, and screening for HCWs as part of the infection-control plan.</li> <li>• Establish protocols for problem evaluation.</li> <li>• Collaborate with state or local health departments when appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental controls should be implemented based on the types of activities that are performed .</li> <li>• Patients with suspected or confirmed infectious TB disease requiring transport should be transported as discussed in the EMS section.</li> <li>• Patients with suspected or confirmed</li> </ul>	<ul style="list-style-type: none"> <li>• For HCWs, visitors,¶ and others entering the All room of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible (e.g., if patient is not using a breathing circuit), during transport, in waiting areas, or when others are present.</li> </ul>
EMS	<ul style="list-style-type: none"> <li>• Include exposed emergency medical HCWs in the contact investigation of patients with TB disease if administrative, environmental, and respiratory protection controls for TB infection control were not followed.</li> </ul>	<ul style="list-style-type: none"> <li>• Patients with suspected or confirmed infectious TB disease requiring transport should be transported in an ambulance whenever possible. The ambulance ventilation system should be operated in the non-recirculating mode, and the maximum amount of outdoor air should be provided to facilitate dilution. If the vehicle has a rear exhaust fan, use this fan during transport. Airflow should be from the cab (front of vehicle), over the patient, and out the rear exhaust fan.</li> <li>• If an ambulance is not used, the ventilation system for the vehicle should bring in as much outdoor air as possible, and the system should be set to non-recirculating. If possible, physically isolate the cab from the rest of the vehicle and have the patient sit in the back</li> </ul>	<ul style="list-style-type: none"> <li>• If risk assessment indicates the need for respiratory protection, drivers or HCWs who are transporting patients with suspected or confirmed infectious TB disease in an enclosed vehicle should wear at least an N95 disposable respirator. The risk assessment should consider the potential for shared air.</li> <li>• If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present.</li> </ul>

Table . (Continued) Administrative, environmental, and respiratory-protection controls for selected health-care settings

Setting	Administrative controls*	Environmental controls†	Respiratory-protection controls§
<b>Inpatient Settings in Which Patients with Suspected or Confirmed Infectious TB Disease are Expected to be Encountered</b>			
Medical settings in correctional facilities	<ul style="list-style-type: none"> <li>Follow recommendations for inpatient and outpatient settings as appropriate. In waiting rooms or areas, follow recommendations for TB treatment facilities.</li> <li>If possible, postpone transporting patients with suspected or confirmed infectious TB disease until they are determined not to have TB disease or to be noninfectious.</li> </ul>	<ul style="list-style-type: none"> <li>At least one room should meet requirements for an All room .</li> <li>Air-cleaning technologies (e.g., HEPA filtration and UVGI) can be used to increase the number of equivalent ACH .</li> <li>When transporting patients with suspected or confirmed infectious TB disease in a vehicle (ideally an ambulance), if possible, physically isolate the cab (the front seat) from rest of the vehicle, have the patient sit in the back seat, and open the windows.</li> </ul>	<ul style="list-style-type: none"> <li>For HCWs or others entering the All room of a patient with suspected or confirmed infectious TB disease, at least N95 disposable respirators should be worn.</li> <li>If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present.</li> </ul>
Home-based health-care and out reach settings	<ul style="list-style-type: none"> <li>Patients and household members should be educated regarding the importance of taking medications, respiratory hygiene and cough etiquette procedures, and proper medical evaluation.</li> <li>If possible, postpone transporting patients with suspected or confirmed infectious TB disease until they are determined not to have TB disease or to be noninfectious.</li> <li>Certain patients can be instructed to remain at home until they are determined not to have TB disease or to be noninfectious.</li> </ul>	<ul style="list-style-type: none"> <li>Do not perform cough-inducing or aerosol-generating procedures unless appropriate environmental controls are in or perform those procedures outside, if possible.</li> </ul>	<ul style="list-style-type: none"> <li>For HCWs entering the homes of patients with suspected or confirmed infectious TB disease, at least N95 disposable. Respirators should be worn.</li> <li>For HCWs transporting patients with suspected or confirmed infectious TB disease in a vehicle, consider at least an N95 disposable respirator.</li> <li>If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present</li> </ul>
Long-term-care settings (e.g., hospices and skilled nursing facilities)	<ul style="list-style-type: none"> <li>Patients with suspected or confirmed infectious TB disease should not be treated in a long term-care setting, unless proper administrative and environmental controls and a respiratory protection program are in place.</li> </ul>	<ul style="list-style-type: none"> <li>Do not perform cough-inducing or aerosol-generating procedures unless appropriate infection controls are in place (see Supplement, Environmental Controls), or perform those procedures outside, if possible.</li> </ul>	<ul style="list-style-type: none"> <li>If the patient has signs or symptoms of infectious TB disease (positive AFB sputum smear result), consider having the patient wear a surgical or procedure mask, if possible, during transport, in waiting areas, or when others are present.</li> </ul>

\* Administrative controls must be implemented to ensure the effectiveness of environmental controls and respiratory-protection programs, and should be in place for all settings where patients with suspected or confirmed TB disease are expected to be encountered. Administrative controls include a written TB infection-control plan (which should be reassessed at least annually), assignment of responsibility for the plan, setting risk assessment, HCW risk classification, HCW training and education, and a TB screening program to test HCWs for infection with *M. tuberculosis*.

† Environmental controls include local exhaust and general ventilation (i.e., achieving negative pressure), using All rooms, and air-cleaning methods (i.e., HEPA filtration and UVGI).

§ All settings where patients with suspected or confirmed TB disease will be encountered need to have a respiratory-protection program. A respiratory protection program might not be necessary for settings where patients with TB disease are not encountered or where a procedure exists for the prompt transfer of patients with suspected or confirmed TB disease to a setting where they can be evaluated.

¶ Visitors with suspected or confirmed TB disease should not have contact with patients, including contact with those who have suspected or confirmed TB disease.

\*\* Laboratories that are not based in inpatient settings should observe the same TB infection-control measures as laboratories in inpatient settings.

†† Certain bronchoscopy suites are built to have positive pressure.

§§ Although the majority of these settings are routinely considered "outpatient," they might be part of inpatient services in certain settings. If so, follow the recommendations for inpatient settings for patient rooms.

## Appendices

### Appendix A

#### Extra –Pulmonary Tuberculosis

Diagnosis of extra-pulmonary TB is difficult and is often determined by the exclusion of other conditions. The following table outlines the most common and severe forms of extra-pulmonary TB and what is affected in these forms.

<b>Tuberculous most commonly affects</b>	<b>Less severe extra-pulmonary TB includes</b>	<b>Severe extra-pulmonary TB includes</b>
<ul style="list-style-type: none"> <li>◆ The pleura</li> <li>◆ The lymph nodes</li> </ul> <p>In decreasing frequency:</p> <ul style="list-style-type: none"> <li>◆ The bones</li> <li>◆ The genitor-urinary system</li> <li>◆ Multiple organs in military system</li> </ul>	<ul style="list-style-type: none"> <li>◆ Lymph node</li> <li>◆ Pleural effusion (unilateral)</li> <li>◆ Bone (excluding spine)</li> <li>◆ Peripheral joint</li> <li>◆ Genito urinary</li> </ul>	<ul style="list-style-type: none"> <li>◆ Meningitis</li> <li>◆ Miliary</li> <li>◆ Pericarditis</li> <li>◆ Peritonitis</li> <li>◆ Bilateral or extensive pleural effusion* .</li> <li>◆ Spinal</li> <li>◆ Intestinal</li> <li>◆ Adrenal gland</li> </ul>

\* Tuberculous effusions may occur in any of the serotic cavities of the body, i.e., pleural, pericardian or peritoneal cavities.

#### 1. Forms – Signs and symptoms, diagnosis, treatment

The various forms of extra-pulmonary TB should be treated according to the same principles as the standard drug regimen recommended for smear-negative PTB (Regimen III). In severe forms Regimen 1 may be prescribed. In military TB, spinal TB and tuberculous meningitis, it is recommended to prolong the treatment as described on the following pages where symptoms and signs, diagnostic methods, differential diagnosis, treatment recommendations and remarks are outlined for several forms of extra-pulmonary TB. The forms discussed are:

- a. Pleural TB
- b. Tuberculous empyema
- c. Tuberculous lymphadenitis
- d. Miliary TB
- e. Pericardial TB



- f. Tuberculous meningitis
- g. Skeletal TB
- h. Peritoneal TB
- i. Gastrointestinal TB
- j. Genito-urinary TB
- k. Upper respiratory tract TB
- l. Ocular TB
- m. Otologic TB
- n. Endocrine TB
- o. Cutaneous TB

Note: In the descriptions of various extra-pulmonary TB forms outlined on the following pages, only the essential information related specifically to the given form is presented. Thus, for example, treatment is not discussed for every form, and it should be assumed that standard treatment is indicated.

