



Self-Study Modules on Tuberculosis

Infectiousness and Infection Control

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Centers for Disease Control and Prevention

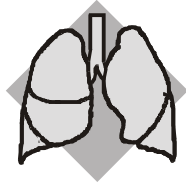
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Infectiousness and Infection Control

CONTENTS

■	Background	1
■	Objectives	1
■	New Terms	2
■	Reading Material	4
□	Infectiousness	4
□	Infection Control	9
■	Summary	42
□	Additional Reading	46
■	Answers to Study Questions	47
■	Answers to Case Studies	52



BACKGROUND

In this module, you will learn about the factors that determine the infectiousness (contagiousness) of a person with TB disease. This will help you and others decide whether a particular patient should be considered infectious. You will also learn about the precautions you should take if you come in contact with patients who are considered infectious to prevent the spread of TB in health care settings and communities. These precautions, or measures, are part of a TB infection-control program that each health care setting should develop to minimize the risk for transmission of Mycobacterium tuberculosis.

OBJECTIVES

After working through this module, you will be able to

1. Describe the factors that determine the infectiousness of a TB patient.
2. Describe the main goals of a TB infection-control program.
3. Describe the three levels of control measures that are the basis of an effective infection-control program.
4. Describe the purpose and the characteristics of a TB airborne infection isolation room.
5. Describe the circumstances when personal respirators should be used.



NEW TERMS

Look for the following new terms in this module and in the glossary.

administrative controls – the first level in the hierarchy of TB infection-control measures; managerial measures that reduce the risk for exposure to persons who have or are suspected to have TB disease

airborne infection isolation (AII) room – formerly called “negative pressure isolation room.” A room with special characteristics to prevent the spread of droplet nuclei expelled by a TB patient, including negative-pressure ventilation

close contact – a person who has shared the same air space in a household or other enclosed environment for a prolonged period of time (days or weeks, not minutes or hours) with a person with suspected or confirmed TB disease

cough-inducing procedures – procedures that make a patient cough, such as sputum induction and bronchoscopy

diagnostic evaluation – an evaluation used to diagnose TB disease; includes a medical history, a chest x-ray, the collection of specimens for bacteriologic examination, and possibly a tuberculin skin test or an interferon-gamma release assay such as the QuantiFERON[®]-TB Gold test

environmental controls – the second level in the hierarchy of TB infection-control measures; engineering systems used to prevent the transmission of TB in health care settings, including ventilation, high-efficiency particulate air (HEPA) filtration, and ultraviolet germicidal irradiation

fit check – see **user check seal**

fit test – a method to evaluate the fit of a respirator on a person

health care setting – a place where health care is delivered; includes inpatient, outpatient settings, TB clinics, settings in which home-based health-care and emergency medical services are provided, and laboratories handling TB clinical samples

HEPA filters (high efficiency particulate air filters) – special filters that can be used in ventilation systems to help remove droplet nuclei from the air

negative pressure – the difference in air-pressure between two areas; 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 nonpowered respirator

negative pressure isolation room – see **airborne infection isolation (AII) room**

personal respirators – special device designed to protect users from inhaling droplet nuclei; used in health care facilities and other settings where TB may be spread

respiratory-protection controls – the third level in the hierarchy of TB infection-control measures; used to minimize the risk for exposure to *M. tuberculosis*

surgical mask – device worn over the nose and mouth of a person with suspected or confirmed infectious TB disease to prevent infectious droplet nuclei from being spread (exhaled) into the air



TB risk assessment – an initial and ongoing evaluation of the risk for transmission of *M. tuberculosis* in a particular health care setting

TB testing – an administrative control measure in which evaluation for latent TB infection (LTBI) and TB disease are performed through initial and serial testing of health care workers

ultraviolet germicidal irradiation – the use of special lamps that give off ultraviolet light, which kills the tubercle bacilli contained in droplet nuclei

user seal check – formerly called “fit check”; procedure performed to check for the proper seal of a respirator each time a respirator is put on

ventilation systems – air systems designed to maintain negative pressure and to exhaust the air properly; designed to minimize the spread of TB in a health care facility



READING MATERIAL

Infectiousness

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Infectiousness is directly related to the number of tubercle bacilli that a TB patient expels into the air.
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TB patients expel more tubercle bacilli if they have a cough that produces a lot of sputum.
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Usually, only people with TB of the lungs (pulmonary), airway, or larynx are infectious.
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.....
Patients who do not cover their cough are more likely to expel tubercle bacilli.
.....

Infectiousness is directly related to the number of tubercle bacilli the TB patient expels into the air. Patients who expel many tubercle bacilli are more infectious than patients who expel few or no bacilli. The number of tubercle bacilli expelled by a TB patient depends on the following factors.

- **Presence of a cough**
TB patients expel more tubercle bacilli if they have a cough that produces a lot of sputum.
- **Cavity in the lung**
Because there are many tubercle bacilli in a cavity, TB patients who have a cavity in the lung may be expelling large amounts of tubercle bacilli if they are coughing.
- **Positive sputum smear result and/or culture**
The presence of acid-fast bacilli on a sputum smear or a positive sputum culture indicates that the patient may be expelling many tubercle bacilli.
- **Site of the disease**
Usually, only people with TB of the lungs (pulmonary), airway, or larynx are infectious. This is because these people may be coughing and expelling tubercle bacilli into the air. People with extrapulmonary TB other than the airway and larynx (no pulmonary TB) generally are not infectious. This is because tubercle bacilli usually cannot be expelled into the air from a non-respiratory extrapulmonary site.
- **Covering mouth and nose when coughing**
Patients who do not cover their mouth when they cough are more likely to expel tubercle bacilli.



.....
 Patients who have not been receiving adequate treatment are much more likely to be infectious than patients who have been receiving adequate treatment.

- **Lack of or inadequate treatment**
 Patients who have NOT been receiving adequate TB treatment are much more likely to be infectious than patients who have been receiving adequate treatment for 2 weeks or longer. Patients who have been receiving adequate treatment usually respond to treatment; in other words, their symptoms improve and eventually go away.
- **Cough-inducing procedures**
 Patients may expel tubercle bacilli if they are undergoing medical procedures that cause them to cough (for example, bronchoscopy or sputum induction).

Table 5.1
Infectiousness of People Known to Have or Suspected of Having TB Disease*

Factors Associated with Infectiousness	Factors Associated with Noninfectiousness
Presence of a cough	No cough
Cavity in the lung	No cavity in the lung
Acid-fast bacilli on sputum smear	No acid-fast bacilli on sputum smear
TB of the lungs, airway, or larynx	Most extrapulmonary (non-respiratory) TB
Patient not covering mouth or nose when coughing	Patient covering mouth or nose when coughing
Not receiving adequate treatment	Receiving adequate treatment for 2 weeks or longer
Undergoing cough-inducing procedures	Not undergoing cough-inducing procedures
Positive sputum cultures	Negative sputum cultures

* Infectiousness depends on a variety of factors. Clinicians should consider all of these factors when determining whether a TB patient should be considered infectious.



.....
Young children with TB disease are much less likely than adults to be infectious.
.....

.....
Infectiousness appears to decline very rapidly after adequate treatment is started, but how quickly it declines varies from patient to patient.
.....

Young children with pulmonary or laryngeal TB disease are much less likely than adults to be infectious. This is because children generally do not produce sputum when they cough. However, it is still possible for children to transmit TB to others if they have characteristics, such as a positive AFB smear or cavity on a chest x-ray, that are associated with infectiousness.