### **Pleural TB**

<b>Over view</b>	Most cases of pleural TB are caused by rupture of a subpleural focus of pulmonary TB or by lymphohaematogenic dissemination. Pleural TB usually occurs within a few months of the primary pulmonary infection.
<b>Symptoms and signs</b>	The clinical presentation is usually acute and typical clinical features of pleural effusion are: <ul style="list-style-type: none"> <li>• Constitutional (fever, malaise) and</li> <li>• Local, i.e., chest pain, discomfort</li> </ul> The radiological picture of pleural fluid is usually characteristic and ultrasound of the pleural space confirms the presence of fluid.
<b>Diagnosis</b>	Fluid is usually straw-colored, exudates, with a protein concentration usually greater than 5g/ 100ml, with a high white-cell count (approx.1000-2500per mm <sup>3</sup> ) with predominant lymphocytes. The variable rate of recovery results from examination of sediment for acid-fast bacilli from centrifuged fluid. Specimens from closed pleural biopsy done using an Abrams needle are sent for culture and histology.  In some cases open pleural biopsy is needed. Video-thoracoscopy is recommended in such circumstances.
<b>Differential diagnosis</b>	Malignancy, post pneumonic effusion, pulmonary embolism.

### **Tuberculous Lymphadenitis**

<b>Over view</b>	Caused by rupture of a tuberculous cavity into the pleural space.
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<b>Differential diagnosis</b>	Includes bacterial empyema when patient is more acutely ill and toxic
<b>Treatment</b>	Standard short-course chemotherapy. Intercostals drain should be inserted to remove pus. Evacuation of fluid is essential because resistant organisms often develop while the patient is on anti-tuberculous chemotherapy. Surgery may be required in some cases.

### Tuberculous Lymphadenitis

<b>Overview</b>	Tuberculous lymphadenitis of peripheral lymph nodes is more common in older adults in countries with a low prevalence of TB. Lymph nodes in the cervical region are frequently affected. Disease may affect a single lymph node or a number of lymph nodes in a particular chain, sometimes bilaterally. Generalized lymphadenopathy is rare in persons with HIV-negative status.
<b>Symptoms and signs</b>	Beginning: nodes are discrete and firm. Later: nodes become tender, fluctuant and matted together. Abscesses and formation of chronic sinuses result in chronic discharge of pus. Constitutional symptoms possibly present: fever, malaise
<b>Diagnosis</b>	Needle biopsy or surgical excision of a node with smear for AFB; culture and histological examination. Diagnostic sensitivity of tuberculous lymphadenopathy by aspirate and smear for AFB is 70%, by lymph node biopsy, 80%. Mediastinal TB lymphadenitis: diagnosis made through bronchoscopy and mediastinoscopy.
<b>Treatment</b>	Standard six-month short course chemotherapy, sometimes lymph nodes enlarge during or after anti-TB chemotherapy. Glucocorticoids may be helpful in such cases. Surgery may be performed for cosmetic reasons, but may cause chronically discharging sinuses. Mediastinal TB lymphadenitis: may causes bronchial compression and changes in surrounding structures (major vessels, lymphatic vessels with chylothorax, chest wall, abdomen). Glucocorticoids may be added to anti-TB chemotherapy to reduce such complications.

### Miliary TB

<b>Overview</b>	Miliary TB results from blood-borne dissemination of TB bacilli as either a consequence of recent primary infection, or erosion of tuberculous lesion into blood vessel. The spleen, liver and lungs are most frequently affected, but bone marrow, kidneys, the central nervous system, adrenal glands and the peritoneum may also be involved.
<b>Symptoms and signs</b>	Constitutional features: fever, weakness, anorexia, weight loss, fatigue and

	respiratory symptoms. Onset of symptoms may be acute or chronic. Acute form: rapidly progressive. Chronic miliary TB presents usually as fever of unknown origin. Chest X-ray: diffuse, uniformly distributed, miliary shadows. There is hepatosplenomegaly. Pancytopenia may be present. Liver function tests: usually abnormal (SGOT and SGPT often 2-5 times normal values). Fundoscopy: may show choroidal tubercles.
<b>Diagnosis</b>	Smear and culture for AFB of sputum and bronchoalveolar lavage fluid. Bacteriological and histological examination of specimens from transbronchial biopsy, and biopsy or fluid from the organs affected, such as cerebrospinal fluid or bone marrow.
<b>Treatment</b>	Prolongation of continuation phase to 7 months in order to complete treatment within 9 months. Surgery may also be necessary for treating complicated cases.

### Pericardial Overview

<b>Overview</b>	Mainly due to haematogenous dissemination.
<b>Symptoms and signs</b>	Cardiovascular symptoms include: chest pain, dyspnoea, cough, weakness caused by low cardiac output, leg swelling, ascites, right abdominal pain caused by liver congestion. Signs may be subtle. Cardiovascular signs include: Tachycardia, low blood pressure, pulses paradoxus, raised jugular venous pressure with small amplitude “a” and “v” waves, impalpable apex beat, quiet heart sounds, pericardial friction rub, signs of right sided heart failure such as hepatomegaly, ascites, oedema. Chest X-ray: large globular heart. ECG: tachycardia, ST and T wave changes and low voltage QRS complexes. Echocardiography: pericardial fluid and strand crossing between visceral and parietal pericardium.
<b>Diagnosis</b>	Usually made at another site or a pericardiocentesis may be required for smears and culture of the pericardial fluid. Smears often negative. In some cases pericardial biopsy or pericardiectomy may give diagnosis.
<b>Differential diagnosis</b>	Malignancy, bacterial pericardial empyema, hypothyroidism.
<b>Treatment</b>	Standard short-course chemotherapy, systemic corticosteroids are beneficial at the beginning of treatment. If there is a cardiac tamponade, pericardiocentesis is necessary. Pericardial constriction may begin very soon after onset of disease. It may develop despite TB cure. Pericardiectomy should be considered in such cases.

### Tuberculous Meningitis

<b>Overview</b>	Tuberculous meningitis is caused by rupture of cerebral tuberculoma into the subarachnoid space or is blood borne.
<b>Symptoms and signs</b>	Symptoms: gradual onset and progression of headache and decreased consciousness, neck stiffness and positive Kernig's sign. Cranial nerve palsies may occur as a result of exudates around the base of the brain. Tuberculomas and vascular occlusion may cause focal neurological deficits and seizures. Obstructive hydrocephalus may develop. Spastic or flaccid paraplegia caused by spinal meningeal involvement. Constitutional features also occur.
<b>Diagnosis</b>	Clinical features and cerebrospinal fluid (CSF) examination. Cerebrospinal fluid: looks clear or cloudy. White cell count: usually about 500 per mm <sup>3</sup> with predominantly polymorphs early in course of disease and later with predominantly lymphocytes. Protein level is increased and glucose low. Cerebrospinal fluid is scanty for AFB. A fast and sensitive culture method is recommended. Normal cerebrospinal fluid does not exclude TB, especially in HIV positive persons. Computed tomography and magnetic resonance may be suggestive. Single or multiple intra-cranial tuberculomas possible.
<b>Treatment</b>	Almost all subjects with untreated TB meningitis die. Full treatment must be started without waiting for microbiological results. The best drugs for treatment of meningeal TB are isoniazid, rifampicin, pyrazinamide and streptomycin for the first 2 months and later a combination of isoniazid and rifampicin. Chemotherapy should be given for 12 months. The CSF concentrations of ethambutol are low, even in presence of meningeal inflammation. Systemic corticosteroids are beneficial in presence of altered consciousness, focal neurological findings, very high opening pressure, spinal block, cerebral oedema and hydrocephalus. Surgery may be necessary in some cases of hydrocephalus or opticohiasmatic arachnoiditis. Treatment duration of tuberculomas depends on CT resolution and must sometimes last as long as 24 months.