Infectiousness appears to decline very rapidly after adequate treatment is started, but how quickly it declines varies from patient to patient. Some patients may remain infectious for weeks or even months. Patients with drug-resistant TB may not respond to the initial drug regimen; they will probably remain infectious until they receive an adequate treatment regimen.

Patients can be considered noninfectious when they meet **all** of the following criteria:

- **They have been receiving adequate treatment for 2 weeks or longer;**
- **Their symptoms have improved (for example, they are coughing less and they no longer have a fever); and**
- **They have THREE consecutive negative sputum smears from sputum collected in 8-24 hour intervals (at least one being an early morning specimen).**



Case Study 5.1

For each of the following situations, decide whether the patient should be considered infectious or noninfectious, and explain why.

- **Two weeks ago, Mr. Lopez had a sputum smear that was positive; since then no sputum specimens have been tested. Mr. Lopez started self-administered TB treatment 7 days ago. He still has a cough.**

Ms. Nguyen, a patient with pulmonary TB, has been receiving DOT treatment for 6 weeks and no longer has symptoms of TB. She has had three sputum smears. The first one was positive, but the last two were negative.

Mr. Martin started DOT treatment for pulmonary TB in April. His symptoms went away and his sputum smears were negative in May. However the outreach worker was unable to locate him on June 5th and has not been able to contact him since that time. Mr. Martin returned to the TB clinic today, August 2, and is coughing.

Answers to case study questions are on pages 52-53.



Infection Control

.....
About 30-40% of close contacts of someone who has infectious TB disease become infected with *M. tuberculosis*.
.....

TB is a communicable disease. On average, 30-40% of **close contacts** of someone who has infectious TB disease become infected with *M. tuberculosis*. However, TB patients vary in their infectiousness; some infect most or all of their close contacts, whereas others infect few or none of their contacts. Close contacts are defined as persons who share the same air space in a household or other enclosed environment for a prolonged period of time (days or weeks, not minutes or hours) with a person with suspected or confirmed TB disease.

.....
TB is most likely to be transmitted when health care workers and patients come in contact with persons who have unsuspected TB disease, who are not receiving adequate treatment, and who have not been isolated from others.
.....

TB can be transmitted in just about any setting. It can be spread in places such as homes or worksites. However, TB is most likely to be transmitted in health care settings when health care workers and patients come in contact with persons who have unsuspected TB disease, who are not receiving adequate treatment, and who have not been isolated from others. These **health care settings** include clinics, hospitals, and settings in which home-based health care and emergency medical services are provided. Several outbreaks of TB in health care settings, including outbreaks of multidrug-resistant TB (MDR TB) and extensively drug-resistant TB (XDR TB) have heightened concerns about the spread of TB in these settings. The exposure to *M. tuberculosis* to persons living with HIV is of particular concern; these persons are at a very high risk of developing TB disease if infected with *M. tuberculosis*. To prevent the spread of TB, all health care settings should implement infection-control measures. To ensure that infection-control measures are properly implemented, each health care setting should develop an **infection-control program**. Other non-traditional facility-based settings that should develop a TB infection control program include congregate settings such as nursing homes, correctional facilities, homeless shelters, drug treatment centers, and other places that serve clients who are at risk for being infected with *M. tuberculosis*.



Role of the Health Department in Infection Control

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The health department should work closely with health care facilities to help them report confirmed or suspected TB cases as quickly as possible.
.....

Health department TB control programs should not only ensure that each of their clinics develops a TB infection-control program, they should also be able to provide consultation about TB infection control to other health care and congregate settings in their communities.

Specifically, health departments should be able to assist health care settings with

- **Reporting confirmed or suspected TB cases as quickly as possible**
- **Conducting contact investigations**
- **Ensuring there is a plan for TB patients to receive follow-up care after they are discharged**
- **Testing, surveillance, outbreak investigations, and other aspects of a TB infection-control program**

The health department should work closely with health care facilities to help them report confirmed or suspected TB cases as quickly as possible. When the health department receives a report of a TB case or suspected case, it should begin a contact investigation.

Moreover, health departments and health care settings should work together to make sure there is a plan for TB patients to receive follow-up care after they are discharged. Health departments should also ensure that health care workers who visit TB patients at homes or other settings follow proper precautions to protect themselves from exposure to *M. tuberculosis*. The health department should also be able to help facilities with a TB risk assessment, testing, surveillance, outbreak investigations, and other aspects of a TB infection-control program.



.....
 The main goals of an infection-control program are to detect TB disease early and to promptly isolate and treat people who have TB disease.

TB Infection-Control Program Fundamentals

The main goals of a TB infection-control program are to ensure early and prompt

- **Detection of TB disease**
- **Isolation of people who have or are suspected of having TB disease (airborne precautions)**
- **Treatment of people who have or are suspected of having TB disease**

Detection of TB Disease

In areas where TB is common, staff of health care facilities should be alert for TB. Staff at public health and community clinics, should be especially aware of TB signs and symptoms, as patients who are at high risk for TB often receive care at these settings prior to diagnosis or treatment. Personnel who admit patients to facilities should be trained to ask appropriate questions to help detect patients who have signs or symptoms of TB. Staff at homeless shelters, nursing homes, and correctional facilities should also be aware of TB signs and symptoms to detect TB among their clients or workers.

To detect persons who have TB disease as soon as possible, clinicians and other health care workers should suspect TB disease in anyone who has any of these symptoms:

- **Persistent cough (3 weeks or longer)**
- **Bloody sputum**
- **Weight loss or loss of appetite**
- **Fever**
- **Night sweats**

TB suspects/patients should be given a diagnostic evaluation as soon as possible (for more information on TB diagnosis, please refer to *Module 3, Targeted Testing and the Diagnosis of Latent Tuberculosis Infection and TB Disease*). TB suspects/patients should be asked to cover their nose and mouth when coughing or sneezing, even when in an area away from others. These patients/suspects should be given a surgical mask (Figure 5.3) and instructed to keep it on, or they should be supplied with tissues to



cover their cough or sneeze.

.....
Airborne precautions should
be taken for any person who
has signs or symptoms of TB
disease.
.....

Airborne Precautions

Airborne precautions should be taken for any persons who have signs or symptoms of TB disease. This means that persons who have or are suspected of having TB should be placed in an area away from other patients. If a facility has an **airborne infection isolation (AII) room** suspects/patients should preferably be placed there (for more information on AII rooms, see the Environmental Controls Section of this Module, p. 22). If a facility does not have AII rooms, suspects/patients should be placed in a room that has been designated for isolation of persons with suspected or known infectious TB. Patients should be instructed to observe strict respiratory hygiene and cough etiquette procedures (covering their cough or sneeze).

Clinics should take special care to separate others, especially patients with suspected or confirmed infectious TB from those with HIV infection and other immunocompromising conditions that increase the likelihood of development of TB disease if infected with *M. tuberculosis*. Immunosuppressed patients with suspected or confirmed infectious TB disease need to be physically separated from others to protect both the patient and others they may infect. One strategy to avoid exposing HIV-infected and other immunocompromised persons to *M. tuberculosis* at clinics is to designate certain times of the day to schedule appointments for patients with infectious TB disease. Another strategy is to treat patients with infectious TB in areas at the facility in which immunocompromised persons are not treated.

Health care settings, such as TB clinics, in which patients with suspected or confirmed TB disease are expected to be encountered, should also implement a respiratory protection program. In these settings health care workers who enter AII rooms, visit areas in which persons with suspected or confirmed TB disease are located, or transport patients with suspected or confirmed TB disease in vehicles should be included in the respiratory protection program. When persons with suspected or confirmed infectious TB disease are in the TB clinic and not in an AII



room, they should wear a surgical mask, if possible (for more information see, Respiratory Protections Controls Section, page 26).

For settings other than clinics, patients with suspected TB should be promptly referred so that they can receive a medical evaluation. These patients should not stay in the setting any longer than the time it takes to arrange a referral or transfer to an AII room. The suspected infectious TB patient should be given a surgical mask, if possible. The patient should also be instructed to follow proper cough etiquette procedures.

All cough-inducing and aerosol-generating procedures should be performed using environmental controls (e.g., in a booth or an AII room). Patients should be left in the booth or AII room until coughing subsides. Another patient or health care worker should not be allowed to enter the booth or the AII room until enough time has passed for adequate removal of *M. tuberculosis*-contaminated air (for more information, see Environmental Controls, page 22).

Treatment

Patients who are diagnosed with TB should start appropriate treatment immediately, preferably by directly observed therapy (DOT) to ensure adherence (for more information on TB treatment, please refer to *Module 4, Treatment of Latent TB Infection and TB Disease*).

Developing an Infection-Control Program

A health care or congregate setting’s TB infection-control program should be based on a three-level hierarchy of control measures.

The three-levels of control include:

- **Administrative controls**
- **Environmental controls**
- **Respiratory-protection controls**

Administrative controls, the first and most important level of the infection-control program, are management

.....
 Administrative controls are the first and most important level of a TB infection-control program.



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Environmental controls aim to reduce level of the concentration on infections *M. tuberculosis* droplet nuclei in the air.
.....

.....
Respiratory-protection controls are used in settings where persons may be exposed to airborne *M. tuberculosis*.
.....

measures that are intended to reduce the risk or exposure to persons with infectious TB. The second level of the hierarchy, **environmental controls**, aims to reduce the concentration of infectious *M. tuberculosis* droplet nuclei in the air.

These two measures should also reduce, but not eliminate, the risk of TB in areas where exposure can still occur (for example, AII rooms and rooms where cough-inducing or aerosol-generating procedures are performed). Because persons entering these areas may be exposed to airborne *M. tuberculosis*, the third level of the infection-control program is the use of **respiratory-protection controls**. Respiratory-protection control procedures also need to be in place for persons in other settings in which administrative and environmental controls may not protect them from inhaling infectious droplet nuclei. These persons may include those who transport patients with suspected or confirmed infectious TB disease in ambulances, or persons who provide home-based health care to TB patients.

The specifics of each TB infection-control program for health care or congregate settings may differ depending on whether a setting will provide health care or will transfer patients with suspected or confirmed TB disease. The specifics of each TB infection-control program will also differ based on the setting's TB risk assessment (for more information, see TB Risk Assessment section, page 32).



Study Questions 5.4 – 5.6

5.4 Under what circumstances is TB most likely to be transmitted in health care facilities?

5.5 How can the health department help health care facilities in preventing the spread of TB?

5.6 What are the main goals of a TB infection-control program?

Answers to study questions are on pages 47-51.



Study Questions 5.7 – 5.9

- 5.7 What would make a health care worker suspect that a patient has TB disease?
- 5.8 What should be done when a health care worker suspects that a patient has TB disease?
- 5.9 What are the three levels of control that form the basis of a TB infection-control program?

Answers to study questions are on pages 47-51.



Case Study 5.2

You are checking patients into the TB clinic. An elderly man comes to the desk and says he was told to come and get checked because one of his friends has TB. You notice that he looks sick and is coughing frequently. The waiting room is full of patients, and you know it will probably be more than an hour before the physician can see him.

- **What should you do?**

Answers to case study questions are on pages 52-53.



Administrative Controls

The first and most important level of a TB infection-control program is the use of administrative measures to reduce the risk of exposure to persons who might have TB disease.

Administrative controls consist of the following activities:

.....
Each health care setting should assign someone the responsibility for implementing the TB infection-control program.
.....

■ **Assigning someone the responsibility for TB infection control in the setting**

At each health care setting, a person or group with expertise in TB and infection control should be assigned supervisory responsibility for implementing the TB infection-control program. The supervisor should be in charge of conducting a **TB risk assessment** and ensuring appropriate training and education of health care workers.

.....
All settings should conduct an initial and ongoing TB risk assessments to monitor and evaluate the quality of TB infection control.
.....

■ **Conducting a TB Risk Assessment**

A TB risk assessment consists of evaluating the risk of TB transmission in the health care setting. A TB risk assessment examines a number of factors, including:

- Community rate of TB disease
- Number of patients with TB disease encountered in the setting during the last 5 years
- Timeliness of the detection, isolation, and evaluation of patients with suspected or confirmed TB
- Evidence of transmission of *M. tuberculosis* in the setting
- Environmental controls already in place or needed in the setting

All health care settings should conduct initial and ongoing TB risk assessments to monitor and evaluate the quality of TB infection control. For more information on assessing the risk of TB transmission in your health care setting, please refer to the TB Risk Assessment and Testing Program section of this module, page 32.



.....
 Each health care setting
 should develop and
 implement a written TB
 infection control plan.

- **Developing and implementing a written TB-infection control plan**
 Each health care setting should develop and implement a written TB infection control plan. The plan should specify policies and work practices to ensure prompt detection, isolation, and treatment or transfer of persons who have suspected or confirmed TB disease.
- **Ensuring the availability of prompt laboratory processing, testing, and reporting of results**
 In hospital and clinic health care settings, workers should have access to a laboratory that will process, test, and report results back to them and the infection-control team in a prompt manner. This will help determine if patients are still infectious and if they need to remain in an AII room.
- **Implementing effective work practices for managing patients who may have TB**
 The primary TB risk to health care workers is when they come in contact with patients who have undiagnosed or unsuspected TB disease. Once a patient with TB disease is identified or suspected, the appropriate measures should be taken to decrease the risk of TB transmission to other patients and health care workers.
- **Ensuring proper cleaning and sterilization or disinfection of equipment that might be contaminated**
 Medical instruments and equipment used on patients who have TB disease are usually not involved in the transmission of TB. However, there have been some cases where the transmission of TB has been linked to bronchoscopes that were contaminated with *M. tuberculosis*. Equipment should be cleaned, disinfected, or sterilized to decrease the risk for TB transmission.



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All health care workers should be educated about basic TB concepts, infection control, and the importance TB testing programs.
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Health care workers who may be exposed to TB should be included in a TB testing and prevention program.
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Each health care setting should determine if and how often serial testing is offered depending upon the risk of TB transmission in their setting
.....

■ **Educating, training, and counseling health care workers about TB**

Training and education for health care workers is an important part of administrative controls. All health care workers should be educated about the basic concepts of TB transmission and pathogenesis, including information on the difference between latent TB infection and active TB disease, infection control practices, the signs and symptoms of TB, environmental controls, personal respirator training, and the importance of participating in the employee **TB testing** program. Health care worker training and education can help ensure that TB infection-control measures are properly followed.

■ **Testing and evaluating workers who are at risk for TB or may be exposed to TB**

TB testing programs can protect both workers and patients. Testing can help to prevent the chance of future TB transmission by identifying gaps in infection control, as well as the prompt treatment of health care workers who have TB disease or latent TB infection. Baseline tuberculin skin testing (TST) or testing with an interferon-gamma release assay (IGRA) such as then QuantiFERON[®]-Gold TB (QFT-G) test is recommended for all health care workers who may have come in contact with persons with TB. Each setting should determine if and how often serial testing is offered depending upon the risk of TB transmission in their setting. Any worker who develops symptoms of TB disease or whose TST or QFT-G result converts to positive should be evaluated immediately. For more information on assessing the risk of TB transmission in your health care setting and determining the frequency of TB testing, please refer to the TB Risk Assessment and Testing Program section of this module, page 32).