### Skeletal TB

<b>Overview</b>	Skeletal TB affects mainly the elderly population in developed countries. The disease may involve any bone or joint, but typically affect the vertebrae and weight-bearing bones. The spine is most commonly involved, followed by knee, hip and ankle. A single joint is usually involved. Occasionally a lesion ruptures through the bone into soft tissues, causing a cold abscess. Such
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	abscesses may move along facial planes in soft tissues and appear at distant sites.
	Vertebral TB (Pott's disease) affects lower thoracic, lumbar and lumbosacral regions of the spine. Consequence of untreated thoracic or cervical spinal TB is paralysis. Complications include gibbus and psoas abscess formation.
<b>Symptoms and signs</b>	Back pain, radicular pains and signs of spinal cord compression. Pain is the most common complaint and is usually localized at the area of involvement. Physical examination: local tenderness, muscular spasm or kyphosis.
<b>Diagnosis</b>	<ul style="list-style-type: none"> <li>◆ Radiology: Spinal TB-typical appearance is erosion of the anterior edges of the superior and inferior borders of adjacent vertebral bodies. Disc space is narrowed. Imaging of the spine by magnetic resonance and computer tomography is of great value.</li> <li>◆ Histological and microbiological examination: fine-needle aspiration or tissue biopsy achieved by wide surgical excision. Tuberculous arthritis is best diagnosed by aspiration and synovial biopsy.</li> </ul>
<b>Treatment</b>	<ul style="list-style-type: none"> <li>◆ Spinal TB-prolongation of the continuation phase to 7 months. Surgery may also be necessary for treating complicated cases.</li> <li>◆ Tuberculous arthritis: standard short-course chemotherapy.</li> </ul>

### Peritoneal TB and Tuberculous ascites

<b>Overview</b>	Peritoneal TB and tuberculous ascites may be caused by spread of tuberculous mesenteric lymph nodes from intestinal TB (pulmonary TB patients may develop intestinal ulcers and fistulae as a result of swallowing infected sputum). The disease may also be due to haematogenous dissemination.
<b>Symptoms and signs</b>	Onset: often insidious with the development of symptoms observed for several months, sometimes it may be acute. Constitutional features: abdominal pain and ascites, palpable abdominal masses formed by mesenteric lymph nodes. Complications: adhesion of nodes to bowel may cause bowel obstruction. Fistulae may develop between bowel, bladder and abdominal wall
<b>Diagnosis</b>	Aspirated fluid is usually straw-colored. It is exudates, usually with more than 300 white cells per mm <sup>3</sup> and predominantly lymphocytes. Ultrasound: may show enlarged mesenteric or retroperitoneal lymph nodes. Laparoscopy: enables direct visualization and biopsy of peritoneal TB lesions. Laparotomy: confirms a diagnosis in difficult cases. The diagnosis is confirmed by identification of M.tuberculosis in the peritoneal fluid or by peritoneal biopsy.
<b>Differential</b>	Includes heart failure, renal failure, nephritic syndrome, liver failure,

<b>diagnosis</b>	hypoproteinaemis (transudates), malignancy (exudates)
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### Gastrointestinal TB

<b>Overview</b>	Gastrointestinal TB is mainly caused by the ingestion of secretions containing AFB of/by patients with smear-positive pulmonary tuberculosis. The ileocecal area is most frequently affected.
<b>Symptoms and signs</b>	<ul style="list-style-type: none"> <li>- Constitutional features</li> <li>- Gastrointestinal features: abdominal pain, chronic diarrhea, subacute obstruction and a right iliac fossa mass.</li> </ul>
<b>Diagnosis</b>	Barium examination of the small and large bowel and colonoscopy. Histological and microbiological examination of biopsy specimens from intestinal mucus confirms diagnosis.
<b>Differential diagnosis</b>	Lieo-caecal crohns disease, carcinoma of the caecum , appendix abscess, lymphoma dn tubo –ovaraian abscess. Since abdominal TB may be insidious and difficult to diagnose, it is important to have a high index of suspicion.
<b>Treatment</b>	Standard short course chemotherapy, surgery may be necessary for cases of bowel, obstruction, abscess formation or perforation
<b>Hepatitis TB overview</b>	Miliary TB may involve liver, Hepatic TB present s as solitary or multiple TB abscess or tumour.
<b>Symptoms and signs</b>	Physical findings include local tenderness, hepatomegaly and jaundice. The CT scan shows hepatomegaly or mass in the liver.
<b>Diagnosis</b>	Liver biopsy and culture.

### Genito-urinary TB

<b>Overview</b>	Genitourinary TB is usually a late manifestation of infections and affects older patients. Lesions first appear in the renal cortex and TB may spread from the kidney into the renal pelvis, urethra, bladder and genital tract	
	<b>Urinary tract TB</b>	
	Symptoms and signs	Urinary tract TB should be suspected in the presense of symptoms (dysuria, frequent urination, uretheric colic) and sterile pyuria. Haematuria may also occur. Loin pain and swelling may occur due to a cold abscess. Uretheric obstruction with hydronephrosis is the most common complication.  Ultrasonography/urography: recommended before, during and after chemotherapy to detect any uretheric

		obstruction.
	Diagnosis	Urine culture. At least three early morning urine specimens should be collected on separate days and sent quickly to the laboratory to avoid the development of alkalinity. Monthly urine culture is advised to monitor the response to treatment.
	Treatment	Standard short course chemotherapy. Surgery may be required for urethric obstruction to remove a destroyed kidney or large renal abscess
<b>Genital tract TB</b>		
	Symptoms and signs	Male: most common genital site is epididymis. Female: genital tract TB may affect the fallopian tubes, endometrium, ovaries and cervix; vaginal and vulval involvements are rare. Signs: pelvic inflammatory disease causes ectopic pregnancy and infertility.
	Diagnosis	Made by biopsy and culture of mass lesion. Diagnosis in women: may be confirmed by bacteriological /histological examination of endometrial biopsy, cervical biopsy, vaginal discharge, or menstrual blood.

### **Upper respiratory tract TB**

<b>Overview</b>	Upper respiratory tract TB is usually a complication of a pulmonary disease. Cases of laryngeal TB are very infectious due to the frequent cough and the load of bacilli in the lungs and the larynx.
<b>Symptoms and signs</b>	Hoarseness, pain on swallowing, cough.
<b>Diagnosis</b>	Laryngeal endoscopy may show vegetations nodules or ulceraton.

### **Ocular TB**

<b>Overview</b>	May involve the uvea, with generalized uveitis, choroditis, choroiditis , choroidal and ciliary body tubercle granulomas, or iritis. Choroidal tubercle granulomas may be seen. It may involve retina with retinitis or retinal vasculitis.
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### **Otologic TB**

<b>Symptoms and signs</b>	Ear discharge
<b>Diagnosis</b>	Ear discharge smear and culture for AFB or biopsy. Early diagnosis and treatment is essential to prevent permanent hearing loss.

### **Endocrine TB**

<b>Symptoms and signs</b>	Adrenal gland TB has symptoms of hypoadrenalism, such as hypotension, low serum sodium with normal or high potassium, raised urea and low glucose. The adrenals are almost always enlarged.
<b>Diagnosis</b>	There are calcifications on a plain X-ray and in ultrasound examination. CT scan is also useful.

### **Cutaneous TB**

<b>Diagnosis</b>	Histological and microbiological examination of the biopsy of the affected skin. Part of cutaneous TB is tuberculous mastitis. It may present with a mass in the breast with axillary lymphadenopathy.
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Reference: Catena E; De Simone G; Caramori G; Ciaccia A. Extrapulmonary Tuberculosis. The European Respiratory Monograph 1997, 4, 175- 194

### **Adjuvant steroid treatment in extra pulmonary TB**

<b>Indications</b>	<b>Specifications / suggested doses</b>
TB meningitis	<ul style="list-style-type: none"> <li>- Decreased consciousness</li> <li>- Neurological defects</li> <li>- Spinal block</li> <li>- 60 mg daily for weeks 1- 4, then decrease over several weeks.</li> </ul>
TB pericarditis	<ul style="list-style-type: none"> <li>- 60 mg daily for weeks 1-4</li> <li>- 30 mg daily for weeks (2) or 5-8, then decrease over several weeks</li> </ul>
TB pleural effusion	When large with severe symptoms <ul style="list-style-type: none"> <li>- Administer 40 mg daily for 1-2 weeks</li> </ul>
Hypo-adrenalism	<ul style="list-style-type: none"> <li>- Substitutive doses</li> </ul>
TB laryngitis	<ul style="list-style-type: none"> <li>- With life-threatening airway obstruction</li> </ul>



Anti-TB drug reaction	- Severe hypersensitivity airway obstruction
Renal tract TB	- To prevent urethral scanning
Lymph node	- Massive lymph node enlargement with pressure effects

**Appendix B. Tuberculosis (TB) risk assessment worksheet**

This model worksheet should be considered for use in performing TB risk assessments for health-care settings and nontraditional facility-based settings. Facilities with more than one type of setting will need to apply this table to each setting.