.....
Use posters and signs to
remind patients of proper
cough etiquette and
respiratory hygiene
.....

.....
State and local TB should
communicate with high risk
health care settings
.....

- **Using posters and signs to remind patients of proper cough etiquette and respiratory hygiene**
Posters and signs reminding patients of the importance of covering their nose and mouth when coughing or sneezing should be placed in highly visible areas.

- **Coordinating efforts between local health department and high risk health care and congregate settings**
State or local health department TB control programs and high risk health care and congregate settings should establish regular communication. The TB control program can help with the planning and implementation of TB control activities in these settings. TB control programs should also work together with health care and congregate settings when conducting contact investigations for patients or health care workers who have TB disease.



.....
Environmental control consists of technologies that are designed to remove or inactivate airborne *M. tuberculosis*.
.....

Environmental Controls

The second level of an infection-control program is the use of environmental controls. Environmental controls consist of engineering technologies that are designed to prevent the spread and reduce the concentration of infectious TB droplet nuclei in the air. The technologies include

- **Ventilation technologies**
 - **Natural ventilation**
 - **Mechanical ventilation**
- **High efficiency particulate air filtration (HEPA)**
- **Ultraviolet germicidal irradiation (UVGI)**

The specifics of the environmental controls will differ for each health care setting. Health care and congregate settings should seek the advice of experts for designing, implementing, and maintaining an effective ventilation system and using other environmental technologies for infection control purposes. For additional and more detailed information on environmental technologies, please refer to the CDC's *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Setting, 2005* and the Francis J. Curry's *Tuberculosis Infection Control: A Practical Manual for Preventing TB*.

Ventilation Technologies

Ventilation is the movement of air in a building and the replacement of air in a building with air from outside. When fresh air enters a room, it dilutes the concentration of particles in room air, such as droplet nuclei containing *M. tuberculosis*. There are two general types of ventilation:

- **Natural Ventilation**
- **Mechanical Ventilation**

Natural ventilation relies on open doors and windows to bring in air from the outside. Natural ventilation can be useful for non-traditional facility-based and congregate



.....
 When using natural ventilation, facility staff should sit near fresh air source and clients should sit near exhaust location.

settings that do not have a central ventilation system. In these settings, waiting rooms, shelter dormitories, or other rooms in which people congregate should have an operable window, door, or skylight that is kept open as often as possible. Fans can be used to help distribute the air. When using natural ventilation, facility staff should be aware of the direction of airflow. If the air direction is known, staff should sit near the fresh air source and clients should sit near the exhaust location. This can help protect staff from *M. tuberculosis* expelled by unidentified TB patients.

Mechanical ventilation refers to the use of technological equipment to circulate and move air in a building. Mechanical ventilation technologies should be used by hospitals, TB clinics, and other health care and congregate settings in which it is expected to see a confirmed or suspected TB patient. Mechanical ventilation can consist of two types of technologies

- **Local Exhaust Ventilation**
- **General Ventilation**

Local Exhaust Ventilation

Local exhaust ventilation is used to control the source of infection by stopping airborne contaminants before they spread into the general environment. Local exhaust ventilation, which includes the use of external hoods, booths, and tents, should be used for cough-inducing and aerosol-generating procedures. If local exhaust ventilation cannot be used, cough-inducing and aerosol-generating procedures should be performed preferably in an **airborne infection isolation room (AII)**. If an AII room is not available, the procedures should be performed outdoors or somewhere away from people, windows, and air intakes.

General Ventilation

General ventilation systems maintain air quality in health care settings by the

- Dilution of contaminated air
- Removal of contaminated air
- Control of airflow patterns in patient/procedure

.....
 Cough-inducing procedures should be done in AII rooms or sputum induction booths.



room or setting (for example, negative pressure in AII rooms)

Air **dilution** occurs when an uncontaminated air supply mixes with contaminated air in a room. The air is then moved from the room, outside, away from people, air intakes, or windows, by the exhaust system (**removal**). This process reduces the concentration of TB droplet nuclei in the room.

In TB clinics, hospitals, and other inpatient settings, patients known to have TB disease or suspected of having TB disease should be placed in a TB airborne infection isolation (AII) room right away. TB AII rooms are designed to prevent the spread of droplet nuclei expelled by a TB patient. Health care facilities that provide care for patients with suspected or confirmed infectious TB disease should have at least one AII room. Medical facilities in correctional settings should also have at least one AII room. The need for additional AII rooms should be based on the TB risk assessment for the setting.

.....
Patients known to have TB disease or suspected of having TB disease should be placed in TB AII room right away.
.....

One characteristic of TB AII rooms is that they are at **negative pressure** relative to other parts of the facility. Negative pressure allows the uncontaminated air to flow **from the corridors into the AII room**. The air from the AII room cannot escape to other parts of the health care setting. Air from the AII room can be exhausted directly to the outdoors, where any infectious droplet nuclei will be diluted in the outdoor air and killed by the sunlight. Alternatively, the air can be passed through a special filter that removes all of the droplet nuclei before the air is returned to the general circulation (see HEPA filters, below). The door must be kept closed in order to maintain negative pressure, and the room must be checked periodically to make sure that it remains at negative pressure.

High Efficiency Particulate Air (HEPA) filters
HEPA filters are special filters that can be used in ventilation systems to help remove droplet nuclei from the air. HEPA filters must be used when releasing air from local exhaust ventilation booths into surrounding areas and when releasing air from an AII room to the general

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HEPA filters can be used in ventilation systems to help remove droplet nuclei from the air.
.....



ventilation system.

Ultraviolet Germicidal Irradiation (UVGI)

UVGI, is an air-cleaning technology that consists of special lamps that give off ultraviolet light. The lamps are used to kill the tubercle bacilli contained in droplet nuclei. However, exposure to ultraviolet light can be harmful to the skin and eyes of humans, so the lamps must be installed in the upper part of rooms or corridors or placed in exhaust ducts. HEPA filters and UVGI should be used in conjunction with other infection control measures.



Respiratory-Protection Controls

The third level of infection-control is the use of respiratory protection equipment. Respiratory-protection controls include

- Implementing a respiratory-protection program
- Training health care workers on respiratory-protection
- Educating patients on respiratory hygiene and the importance of covering their cough

All health care settings that use respiratory-protection controls are required by the Occupational Safety and Health Administration (OSHA) to develop, implement, and maintain a respiratory-protection program.

Respiratory-protection controls reduce the risk of TB transmission in settings where administrative and environmental controls may not fully protect persons against droplet nuclei.

In these settings, personal respirator protection should be used by all persons, including health care workers and visitors. These settings include

- TB AII rooms
- Rooms where cough-inducing or aerosol generating procedures are done
- Ambulances and other vehicles transporting infectious TB patients
- The homes of infectious TB patients

.....
 Health care workers should use personal respirators in TB AII rooms, rooms where cough-inducing procedures are done, ambulances transporting infectious TB patients, and homes of infectious TB patients.

Health care workers should use **personal respirators**, or special masks designed to filter out droplet nuclei, in these settings (Figures 5.1, 5.2, and 5.3). Health care workers should be taught how and when to use personal respirators.