**Scoring:** ✓ or Y = Yes X or N = No NA = Not Applicable

**1. Incidence of TB**

- a. What is the incidence of TB in your community (county or region served by the health-care setting), and how does it compare with the state and national average?
- b. What is the incidence of TB in your facility and specific settings, and how do those rates compare? (Incidence is the number of TB cases in your community during the previous year. A rate of TB cases per 100,000 persons should be obtained for comparison.)\* This information can be obtained from the state or local health department.
- c. Are patients with suspected or confirmed TB disease encountered in your setting (inpatient and outpatient)?
  - 1) If yes, how many are treated in your health-care setting in 1 year? (Review laboratory data, infection-control records, and databases containing discharge diagnoses for this information.)
  - 2) If no, does your health-care setting have a plan for the triage of patients with suspected or confirmed TB disease?
- d. Currently, does your health-care setting have a cluster of persons with confirmed TB disease that might be a result of ongoing transmission of Mycobacterium tuberculosis?

**Rate**

Community \_\_\_\_\_  
 State \_\_\_\_\_  
 National \_\_\_\_\_  
 Facility \_\_\_\_\_  
 Department 1 \_\_\_\_\_  
 Department 2 \_\_\_\_\_  
 Department 3 \_\_\_\_\_

	No. patients	
Year	Suspected	Confirmed
1 year ago	_____	_____
2 years ago	_____	_____
5 years ago	_____	_____

**2. Risk Classification**

**a. Inpatient settings**

- 1) How many inpatient beds are in your inpatient setting?
- 2) How many patients with TB disease are encountered in the inpatient setting in 1 year? (Review laboratory data, infection-control records, and databases containing discharge diagnoses.)
- 3) Depending on the number of beds and TB patients encountered in 1 year, what is the risk classification for your inpatient setting?
- 4) Does your health-care setting have a plan for triaging patients with suspected or confirmed TB disease?

Quantity \_\_\_\_\_  
Previous year \_\_\_\_\_  
5 years ago \_\_\_\_\_  
\_\_\_ Low risk  
\_\_\_ Medium risk  
\_\_\_ Potential ongoing transmission

b. Outpatient settings

- 1) How many TB patients are evaluated at your outpatient setting in 1 year? (Review laboratory data, infection-control records, and databases containing discharge diagnoses for this information.)
- 2) Is your health-care setting a TB clinic? (If yes, a classification of at least medium risk is recommended.)
- 3) Does evidence exist that a high incidence of TB disease has been observed in the community that the health-care setting serves?
- 4) Does evidence exist of person-to-person transmission in the health-care setting? (Use information from case reports. Determine if any TST or blood assay for M. tuberculosis [BAMT] conversions have occurred among health-care workers [HCWs].)
- 5) Does evidence exist that ongoing or unresolved health-care-associated transmission has occurred in the health-care setting (based on case reports)?
- 6) Does a high incidence of immunocompromised patients or HCWs in the health-care setting exist?
- 7) Have patients with drug-resistant TB disease been encountered in your health-care setting within the previous 5 years?
- 8) When was the first time a risk classification was done for your health-care setting?
- 9) Considering the items above, would your health-care setting need a higher risk classification?

Previous year \_\_\_\_\_  
5 years ago \_\_\_\_\_  
Year encountered \_\_\_\_\_  
Date of classification \_\_\_\_\_

- 10) Depending on the number of TB patients evaluated in 1 year, what is the risk classification for your outpatient setting (see Appendix C)?
- 11) Does your health-care setting have a plan for the triage of patients with suspected or confirmed TB disease?

Low risk  
Medium risk  
Potential ongoing transmission

c. Nontraditional facility-based settings

- 1) How many TB patients are encountered at your setting in 1 year?
- 2) Does evidence exist that a high incidence of TB disease has been observed in the community that the setting serves?
- 3) Does evidence exist of person-to-person transmission in the setting?
- 4) Have any recent TST or BAMT conversions occurred among staff or clients?
- 5) Is there a high incidence or prevalence of immunocompromised patients or HCWs in the setting?
- 6) Have patients with drug-resistant TB disease been encountered in your health-care setting within the previous 5 years?
- 7) When was the first time a risk classification was done for your setting?
- 8) Considering the items above, would your setting require a higher risk classification?
- 9) Does your setting have a plan for the triage of patients with suspected or confirmed TB disease?

10) Depending on the number of patients with TB disease who are encountered in a nontraditional setting in 1 year, what is the risk classification for your setting (see Appendix C)?

Previous year \_\_\_\_\_

5 years ago \_\_\_\_\_

Year encountered \_\_\_\_\_

Date of classification \_\_\_\_\_

Low risk

Medium risk

Potential ongoing transmission

### 3. Screening of HCWs for *M. tuberculosis* Infection

a. Does the health-care setting have a TB screening program for HCWs?

If yes, which HCWs are included in the TB screening program? (check all that apply)

Physicians

Mid-level practitioners

(nurse practitioners [NP] and  
physician's assistants [PA])

Nurses

Administrators

Laboratory workers

Respiratory therapists

Physical therapists

Contract staff

Construction or renovation workers

Service workers

Janitorial staff

Maintenance or engineering staff

Transportation staff

Dietary staff

Receptionists

Trainees and students

Volunteers

Others

b. Is baseline skin testing performed with two-step TST for HCWs?

c. Is baseline testing performed with QuantiFERON®-TB or other BAMT for HCWs?

d. How frequently are HCWs tested for *M. tuberculosis* infection?

e. Are *M. tuberculosis* infection test records maintained for HCWs?

f. Where are test records for HCWs maintained?

g. Who maintains the records?

h. If the setting has a serial TB screening program for HCWs to test for *M. tuberculosis* infection, what are the conversion rates for the previous years?†

i. Has the test conversion rate for *M. tuberculosis* infection been increasing or decreasing, or has it remained the same over the previous 5 years? (check one)

Frequency \_\_\_\_\_

Location \_\_\_\_\_

Name \_\_\_\_\_

1 year ago \_\_\_\_\_

2 years ago \_\_\_\_\_

3 years ago \_\_\_\_\_

4 years ago \_\_\_\_\_

5 years ago \_\_\_\_\_

Increasing

Decreasing

No change in previous 5 years

j. Do any areas of the health-care setting (e.g., waiting rooms or clinics) or any group of HCWs (e.g., laboratory workers, emergency department staff, respiratory therapists, and HCWs who attend bronchoscopies) have a test conversion rate for *M. tuberculosis* infection that exceeds the health-care setting's annual average? If yes, list.

k. For HCWs who have positive test results for *M. tuberculosis* infection and who leave employment at the health setting, are efforts made to communicate test results and recommend follow-up of latent TB infection treatment with the local health department or their primary physician?

Rate \_\_\_\_\_

Not applicable

#### **4. TB Infection-Control Program**

a. Does the health-care setting have a written TB infection-control plan?

b. Who is responsible for the infection-control program?

c. When was the TB infection-control plan first written?

d. When was the TB infection-control plan last reviewed or updated?

e. Does the written infection-control plan need to be updated based on the timing of the previous update (i.e., >1 year, changing TB epidemiology of the community or setting, the occurrence of a TB outbreak, change in state or local TB policy, or other factors related to a change in risk for transmission of *M. tuberculosis*)?

f. Does the health-care setting have an infection-control committee (or another committee with infection-control responsibilities)?

1) If yes, which groups are represented on the infection-control committee? (check all that apply)

Physicians

Nurses

Epidemiologists

Engineers

Pharmacists

Laboratory personnel

Health and safety staff

Administrator

Risk assessment

Quality control

Others (specify)

2) If no, what committee is responsible for infection control in the setting?

Name \_\_\_\_\_

Date \_\_\_\_\_

Date \_\_\_\_\_

## 5. Implementation of TB Infection-Control Plan Based on Review by Infection-Control Committee

- a. Has a person been designated to be responsible for implementing an infection-control plan in your health-care setting? If yes, list the name.
- b. Based on a review of the medical records, what is the average number of days for the following:
  - \_\_\_ Presentation of patient until collection of specimen.
  - \_\_\_ Specimen collection until receipt by laboratory.
  - \_\_\_ Receipt of specimen by laboratory until smear results are provided to health-care provider.
  - \_\_\_ Diagnosis until initiation of standard anti tuberculosis treatment.
  - \_\_\_ Receipt of specimen by laboratory until culture results are provided to health-care provider.
  - \_\_\_ Receipt of specimen by laboratory until drug-susceptibility results are provided to healthcare provider.
  - \_\_\_ Receipt of drug-susceptibility results until adjustment of anti tuberculosis treatment, if indicated.
  - \_\_\_ Admission of patient to hospital until placement in airborne infection isolation (AII).
- c. Through what means (e.g., review of TST or BAMT conversion rates, patient medical records, and time analysis) are lapses in infection control recognized?
- d. What mechanisms are in place to correct lapses in infection control?
- e. Based on measurement in routine QC exercises, is the infection-control plan being properly implemented?
- f. Is ongoing training and education regarding TB infection-control practices provided for HCWs?
  - Committee \_\_\_\_\_
  - Name \_\_\_\_\_
  - Means \_\_\_\_\_
  - Mechanisms \_\_\_\_\_

## 6. Laboratory Processing of TB-Related Specimens, Tests, and Results Based on Laboratory Review

- a. Which of the following tests are either conducted in-house at your health-care setting's laboratory or sent out to a reference laboratory? (check all that apply)

### In-house Sent out

- \_\_\_ Acid-fast bacilli (AFB) smears
  - \_\_\_ Culture using liquid media (e.g., Bactec and MB-BacT)
  - \_\_\_ Culture using solid media
  - \_\_\_ Drug-susceptibility testing
  - \_\_\_ Nucleic acid amplification testing
- b. What is the usual transport time for specimens to reach the laboratory for the following tests?
    - AFB smears \_\_\_\_\_
    - Culture using liquid media (e.g., Bactec, MB-BacT) \_\_\_\_\_
    - Culture using solid media \_\_\_\_\_
    - Drug-susceptibility testing \_\_\_\_\_
    - Nucleic acid amplification testing \_\_\_\_\_
    - Other (specify) \_\_\_\_\_
  - c. Does the laboratory at your health-care setting or the reference laboratory used by your healthcare setting report AFB smear results for all patients within 24 hours of receipt of specimen?  
What is the procedure for weekends?

## 7. Environmental Controls

a. Which environmental controls are in place in your health-care setting? (check all that apply and describe)

Environmental control	Description
<input type="checkbox"/> All rooms	_____
<input type="checkbox"/> Local exhaust ventilation (enclosing devices and exterior devices)	_____
<input type="checkbox"/> General ventilation (e.g., single-pass system, recirculation system)	_____
<input type="checkbox"/> Air-cleaning methods (e.g., high efficiency particulate air [HEPA] filtration and Ultraviolet germicidal irradiation [UVGI])	_____

b. What are the actual air changes per hour (ACH) and design for various rooms in the setting?

Room	ACH	Design
_____	_____	_____
_____	_____	_____
_____	_____	_____

c. Which of the following local exterior or enclosing devices such as exhaust ventilation devices are used in your health-care setting? (check all that apply)

- Laboratory hoods
- Booths for sputum induction
- Tents or hoods for enclosing patient or procedure

d. What general ventilation systems are used in your health-care setting? (check all that apply)

- Single-pass system
- Variable air volume
- Constant air volume
- Recirculation system
- Other \_\_\_\_\_

e. What air-cleaning methods are used in your health-care setting? (check all that apply)

- | <u>HEPA filtration</u>   | <u>UVGI</u>   |
|--|---|
| <input type="checkbox"/> Fixed room-air recirculation systems    | <input type="checkbox"/> Duct irradiation           |
| <input type="checkbox"/> Portable room-air recirculation systems | <input type="checkbox"/> Upper-air irradiation      |
|  | <input type="checkbox"/> Portable room-air cleaners |

f. How many All rooms are in the health-care setting?

g. What ventilation methods are used for All rooms? (check all that apply)

Primary: (general ventilation)

- Single-pass heating, ventilating, and air conditioning (HVAC)
- Recirculating HVAC systems

Secondary (methods to increase equivalent ACH):

- Fixed room recirculating units
- HEPA filtration
- UVGI
- Other \_\_\_\_\_

(specify) \_\_\_\_\_

h. Does your health-care setting employ, have access to, or collaborate with an environmental engineer (e.g., professional engineer) or other professional with appropriate expertise (e.g., certified

industrial hygienist) for consultation on design specifications, installation, maintenance, and evaluation of environmental controls?

- i. Are environmental controls regularly checked and maintained with results recorded in maintenance logs?
- j. Is the directional airflow in AII rooms checked daily when in use with smoke tubes or visual checks?
- k. Are these results readily available?
- l. What procedures are in place if the AII room pressure is not negative?

m. Do AII rooms meet the recommended pressure differential of 0.01-inch water column negative to surrounding structures?

### 8. Respiratory-Protection Program

- a. Does your health-care setting have a written respiratory-protection program?
- b. Which HCWs are included in the respiratory-protection program? (check all that apply)

- Physicians
- Mid-level practitioners (NPs and PAs)
- Nurses
- Administrators
- Laboratory personnel
- Contract staff
- Construction or renovation staff
- Service personnel

- c. Are respirators used in this setting for HCWs working with TB patients? If yes, include manufacturer, model, and specific application (e.g., ABC model 1234 for bronchoscopy and DEF model 5678 for routine contact with infectious TB patients).

Manufacturer	Model	Specific application
_____	_____	_____
_____	_____	_____
_____	_____	_____

- d. Is annual respiratory-protection training for HCWs performed by a person with advanced training in respiratory protection?
- e. Does your health-care setting provide initial fit testing for HCWs? If yes, when is it conducted?
- f. Does your health-care setting provide periodic fit testing for HCWs? If yes, when and how frequently is it conducted?
- g. What method of fit testing is used?
- h. Is qualitative fit testing used?
- i. Is quantitative fit testing used?

Quantity \_\_\_\_\_  
Date \_\_\_\_\_  
Date \_\_\_\_\_  
Frequency \_\_\_\_\_  
Method \_\_\_\_\_

- Janitorial staff
- Maintenance or engineering staff
- Transportation staff
- Dietary staff

\_\_\_ Students  
\_\_\_ Others (specify) \_\_\_\_\_

**9. Reassessment of TB Risk**

- a. How frequently is the TB risk assessment conducted or updated in the health-care setting?
- b. When was the last TB risk assessment conducted?
- c. What problems were identified during the previous TB risk assessment?

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_
- 5) \_\_\_\_\_

- d. What actions were taken to address the problems identified during the previous TB risk assessment?

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_
- 5) \_\_\_\_\_

- e. Did the risk classification need to be revised as a result of the last TB risk assessment?

Frequency \_\_\_\_\_

Date \_\_\_\_\_

\* If the population served by the health-care facility is not representative of the community in which the facility is located, an alternate comparison population might be appropriate.

† Test conversion rate is calculated by dividing the number of conversions among HCWs by the number of HCWs who had previous negative results during a certain period (see Supplement, Surveillance and Detection of M. tuberculosis infections in Health-Care Settings).