Laboratorians who conduct aerosol-producing procedures may require respiratory protection. The decision to use respiratory protection in this setting should be made on an



individual basis, depending upon ventilation and the lab procedure.

Selection and Fit Testing of Respirators

Personal respirators that can be used to protect against *M. tuberculosis* include

- Nonpowered respirators with N95, N99, N100, R95, R99, R100, P95, P99, and P100 filters (including disposable respirators); and
- Powered air-purifying respirators (PAPRs) with high-efficiency filters.

When selecting respirators for use in a health care setting, the most important factor to consider is whether or not the respirator can fit the varying facial sizes and characteristics of health care workers. A **fit test** is a method used to determine which respirator fits the user. A **user seal check** is a procedure done each time a respirator is put on to ensure that the respirator is properly sealed.

Respirators and Surgical Masks

It is very important to understand the difference between a respirator and a surgical mask.

Respirators are designed to protect health care workers and other individuals from breathing in (inhaling) droplet nuclei. This can protect these individuals from becoming infected with *M. tuberculosis* when in contact with a person with infectious TB.

Surgical masks (Figure 5.3) are designed to stop droplet nuclei from being spread (exhaled) into the air by the person wearing them when they breathe, talk, cough, or sneeze. Persons who are suspected or confirmed of having infectious TB may be given a surgical mask to wear to prevent them from expelling infectious droplet nuclei.



Figure 5.1 The personal respirators in this photograph are specially designed to filter out droplet nuclei.



Figure 5.2 Health care worker wearing a personal respirator.



Figure 5.3 Patient wearing a surgical mask. This mask is designed to stop droplet nuclei from being spread (exhaled) by the patient.



Table 5.2
TB Infection-Control Program: Level of Controls

Administrative Controls
<ul style="list-style-type: none"> • Assign responsibility for TB infection control • Conduct TB risk assessment • Develop and institute a written TB infection-control plan • Ensure the timely availability of recommended laboratory processing, testing, and reporting of results • Implement effective work practices for the management of patients with suspected or confirmed TB disease • Ensure proper cleaning and sterilization or disinfection of potentially contaminated equipment • Train and educate health care workers • Test and evaluate health care workers for TB infection and disease • Apply epidemiologic-based prevention principles • Use posters and signs demonstrating and advising respiratory hygiene and cough etiquette • Coordinate efforts with the local or state health department.
Environmental Controls
<ul style="list-style-type: none"> • Reduce concentration of infectious droplet nuclei through following technologies <ul style="list-style-type: none"> ○ Ventilation technologies, including <ul style="list-style-type: none"> ▪ Natural ventilation ▪ Mechanical ventilation ○ High efficiency particulate air filtration (HEPA) ○ Ultraviolet germicidal irradiation (UVGI)
Respiratory-Protection Controls
<ul style="list-style-type: none"> • Implement a respiratory protection program • Train health care workers on respiratory protection • Educate patients on respiratory hygiene and the importance of covering their cough



Study Questions 5.10 -- 5.12

5.10 List five administrative control measures that should be taken in health care settings to reduce the risk of exposure to persons who may have TB disease.

5.11 Where should sputum induction, bronchoscopy, or other cough-inducing procedures be done?

5.12 What is a TB airborne infection isolation (AII) room? What are the important characteristics of an AII room?

Answers to study questions are on pages 47-51.



Study Questions 5.13 -- 5.15

5.13 How do ventilation systems help prevent the spread of TB?

5.14 Give four examples of settings where personal respirators should be used.

5.15 What is the difference in use between a respirator and a surgical mask?

Answers to study questions are on pages 47-51.



TB Risk Assessment and Testing Program

.....
All residential facilities where patients with TB receive care should establish and follow an infection-control program.
.....

TB Risk Assessment

Every health care and congregate setting should conduct initial and ongoing evaluations of the risk for transmission of *M. tuberculosis*. The TB risk assessment determines the types of administrative, environmental, and respiratory-protection controls needed for a setting. It also serves as an ongoing monitoring and evaluation tool of the infection-control program. The TB risk assessment examines a number of factors, including:

- Number of patients with TB disease in the setting
- Promptness of the detection, isolation, and evaluation of patients with suspected or confirmed TB
- Evidence of transmission of *M. tuberculosis* in the setting
- Community rate of TB disease

For more detailed information on how to conduct a TB risk assessment, please refer to the CDC *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Settings, 2005*.

Risk Classification

The risk level, or risk classification, will vary from setting to setting. There are three TB risk classifications

- Low risk
- Medium risk
- Potential ongoing transmission

The ***low risk classification*** should be used for settings in which persons with TB disease are not expected to be encountered. Exposure to *M. tuberculosis* in these settings is unlikely.



The **medium risk classification** should be used for settings in which the risk assessment has determined that health care workers will possibly be exposed to persons with TB disease. Medium risk classification can also be used for settings in which health care workers will be exposed to clinical specimens that may contain *M. tuberculosis*.

The **potential ongoing transmission classification** should be temporarily assigned to any setting where there is evidence of person-to-person transmission of *M. tuberculosis* in the past year.

TB Testing Program

Conducting a TB risk assessment helps the health care and congregate setting determine the need for a TB testing program and the frequency of the testing.

For health care settings that are classified as **low risk**, all health care workers should receive baseline TB testing when they are hired. A two-step TST or a single-step interferon-gamma release assay (IGRA), such as the QFT-G, can be used for the testing (for more information on LTBI diagnosis, please refer to *Module 3, Targeted Testing and the Diagnosis of Latent Tuberculosis Infection and Tuberculosis Disease*). After baseline testing for TB infection, there is no need for additional TB testing for the health care workers unless a situation has occurred where they have been exposed to *M. tuberculosis*. Health care workers with a positive baseline test result for TB infection or documentation of treatment for LTBI or TB disease should receive a chest radiograph (chest x-ray) to ensure that they do not have TB disease. Repeat chest x-rays are not needed unless the health care worker has signs and symptoms of TB disease.

For health care settings that are classified as **medium risk**, all health care workers should receive baseline TB testing when they are hired. A two-step TST or a single-step QFT-G can be used for the testing. After baseline testing for TB infection, health care workers should receive TB testing **annually**. Health care workers with a positive



baseline or newly positive test result for TB infection or documentation of treatment for LTBI or TB disease should receive a chest x-ray to ensure that they do not have TB disease. Since these health care workers will always test positive on TST or QFT-G, they should not participate in serial testing; instead, they should receive an annual symptom screen. These health care workers should also be educated about the symptoms of TB disease and they should be instructed to report any such symptoms to the occupational health unit. Repeat chest x-rays are not needed unless the health care worker has signs and symptoms of TB disease.

For health care settings that are classified as *potential ongoing transmission*, health care workers may need to be tested for TB infection every 8-10 weeks. This testing should continue until gaps in infection control have been addressed and there is no evidence of ongoing *M. tuberculosis* transmission. Once it has been determined there is no ongoing transmission, the health care setting can be reclassified as a medium risk.

Table 5.3
TB Risk Classification and TB Testing Frequency for Health Care Settings

TB Risk Classification	Frequency for TB Testing
■ Low Risk	<ul style="list-style-type: none">■ Conduct baseline test when health care worker is hired■ No further testing needed unless exposure occurs
■ Medium Risk	<ul style="list-style-type: none">■ Conduct baseline test when health care worker is hired■ Repeat test annually
■ Potential Ongoing Transmission	<ul style="list-style-type: none">■ Conduct baseline test when health care worker is hired■ Repeat test every 8-10 weeks until there is no evidence of ongoing <i>M. tuberculosis</i> transmission in the setting



.....
 All nontraditional facility-based setting where patients with TB receive care should establish and follow an infection-control program.

Special Considerations for Infection Control in Nontraditional Facility-Based Settings

All nontraditional facility-based settings where patients with TB receive care should establish and follow an infection-control program. This includes congregate settings such as nursing homes, correctional facilities, homeless shelters, drug treatment centers, and other places. As in other health care settings, the main goal of the infection-control program should be to detect TB disease early and arrange for the isolation and treatment of patients suspected of having TB. Local health departments and congregate settings should collaborate to provide training and education to clients and employees about TB, as well as conducting contact investigations when necessary. Other nontraditional facility-based settings that should establish an infection-control program include emergency medical services, home-based health care, and outreach settings. For more detailed information on developing an infection control plan for these settings, please refer to CDC’s *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Setting, 2005* and the Francis J. Curry’s *Tuberculosis Infection Control: A Practical Manual for Preventing TB*.

.....
 Medical settings in correctional facilities should be classified as medium risk given the possibility that staff will be exposed to persons with TB disease.

Medical Settings in Correctional Facilities

TB is also a major health concern in correctional facilities. All correctional facilities should have a written infection-control plan for both employees and inmates. Medical settings in correctional facilities should be classified as at least medium risk based on the possibility of exposure to persons with TB disease. Thus, all correctional staff should be tested for TB annually. Furthermore, a respiratory-protection program should be implemented with at least one AII room should be available in the correctional facility. Inmates with suspected or confirmed infectious TB disease who must be transported outside an AII room should wear a surgical mask during transport.

Correctional facilities should maintain a tracking system for inmate TB testing and treatment and establish a mechanism for sharing this information with state and local health departments and other correctional facilities.



Confidentiality of inmate information should be ensured during testing for signs and symptoms of TB.

Homeless Shelters

TB is more common in the homeless population than in the general population. Because persons who visit homeless shelters frequently share exposure and risk characteristics of TB patients who are treated in outpatient clinics, homeless shelters with clinics should observe the same TB infection-control measures as outpatient clinics. Several factors in the shelters' environment can influence the likelihood of TB transmission. Factors include how crowded the shelter is, and the ventilation system of the shelter. For more information on TB and shelters, refer to the CDC's *Prevention and Control of Tuberculosis Among Homeless Persons*.

.....
Homeless shelters with clinics should observe the same TB infection-control measures as outpatient clinics.
.....

Emergency Medical Services

Although the overall risk of TB transmission is low, there is documented transmission of *M. tuberculosis* in emergency medical services (EMS) occupational settings. Thus, EMS workers should be included in a comprehensive testing program for *M. tuberculosis* infection as indicated by the risk classification for their setting. Persons with suspected or confirmed infectious TB who are transported in an ambulance should wear a surgical mask, if possible. The drivers, health care workers, and other staff who are transporting the patient should consider wearing an N95 respirator.

.....
If transporting a patient with suspected or confirmed infectious TB, the ambulance should allow for the maximum amount of outdoor air to be circulated in the vehicle.
.....

The ambulance ventilation system should be operated in the nonrecirculating mode with the maximum amount of outdoor air provided. If the vehicle has a rear exhaust fan, it should be used during transport. If the vehicle is equipped with HEPA filters they should be used. 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 nonrecirculating.

Long Term-Care Facilities

Long term-care facilities (LTCFs) include hospices and nursing homes. Infection with *M. tuberculosis* poses a health risk to patients, health care workers, visitors, and



volunteers. New employees and residents to these settings should receive a symptom screen and possibly a test for *M. tuberculosis* infection.

LTCFs must have adequate administrative and environmental controls, including airborne precaution capabilities and respiratory-protection program if they accept patients with suspected or confirmed infectious TB.

Patients with suspected or confirmed infectious TB disease should not stay in the LTCF unless adequate administrative and environmental controls are in place. Persons with TB disease who are determined to be noninfectious can remain in the LTCF, and do not need to be in an AII room.



Infection Control in the Home

Patients who are suspected or confirmed for having TB disease are frequently sent home after starting treatment, even though they may still be infectious. Patients with TB disease can be sent home even if they do not have three negative sputum smears, if the following criteria are met:

- A follow-up plan has been made with the local TB program;
- The patient is on standard TB treatment and directly observed therapy (DOT) has been arranged;
- No infants or children less than 4 years of age or persons with immunocompromising conditions are present in the household;
- All household members, who are not immunocompromised, have been previously exposed to the person with TB; and
- The patient is willing to not travel outside his/her home until he/she has negative sputum smear results.

.....
 People with TB disease are most likely to transmit TB to members of their household before TB has been diagnosed and treatment has started.

.....
 Patients with TB should be instructed to cover their mouth and nose with a tissue when coughing or sneezing.

If all of the above criteria are met, patients with TB disease are allowed to go back home. Additionally they are more likely to have already transmitted TB to members of their household **before** their TB was diagnosed and treatment was started. However, TB patients and members of their household should still take steps to prevent the spread of TB in their home. For example, patients with TB should be instructed to cover their mouth and nose with a tissue when coughing or sneezing. Infectious TB patients should sleep alone, not in a room with other household members. Furthermore, TB patients should be advised to not have visitors until they are non-infectious.

Patients with infectious TB should not be allowed to return home where they may expose a person who is at high risk for progressing to TB disease if infected (for example, persons living with HIV, or infants and children younger than age 4).



Health care workers in home-based health care or outreach settings should be trained on detecting the signs and symptoms of TB disease. Training should include the role of the health care worker in educating patients about the importance of reporting symptoms or signs. Health care workers should also educate patients and other household members about the importance of taking medications as prescribed.

Health care workers should not perform cough-inducing or aerosol-generating procedures on patients with suspected or confirmed infectious TB disease inside a patient's home. Sputum collection should be performed outdoors, away from other persons, windows, or ventilation intakes.

Health care workers who visit TB patients at their homes should take these precautions to protect themselves from exposure to *M. tuberculosis*:

.....
Health care workers who visit patients at home should take precautions to protect themselves from the spread of TB.
.....

- Instruct patients to cover their mouth and nose with a tissue when coughing or sneezing;
- Wear a personal respirator when visiting the home of an infectious patient with TB or when transporting an infectious patient with TB in a vehicle;
- When it is necessary to collect a sputum specimen in the home, collect the specimen in a well-ventilated area, away from other household members; if possible, the specimen should be collected outdoors; and
- Participate in a TB testing and prevention program.



Study Questions 5.16 – 5.18

- 5.16 What are the 3 different TB risk classifications that can be assigned to health care settings?
- 5.17 Depending on risk classification, how often should health care settings test their workers for TB?
- 5.18 What precautions should a health care worker take when visiting the home of a TB patient who may be infectious?

Answers to study questions are on pages 47-51.



Case Study 5.3

You are sent to deliver directly observed therapy to a woman who started treatment last week for suspected pulmonary TB. Her sputum smear results are not back yet. You are asked to collect another sputum specimen while you are at the woman's home.

- **What precautions should you take?**

Answers to case study questions are on pages 52-53.