## **XI. Glossary of Definitions**

acid-fast bacilli (AFB) examination	A laboratory test that involves microscopic examination of a stained smear of a patient specimen (usually sputum) to determine if mycobacterium are present. A presumptive diagnosis of pulmonary tuberculosis (TB) can be made with a positive AFB sputum smear result; however, approximately 50% of patients with TB disease of the lungs have negative AFB sputum smear results. The diagnosis of TB disease is usually not confirmed until <i>Mycobacterium tuberculosis</i> is identified in culture or by positive nucleic acid amplification (NAA) test result.
administrative controls	Managerial measures that reduce the risk for exposure to persons who might have TB disease. Examples include coordinating efforts with the local health department; (i.e., infection control department and preventive medicine department) conducting a TB risk assessment for the setting; developing and instituting a written TB infection-control plan to ensure prompt detection, airborne infection isolation (AII), and treatment of persons with suspected or confirmed TB disease; and screening and evaluating health-care workers (HCWs) who are at risk for TB disease or who might be exposed to <i>M. tuberculosis</i> .
air change rate	Ratio of the airflow in volume units per hour to the volume of the space under consideration in identical volume units, usually expressed in air changes per hour (ACH).
air change rate (equivalent)	Ratio of the volumetric air loss rate associated with an environmental control (or combination of controls) (e.g., an air cleaner or ultraviolet germicidal irradiation [UVGI] system) divided by the volume of the room where the control has been applied. The equivalent air change rate is useful for describing the rate at which bioaerosols are removed by means other than ventilation.
air change rate (mechanical)	Ratio of the airflow to the space volume per unit time, usually expressed in air changes per hour (ACH).
airborne infection isolation(AII)precautions	The isolation of patients infected with organisms spread through airborne droplet nuclei 1–5 $\mu\text{m}$ in diameter. This isolation area receives substantial ACH (>12 ACH for new construction since 2001 and >6 ACH for construction before 2001) and is under negative pressure (i.e., the direction of the air flow is from the outside adjacent space [e.g., the corridor] into the room). The air in an AII room is preferably exhausted to the outside, but can be recirculated if the return air is filtered through a high efficiency particulate respirator (HEPA) filter.
AII room	A room designed to maintain AII. Formerly called negative pressure isolation room, an AII room is a single-occupancy patient-care room used to isolate persons with suspected or confirmed infectious TB disease. Environmental factors are controlled in AII rooms to minimize the transmission of infectious

	agents that are usually spread from person-to person by droplet nuclei associated with coughing or aerosolization of contaminated fluids. All rooms should provide negative pressure in the room (so that air flows under the door gap into the room), an air flow rate of 6–12 ACH, and direct exhaust of air from the room to the outside of the building or recirculation of air through a HEPA filter.
anergy	A condition in which a person has a diminished ability to exhibit delayed T-cell hypersensitivity to antigens because of a condition or situation resulting in altered immune function. An inability to react to a skin test is called cutaneous anergy. Skin tests for anergy (i.e., control antigens) have poor predictive value and are not recommended.
anteroom	Small room leading from a corridor into an AII room. An anteroom is separated from both the AII room and the corridor by doors. An anteroom can act as an airlock, preventing the escape of contaminants from the AII room into the corridor.
Bacille Calmette-Guérin (BCG)	A vaccine for TB named after the French scientists Calmette and Guérin used in most countries where TB disease is endemic. The vaccine is effective in preventing disseminated and meningeal TB disease in infants and young children. It may have approximately 50% efficacy for preventing pulmonary TB disease in adults.
baseline TB screening	Screening HCWs for LTBI and TB disease at the beginning of employment. TB screening includes a symptom screen for all HCWs, and tuberculin skin tests (TSTs) or blood assay for <i>Mycobacterium tuberculosis</i> (BAMT) for those with previous negative test results for <i>M. tuberculosis</i> infection.
baseline TST or baseline BAMT	The TST or BAMT is administered at the beginning of employment to newly hired HCWs. If the TST method is used, for HCWs who have not had a documented negative test result for <i>M. tuberculosis</i> during the preceding 12 months, the baseline TST result should be obtained by using the two-step method. BAMT baseline testing does not need the two-step method.
biological safety cabinet (BSC)	A ventilated box that provides HCWs with a degree of protection against hazardous aerosols that are generated within it. BSC is the principal device used to contain infectious splashes or aerosols generated by multiple microbiology processes. BSC provides physical barriers and directional airflow to carry hazards away from the HCW. Maintenance is an essential part of ensuring proper BCS function.
Biosafety in Microbiological and Biomedical Laboratories (BMBL)	A publication of the U.S. Public Health Service that describes the combinations of standard and special microbiology practices, safety equipment, and facilities constituting biosafety levels (BSLs) 1–4, which are recommended for work with various infectious agents in laboratory settings. The recommendations are advisory and intended to provide a voluntary guide or code of practice.

Blood assay for <i>Mycobacterium tuberculosis</i> (BAMT)	A general term to refer to recently developed in vitro diagnostic tests that assess for the <i>tuberculosis</i> (BAMT) presence of infection with <i>M. tuberculosis</i> . This term includes, but is not limited to, IFN- $\delta$ release assays (IGRA). In the United States, the currently available test is QuantiFERON®-TB Gold test (QFT-G).
BAMT converter	A change from a negative to a positive BAMT result over a 2-year period.
boosting	When nonspecific or remote sensitivity to tuberculin purified protein derivative (PPD) in the skin test wanes or disappears over time, subsequent TSTs can restore the sensitivity. This process is called boosting or the booster phenomenon. An initially small TST reaction size is followed by a substantial reaction size on a later test, and this increase in millimeters of induration can be confused with a conversion or a recent <i>M. tuberculosis</i> infection. Two-step testing is used to distinguish new infections from boosted reactions in infection control surveillance programs.
close contact (TB)	A person who has shared the same air space in a household or other enclosed environment for a prolonged period (days or weeks, not minutes or hours) with a person with suspected or confirmed TB disease. Close contacts have also been referred to as high-priority contacts because they have the highest risk for infection with <i>M. tuberculosis</i> .
cluster (TB)	A group of patients with LTBI or TB disease that are linked by epidemiologic, location, or genotyping data. Two or more TST conversions within a short period can be a cluster of TB disease and might suggest transmission within the setting. A genotyping cluster is two or more cases with isolates that have an identical genotyping pattern.
combination product surgical mask/N95 disposable respirator	Product certified by CDC's National Institute for Occupational Safety and Health (NIOSH) and cleared by the Food and Drug Administration (FDA) that provides both respiratory protection and blood-borne pathogen protection.
constant air volume (CAV)	A descriptor for an air-handling system which, as the name implies supplies and exhausts air at a constant flow rate. The flow rate does not change over time based on temperature load or other parameters.
contact (TB)	Refers to someone who was exposed to <i>M. tuberculosis</i> infection by sharing air space with an infectious TB patient.
contact investigation	Procedures that occur when a case of infectious TB is identified, including finding persons (contacts) exposed to the case, testing and evaluation of contacts to identify LTBI or TB disease, and treatment of these persons, as indicated.
conversion rate	The percentage of a population with a converted test result (TST or BAMT) for <i>M. tuberculosis</i> within a specified period. This is calculated by dividing the number of conversions among eligible HCWs in the setting in a specified period (numerator) by the number of HCWs who received tests in the setting over the

	same period (denominator) multiplied by 100.
cross contamination	When organisms from one sample are introduced into another sample, causing a false positive result.
delayed-type hypersensitivity (DTH)	Cell-mediated inflammatory reaction to an antigen, which is recognized by the immune system usually because of previous exposure to the same antigen or similar ones. Cell mediated reactions are contrasted with an antibody (or humoral) response. DTH typically peaks at 48–72 hours after exposure to the antigen.
deoxyribonucleic acid	DNA fingerprinting is a clinical laboratory technique used to distinguish between different strains of <i>M. tuberculosis</i> and to help assess the likelihood of TB transmission.
differential pressure	A measurable difference in air pressure that creates a directional airflow between adjacent compartmentalized spaces.
directly observed therapy (DOT)	Adherence-enhancing strategy in which an HCW or other trained person watches a patient swallow each dose of medication. DOT is the standard care for all patients with TB disease and is a preferred option for patients treated for LTBI.
drug-susceptibility test	A laboratory determination to assess whether an <i>M. tuberculosis</i> complex isolate is susceptible or resistant to antituberculosis drugs that are added to mycobacterial growth medium or are detected genetically. The results predict whether a specific drug is likely to be effective in treating TB disease caused by that isolate.
environmental control measures	Physical or mechanical measures (as opposed to administrative control measures) used to reduce the risk for transmission of <i>M. tuberculosis</i> . Examples include ventilation, filtration, ultraviolet lamps, AII rooms, and local exhaust ventilation devices.
epidemiologic cluster	A closely grouped series of cases in time or place.
expert TST trainer	A designated instructor who has documented TST training experience. This may include having received training on placing and reading multiple TST results.
exposed cohorts	Groups of persons (e.g., family members, co-workers, friends, club, team or choir members, persons in correctional facilities, or homeless shelter residents) who have shared the same air space with the suspected patient with TB disease during the infectious period. A person in the exposed cohort is a contact. See also contact and close contact.
false-positive TST or BAMT result	A TST or BAMT result that is interpreted as positive in a person who is not actually infected with <i>M. tuberculosis</i> . A false-positive TST result is more likely to occur in persons who have been vaccinated with BCG or who are infected with non-tuberculous mycobacteria (NTM).