SUMMARY

The infectiousness of a TB patient is directly related to the number of tubercle bacilli that the patient expels into the air. Patients who expel many tubercle bacilli are more infectious than patients who expel few or no bacilli. The number of tubercle bacilli expelled by a TB patient may be increased in the following factors are present

- **Presence of a cough**
- **Cavity in the lung**
- **Positive sputum smear result and/or culture**
- **Site of TB disease in the lungs, airway, or larynx**
- **Not covering mouth and nose when coughing**
- **No or inadequate treatment**
- **Cough-inducing procedures**

Infectiousness appears to decline very rapidly after adequate treatment is started, but how quickly it declines varies from patient to patient. Patients who have been receiving adequate treatment for 2 weeks, whose symptoms have improved (for example, coughing less and no longer have a fever), **and** who have three consecutive negative sputum smears from sputum collected in 8-24 hour intervals (one being a morning specimen) can be considered noninfectious.

TB can be spread in many places, such as homes or worksites. TB is most likely to be transmitted in health care settings where health care workers and patients can come in contact with other patients who have unsuspected TB disease, who are not receiving adequate treatment, and who have not been isolated from others. The health care settings include clinics, hospitals, and home-based health care. TB can also be transmitted in non-traditional facility-based settings such as congregate settings (nursing homes, correctional facilities, and homeless shelters), as well as drug treatment centers and emergency medical services. These settings should take measures to prevent the spread of TB, as well as develop an infection control program.

Health department TB control programs should ensure that their TB clinics develop and implement an infection control program; and, they should be able to provide consultation about infection control to other health care and congregate settings in their communities. The health department should also be able to help health care settings

- **Report confirmed or suspected TB cases as quickly as possible**
- **Conduct contact investigations**
- **Ensure there is a plan for TB patients to receive follow-up care after they are discharged**
- **Conduct testing, surveillance, outbreak investigations, and other aspects of a TB infection-control program.**



The main goals of an infection-control program are to detect TB disease early, and to promptly isolate (airborne precautions) and treat persons who have TB disease. Patients who have signs or symptoms of TB disease should be placed in an area away from other patients (preferably in a TB AII room) and promptly given a diagnostic evaluation. Special care should be taken to separate patients with suspected or confirmed infectious TB from those with HIV infection or other immunocompromising conditions. Patients who are likely to have TB should start appropriate treatment at once.

To ensure that infection control measures are properly implemented, health care and congregate settings should develop an infection-control program based on three levels of controls — administrative controls, environmental controls, and respiratory protection-controls.

Administrative control is the first and most important level of a TB infection-control program. Administrative control activities may differ in each setting, but should include:

- **Assigning responsibility for TB infection control;**
- **Conducting TB risk assessment;**
- **Developing and implementing a written TB infection-control plan;**
- **Ensuring the prompt availability of recommended laboratory processing, testing, and reporting of results;**
- **Implementing effective work practices for the management of patients with suspected or confirmed TB disease;**
- **Ensuring proper cleaning, sterilization, or disinfection of potentially contaminated equipment;**
- **Educating, training, and counseling health care workers about TB;**
- **Testing and evaluating health care workers for TB infection and disease;**
- **Using posters or signs to educate and remind patients of proper cough etiquette and respiratory hygiene; and**
- **Coordinating efforts between health department and high risk health care and congregate settings.**

Environmental controls consist of technologies that are designed to prevent the spread and reduce the concentration of infectious TB droplet nuclei in the air. The technologies include ventilation technologies (local exhaust ventilation and general ventilation), high-efficiency particulate air (HEPA) filtration, and ultraviolet germicidal irradiation (UVGI). The specifics of the environmental controls will differ for each health care setting based upon the TB risk assessment.

In places where administrative and environmental controls may not fully protect health care workers from infectious droplet nuclei, health care settings should establish respiratory-protection controls. Respiratory-protection controls include

- **Implementing a respiratory protection program**
- **Training health care workers on respiratory protection**



- **Educating patients on respiratory hygiene and the importance of covering their cough**

Personal respirator protections should be used by all persons, including health care workers and visitors in the following settings

- **TB AII rooms**
- **Rooms where cough-inducing or aerosol generating procedures are done**
- **Ambulances and other vehicles transporting infectious TB patients**
- **Homes of infectious TB patients**

Health care workers should undergo a fit test to ensure the respirator fits properly. It is also important to ensure that health care workers, patients, and visitors to health care settings understand the difference between respirators and face/surgical masks. Respirators are designed to protect individuals wearing them from inhaling droplet nuclei; surgical masks are designed to stop infectious persons from exhaling droplet nuclei.

In order to develop, monitor, and evaluate an infection control program, each health care and congregate setting should conduct initial and ongoing TB risk assessments. A TB risk assessment examines a number of factors associated with *M. tuberculosis* transmission, including

- **Number of patients with TB disease in the setting;**
- **Promptness of the detection, isolation, and evaluation of patients with suspected or confirmed TB;**
- **Evidence for transmission of *M. tuberculosis* in the setting; and**
- **Community rate of TB disease.**

Depending on the results of the risk assessment, health care and congregate settings should be classified as *low risk*, *medium risk*, or *potential on-going transmission* of *M. tuberculosis*. The risk classifications help determine the need for a TB testing program and the frequency of the testing.

For settings that are classified as *low risk*, all health care workers should receive baseline TB testing when they are hired. Additional testing should be conducted if there has been exposure to *M. tuberculosis*. For settings classified as *medium risk*, all health care workers should receive baseline TB testing when they are hired and annually thereafter. For health care settings classified as *potential ongoing transmission*, health care workers may need to be tested for TB infection every 8-10 weeks.

Some patients with TB can be sent home from the hospital even if they do not have three negative sputum smears. They should only be sent home if they meet the following criteria:

- **A follow-up plan has been made with the local TB program;**
- **The patient is on standard TB treatment and directly observed therapy (DOT) has been arranged;**



- **No infants or children less than 4 years of age or persons with immunocompromising conditions are present in the household;**
- **All immunocompetent household members have been previously exposed to the person with TB; and**
- **The patient will not travel outside the home until sputum smear results are negative.**

Health care workers who visit the homes of TB patients should be trained and educated on detecting and reporting the signs and symptoms of TB disease. The health care workers should also educate the patients and household members about the importance of taking medications as prescribed. The health care workers should take precautions to protect themselves from the spread of TB. They should

- **Instruct patients to cover their mouth and nose with a tissue when coughing or sneezing;**
- **Wear a personal respirator when visiting the home of an infectious TB patient or when transporting an infectious TB patient in a vehicle;**
- **Collect sputum specimens in a well-ventilated area (if possible, outdoors); and**
- **Participate in a TB testing and prevention program.**



Additional Reading

CDC. Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings. The Americas, 2005. MMWR 2005;39(RR-17):1-141.

CDC. Prevention and Control of Tuberculosis Among Homeless Persons Recommendations of the Advisory Council for the Elimination of Tuberculosis. The Americas, 1992. MMWR 1992;41(RR-5):13-23.

CDC. Prevention and Control of Tuberculosis in Correctional and Detention Facilities: Recommendations from CDC. The Americas, 2006. MMWR 2006;55(RR-9):1-44.

CDC. Prevention and Control of Tuberculosis in Facilities Providing Long-Term Care to the Elderly Recommendations of the Advisory Committee for Elimination of Tuberculosis. The Americas, 1990. MMWR 1990;39(RR-10):7-20.

Francis J. Curry National Tuberculosis Center (US). Tuberculosis Infection Control: A Practical Manual for Preventing TB; 2007.