fit factor	A quantitative estimate of the fit of a particular respirator to a specific person; typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.
flutter strips	Physical indicators used to provide a continuous visual sign that a room is under negative pressure. These simple and inexpensive devices are placed directly in the door and can be useful in identifying a pressure differential problem.
genotype	The DNA pattern of <i>M. tuberculosis</i> used to discriminate among different strains.
health-care-associated	Broader term used instead of “nosocomial.”
heating, ventilating, or air conditioning (HVAC)	Mechanical systems that provide either collectively or individually heating, ventilating, or air conditioning for comfort within or associated with a building.
high efficiency particulate air (HEPA) filter	A filter that is certified to remove >99.97% of particles 0.3 $\mu\text{m}$ in size, including <i>M. tuberculosis</i> -containing droplet nuclei; the filter can be either portable or stationary. Use of HEPA filters in building ventilation systems requires expertise in installation and maintenance.
hypersensitivity	A state in which the body reacts with an exaggerated immune response to a foreign substance. Hypersensitivity reactions are classified as immediate or delayed, types I and IV, respectively. See also delayed-type hypersensitivity.
immunocompromised and immunosuppressed	Describes conditions in which at least part of the immune system is functioning at less than normal capacity. According to certain style experts, “immunocompromised” is the broader term, and “immunosuppressed” is restricted to conditions with iatrogenic causes, including treatments for another condition.
incidence	The number of new events or cases of disease that develop during a specified period.
Index case	The first person with TB disease who is identified in a particular setting. This person might be an indicator of a potential public health problem and is not necessarily the source. See also source case or patient.
induration	The firmness in the skin test reaction; produced by immune-cell infiltration in response to the tuberculin antigen that was introduced into the skin. Induration is measured transversely by palpation, and the result is recorded in millimeters. The measurement is compared with guidelines to determine whether the test result is classified as positive or negative.
infectious period	The period during which a person with TB disease might have transmitted <i>M. tuberculosis</i> organisms to others. For patients with positive AFB sputum smear results, the infectious period begins 3 months before the collection date of the first positive smear result or the symptom onset date (whichever is earlier) and

	ends when the patient is placed into AII or the date of collection for the first of consistently negative smear results. For patients with negative AFB sputum smear results, the infectious period extends from 1 month before the symptom onset date and ends when the patient is placed into AII (whichever was earlier).
interferon- $\delta$ release assays (IGRA)	A type of an ex vivo test that detects cell-mediated immune response to this cytokine. In the United States, QFT-G is a currently available IGRA.
latent TB infection (LTBI)	Infection with <i>M. tuberculosis</i> without symptoms or signs of disease have manifested. See also infection with <i>M. tuberculosis</i> .
manometer	An instrument used to measure pressure differentials (i.e., pressure inside an AII room relative to the corridor of the room).
Mantoux method	A skin test performed by intradermally injecting 0.1 mL of PPD tuberculin solution into the volar or dorsal surface of the forearm. This method is the recommended method for TST.
miliary TB	A serious form of TB disease sometimes referred to as disseminated TB. A dangerous and difficult form to diagnose of rapidly progressing TB disease that extends throughout the body. Uniformly fatal if untreated; in certain instances, it is diagnosed too late to save a life. Certain patients with this condition have normal findings or ordinary infiltrates on the chest radiograph.
mitogen	A substance that stimulates the growth of certain white blood cells. Mitogen is used as a positive control in BAMT tests.
multidrug-resistant tuberculosis	TB disease caused by <i>M. tuberculosis</i> organisms that are resistant to at least INH and (MDR TB) rifampin.
N95 disposable respirator	An air-purifying, filtering-facepiece respirator that is >95% efficient at removing 0.3 $\mu\text{m}$ particles and is not resistant to oil. See also respirator.
negative pressure	The difference in air-pressure between two areas. A room that is under negative pressure has a lower pressure than adjacent areas, which keeps air from flowing out of the room and into adjacent rooms or areas. Also used to describe a non-powered respirator. See also AII and AII room.
nontuberculous mycobacteria (NTM)	Refers to mycobacterium species other than those included as part of <i>M. tuberculosis</i> complex. Although valid from a laboratory perspective, the term can be misleading because certain types of NTM cause disease with pathologic and clinical manifestations similar to TB disease. Another term for NTM is mycobacterium other than tuberculosis (MOTT). NTM are environmental mycobacteria.
nosocomial	Acquired in a hospital. The broader term “health-care-associated” is used in this report.
nucleic acid amplification (NAA)	Laboratory method used to target and amplify a single DNA or RNA sequence usually for detecting and identifying a microorganism. The NAA tests for <i>M.</i>

	<i>tuberculosis</i> complex are sensitive and specific and can accelerate the confirmation of pulmonary TB disease.
polymerase chain reaction (PCR)	A system for in vitro amplification of DNA that can be used for diagnosis of infections.
positive predictive value of a TST	The probability that a person with a positive TST result is actually infected with <i>M. tuberculosis</i> . The positive predictive value is dependent on the prevalence of infection with <i>M. tuberculosis</i> in the population being tested and on the sensitivity and specificity of the test.
potential ongoing transmission	A risk classification for TB screening, including testing for <i>M. tuberculosis</i> infection when evidence of ongoing transmission of <i>M. tuberculosis</i> is apparent in the setting. Testing might need to be performed every 8–10 weeks until lapses in infection controls have been corrected, and no further evidence of ongoing transmission is apparent. Use potential ongoing transmission as a temporary risk classification only. After corrective steps are taken, reclassify the setting as medium risk. Maintaining the classification of medium risk for at least 1 year is recommended.
powered air-purifying respirator	A respirator equipped with a tight-fitting facepiece (rubber facepiece) or loose-fitting (PAPR) facepiece (hood or helmet), breathing tube, air-purifying filter, cartridge or canister, and a fan. Air is drawn through the air-purifying element and pushed through the breathing tube and into the facepiece, hood, or helmet by the fan. Loose-fitting PAPRs (e.g., hoods or helmets) might be useful for persons with facial hair because they do not require a tight seal with the face.
prevalence	The proportion of persons in a population who have a disease at a specific time.
qualitative fit test (QLFT)	A pass-fail fit test to assess the adequacy of respirator fit that relies on the response of the person to the test agent.
quality control (QC)	A function to ensure that project tools and procedures are reviewed and verified according to project standards.
QFT and QFT-G	Types of BAMT that are in vitro cytokine assays that detects cell-mediated immune response (see also DTH) to <i>M. tuberculosis</i> in heparinized whole blood from venipuncture. This test requires only a single patient encounter, and the result can be ready within 1 day. In 2005, In United States, QuantiFERON®-TB was replaced by QuantiFERON®-TB Gold (QFT-G), which has greater specificity because of antigen selection. QFT-G appears to be capable of distinguishing between the sensitization caused by <i>M. tuberculosis</i> infection and that caused by BCG vaccination.
quantitative fit test (QNFT)	An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.
recommended exposure limit (REL)	The occupational exposure limit established by CDC/NIOSH. RELs are intended

	to suggest levels of exposure to which the majority of HCWs can be exposed without experiencing adverse health effects.
reinfection	A second infection that follows from a previous infection by the same causative agent. Frequently used when referring to an episode of TB disease resulting from a subsequent infection with <i>M. tuberculosis</i> and a different genotype.
resistance	The ability of certain strains of mycobacteria, including <i>M. tuberculosis</i> , to grow and multiply in the presence of certain drugs that ordinarily kill or suppress them. Such strains are referred to as drug-resistant strains and cause drug-resistant TB disease. See also multidrug resistant TB.
respirator	A CDC/NIOSH-approved device worn to prevent inhalation of airborne contaminants.
respiratory protection	The third level in the hierarchy of TB infection-control measures after administrative and environmental controls is used because of the risk for exposure.
reversion	A subsequent TST or BAMT result that is substantially smaller than a previous test; reversion has been observed to be more likely when the intervening time between TSTs increases.
screening (TB)	Measures used to identify persons who have TB disease or LTBI. See also symptom screen.
secondary (TB) case	A new case of TB disease that is attributed to recent transmission as part of the scenario under investigation. The period for “recent” is not defined but usually will be briefer than 2 years. Technically, all cases are secondary, in that they originate from other contagious cases.
smear (AFB smear)	A laboratory technique for preparing a specimen so that bacteria can be visualized microscopically. Material from the specimen is spread onto a glass slide and usually dried and stained. Specific smear, stain, and microscopy methods for mycobacteria are designed to optimally detect members of this genus. The slide can be scanned by light or fluorescent high-power microscopy. These methods require ongoing quality assurance for prompt and reliable results. The results for sputum smears usually are reported as numbers of AFB per high-powered microscopy field or as a graded result, from +1 to +4. The quantity of stained organisms predicts infectiousness. See also AFB.
source case or patient	The person or the case that was the original source of infection for secondary cases or contacts. The source case can be, but is not necessarily, the index case.
source case investigation	An investigation to determine the source case could be conducted in at least two circumstances: 1) when a health-care setting detects an unexplained cluster of TST conversions among HCWs or 2) when TB infection or disease is diagnosed in a young child. The purposes of a source case investigation are to ascertain that the source case has been diagnosed and treated, to prevent further <i>M. tuberculosis</i>



	transmission, and to ensure that other contacts of that source case are also evaluated and, if indicated, provided treatment.
source control	A process for preventing or minimizing emission (e.g., aerosolized <i>M. tuberculosis</i> ) at the place of origin. Examples of source-control methods are booths in which a patient coughs and produces sputum, BSCs in laboratories, and local exhaust ventilation.
sputum	Mucus containing secretions coughed up from inside the lungs. Tests of sputum (e.g., smear and culture) can confirm pulmonary TB disease. Sputum is different from saliva or nasal secretions, which are unsatisfactory specimens for detecting TB disease. However, specimens suspected to be inadequate should still be processed because positive culture results can still be obtained and might be the only bacteriologic indication of disease.
sputum induction	A method used to obtain sputum from a patient who is unable to cough up a specimen spontaneously. The patient inhales a saline mist, which stimulates coughing from deep inside the lungs.
supervised TST administration	A procedure in which an expert TST trainer supervises a TST trainee who performs all procedures on the procedural observation checklist for administering TSTs.
supervised TST reading	A procedure in which an expert TST trainer supervises a TST trainee who performs all procedures on the procedural observation checklist for reading TST results.
suspected TB	A tentative diagnosis of TB that will be confirmed or excluded by subsequent testing. Cases should not remain in this category for longer than 3 months.
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).
targeted testing	A strategy to focus testing for infection with <i>M. tuberculosis</i> in persons at high risk for LTBI and for those at high risk for progression to TB disease if infected.
tuberculosis (TB) disease	Condition caused by infection with a member of the <i>M. tuberculosis</i> complex that has progressed to causing clinical (manifesting symptoms or signs) or subclinical (early stage of disease in which signs or symptoms are not present, but other indications of disease activity are present [see below]) illness. The bacteria can attack any part of the body, but disease is most commonly found in the lungs (pulmonary TB). Pulmonary TB disease can be infectious, whereas extrapulmonary disease (occurring at a body site outside the lungs) is not infectious, except in rare circumstances. When the only clinical finding is specific chest radiographic abnormalities, the condition is termed “inactive TB” and can be differentiated from active TB disease, which is accompanied by symptoms or other indications of disease activity (e.g., the ability to culture

	reproducing TB organisms from respiratory secretions or specific chest radiographic finding).
TB cases	A particular episode of clinical TB disease. Refers only to the disease, not to the person with the disease. According to local laws and regulation, TB cases and suspect TB cases must be reported to the local health department.
TB contact	A person who has shared the same air space with a person who has TB disease for a sufficient amount of time to allow possible transmission of <i>M. tuberculosis</i> .
TB exposure incident	A situation in which persons (e.g., HCWs, visitors, and inmates) have been exposed to a person with suspected or confirmed infectious TB disease (or to air containing <i>M. tuberculosis</i> ), without the benefit of effective infection-control measures.
TB infection	See LTBI.
TB infection-control program	A program designed to control transmission of <i>M. tuberculosis</i> through early detection, isolation, and treatment of persons with infectious TB. A hierarchy of control measures are used, including 1) administrative controls to reduce the risk for exposure to persons with infectious TB disease and screening for HCWs for LTBI and TB disease, 2) environmental controls to prevent the spread and reduce the concentration of infectious droplet nuclei in the air, and 3) respiratory protection in areas where the risk for exposure to <i>M. tuberculosis</i> is high (e.g., AII rooms). A TB infection-control plan should include surveillance of HCWs who have unprotected high-risk exposure to TB patients or their environment of care.
TB screening	An administrative control measure in which evaluation for LTBI and TB disease are performed through initial and serial screening of HCWs, as indicated. Evaluation might comprise TST, BAMT, chest radiograph, and symptom screening. See also symptom screen.
TB screening program	A plan that health-care settings should implement to provide information that is critical in caring for HCWs and information and that facilitates detection of <i>M. tuberculosis</i> transmission. The TB screening program comprises four major components: 1) baseline testing for <i>M. tuberculosis</i> infection, 2) serial testing for <i>M. tuberculosis</i> infection, 3) serial screening for signs or symptoms of TB disease, and 4) TB training and education.
TB risk assessment	An initial and ongoing evaluation of the risk for transmission of <i>M. tuberculosis</i> in a particular health-care setting. To perform a risk assessment, the following factors should be considered: the community rate of TB, number of TB patients encountered in the setting, and the speed with which patients with TB disease are suspected, isolated, and evaluated. The TB risk assessment determines the types of administrative and environmental controls and respiratory protection needed

	for a setting.
treatment for LTBI	Treatment that prevents the progression of infection into disease.
tuberculin skin test (TST)	A diagnostic aid for finding <i>M. tuberculosis</i> infection. A small dose of tuberculin is injected just beneath the surface of the skin (in the United States by the Mantoux method), and the area is examined for induration by palpation 48–72 hours after the injection. The indurated margins should be read transverse (perpendicular) to the long axis of the forearm. See also Mantoux method and PPD.
TST conversion	A change in the result of a test for <i>M. tuberculosis</i> infection wherein the condition is interpreted as having progressed from uninfected to infected. An increase of >10 mm in induration during a maximum of 2 years is defined as a TST conversion for the purposes of a contact investigation. A TST conversion is presumptive evidence of new <i>M. tuberculosis</i> infection and poses an increased risk for progression to TB disease. See also conversion.
tubercle bacilli	<i>M. tuberculosis</i> organisms.
tuberculin	A precipitate made from a sterile filtrate of <i>M. tuberculosis</i> culture medium.
two-step TST	Procedure used for the baseline skin testing of persons who will receive serial TSTs (e.g., HCWs and residents or staff of correctional facilities or long-term-care facilities) to reduce the likelihood of mistaking a boosted reaction for a new infection. If an initial TST result is classified as negative, a second step of a two-step TST should be administered 1–3 weeks after the first TST result was read. If the second TST result is positive, it probably represents a boosted reaction, indicating infection most likely occurred in the past and not recently. If the second TST result is also negative, the person is classified as not infected. Two-step skin testing has no place in contact investigations or in other circumstances in which ongoing transmission of <i>M. tuberculosis</i> is suspected.
UVGI lamp	An environmental control measure that includes a lamp that kills or inactivates microorganisms by emitting ultraviolet germicidal irradiation, predominantly at a wavelength of 254 nm (intermediate light waves between visible light and radiographs). UVGI lamps can be used in ceiling or wall fixtures or within air ducts of ventilation systems as an adjunct to other environmental control measures.
variable air volume (VAV)	VAV ventilation systems are designed to vary the quantity of air delivered to a space while maintaining a constant supply air temperature to achieve the desired temperature in the occupied space. Minimum levels are mechanical, and outside air is maintained.

## **XII. References**

1. Guidelines for preventing the transmission of mycobacterium tuberculosis in health-care settings, 2005. (CDC)
2. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 1994 (CDC).
3. TB respiratory protection program, in health-care facilities, Administrators guide.
4. Guidelines for the prevention of tuberculosis in health-care facilities in resource-limited settings (WHO, 1999).
5. Diagnostic standards and classification of tuberculosis in adults and children (ATS 2000).