ANSWERS TO STUDY QUESTIONS

5.1 List seven factors that affect the infectiousness of a TB patient. (pages 4-5)

- Presence of a cough
- Chest x-ray showing cavity in the lung
- Positive acid-fast bacilli sputum smear result
- TB of the lungs or larynx
- Patient not covering mouth or nose when coughing
- Not receiving adequate treatment
- Undergoing cough-inducing procedures

5.2 Why does the site of disease affect the infectiousness of a TB patient? (page 4)

Usually, only people with pulmonary or laryngeal TB (TB of the larynx) are infectious. This is because these people may be coughing and expelling tubercle bacilli into the air. People with extrapulmonary TB only (no or laryngeal pulmonary TB) generally are not infectious.

5.3 When can a TB patient be considered noninfectious? List all three criteria. (page 6)

Patients can be considered noninfectious when they meet all of the following criteria:

- They have been receiving adequate TB treatment for a minimum of 2 weeks
- Their symptoms have improved (for example, coughing less and no longer have a fever)
- They have THREE consecutive negative sputum smears from sputum collected in 8-24 hour intervals (one being an early morning specimen)

5.4 In what circumstances is TB most likely to be transmitted in health care facilities? (page 9)

TB is most likely to be transmitted when health care workers and patients come in contact with persons who have unsuspected TB disease, who are not receiving adequate treatment, and who have not been isolated from others.



5.5 How can the health department help health care facilities in preventing the spread of TB? (page 10)

The health department can

- Help health care facilities report confirmed or suspected TB cases as quickly as possible
- Do contact investigations
- Make sure there is a plan for TB patients to receive follow-up care after they are discharged
- Help the facilities with testing, surveillance, outbreak investigations, and other aspects of a TB infection-control program

5.6 What are the main goals of a TB infection-control program? (page 11)

The main goals of a TB infection-control program are to detect TB disease early, and to promptly isolate and treat people who have TB disease.

5.7 What would make a health care worker suspect that a patient has TB disease? (page 11)

Clinicians and other health care workers should suspect TB disease in any patient who has a persistent cough, bloody sputum, weight loss or loss of appetite, fever, or night sweats. They should be especially alert for TB in areas where TB is common. Also, health care workers who admit patients to a facility should be trained to ask appropriate questions to help detect patients who have signs or symptoms of TB.

5.8 What should be done when a health care worker suspects that a patient has TB disease? (pages 11-13)

The patient should be placed in an area away from other patients (preferably in a TB All room) and promptly given a diagnostic evaluation. The patient should be given a surgical mask and instructed to keep it on. The patient should also be given tissues and asked to cover the nose and mouth when coughing or sneezing, even when in an area away from other patients. A patient diagnosed with TB should start appropriate treatment at once.



5.9 What are the three levels of controls that form the basis of a TB infection-control program? (page 13)

The infection-control program should involve three types of controls:

- Administrative controls
- Environmental controls
- Respiratory-protection controls

5.10 List five administrative control measures that should be taken in health care settings to reduce the risk of exposure to persons who may have TB disease. (page 18-21)

List any five of the following activities:

- Assign responsibility for TB infection control
- Conduct TB risk assessment
- Develop and implement a written TB infection-control plan
- Ensure the prompt availability of recommended laboratory processing, testing, and reporting of results
- Implement effective work practices for the management of patients with suspected or confirmed TB disease
- Ensure proper cleaning, sterilization, or disinfection of potentially contaminated equipment
- Train and educate health care workers
- Test, and evaluate health care workers for TB
- Use posters and signs educating and advising respiratory hygiene and cough etiquette
- Coordinate efforts with the local or state health department

5.11 Where should sputum induction, bronchoscopy, or other cough-inducing procedures be done? (page 22)

These medical procedures should be done in special AII rooms or booths to prevent any droplet nuclei expelled during the procedure from reaching other parts of the facility.



5.12 What is a TB airborne infection isolation (AII) room? What are the important characteristics of an AII room? (page 24)

TB AII rooms are rooms in health care settings that have special characteristics to prevent the spread of droplet nuclei expelled by a TB patient. One characteristic is that they are at negative pressure relative to other parts of the facility. Another characteristic is that the air from the AII room is exhausted directly to the outdoors, or passed through a special filter that removes all of the droplet nuclei.

5.13 How do ventilation systems help prevent the spread of TB? (pages 22-24)

Ventilation systems are necessary to maintain negative pressure and to exhaust the air properly. These systems can also be designed to minimize the spread of TB in other areas of the health care facility.

5.14 Give four examples of settings where personal respirators should be used. (page 26)

Personal respirators should be used in

- TB AII rooms
- Rooms where cough-inducing procedures are done
- Ambulances or other vehicles transporting infectious TB patients
- Homes of infectious TB patients

5.15 What is the difference in use between a respirator and a surgical mask? (page 27)

Respirators are designed to protect health care workers and other individuals from breathing in (inhaling) droplet nuclei present in the air. This can protect these individuals from becoming infected with *M. tuberculosis* when in contact with a person with infectious TB.

Surgical masks (Figure 5.3) are designed to stop droplet nuclei from being spread (exhaled) into the air by the person wearing them. Persons with suspected or confirmed infectious TB may be given a surgical mask to wear to prevent them from expelling infectious droplet nuclei.

5.16 What are the 3 different TB risk classifications that can be assigned to health care settings? (page 32)

- Low risk
- Medium risk
- Potential ongoing transmission



5.17 Depending on their risk classification, how often should health care settings screen their workers for TB? (pages 32-34)

- For Low Risk Settings
 - Conduct TB baseline test when health care worker is hired
 - No further testing needed unless exposure occurs
- Medium Risk Settings
 - Conduct TB baseline test when health care worker is hired
 - Repeat test annually
- Potential Ongoing Transmission
 - Conduct TB baseline test when health care worker is hired
 - Repeat test every 8-10 weeks until there is no longer evidence of *M. tuberculosis* transmission in the setting

5.18 What precautions should a health care worker take when visiting the home of a TB patient who may be infectious? (pages 38-39)

Health care workers who visit TB patients at home should take these precautions to protect themselves from the spread of TB:

- Instruct patients to cover their mouth and nose with a tissue when coughing or sneezing;
- Wear a personal respirator when visiting the home of an infectious TB patient or when transporting an infectious TB patient in a vehicle;
- When it is necessary to collect a sputum specimen in the home, collect the specimen in a well-ventilated area, away from other household members; if possible, the specimen should be collected outdoors; and
- Participate in a TB testing and prevention program.



ANSWERS TO CASE STUDIES

5.1 For each of the following situations, decide whether the patient should be considered infectious or noninfectious, and explain why.

- **Two weeks ago, Mr. Lopez had a sputum smear that was positive; since then no sputum specimens have been tested. Mr. Lopez started self-administered TB treatment 7 days ago. He still has a cough.**

Mr. Lopez should be considered infectious. He does not meet the criteria for noninfectiousness because (1) he has been receiving treatment for only 7 days, not 2 weeks, (2) his symptoms haven't improved, and (3) he doesn't have three consecutive negative sputum smears. Mr. Lopez should be given his treatment by DOT to ensure he receives adequate treatment.

- **Ms. Nguyen, a patient with pulmonary TB, has been receiving DOT treatment for 6 weeks and no longer has symptoms of TB. She has had three sputum smears. The first one was positive, but the last two were negative.**

Ms. Nguyen meets the first two criteria for noninfectiousness: she has been receiving treatment for at least 2 weeks; and her symptoms have improved. However, she should be considered infectious until she has three consecutive negative sputum smears.

- **Mr. Martin started DOT treatment for pulmonary TB in April. His symptoms went away and his sputum smears were negative in May. However the outreach worker was unable to locate him on June 5th and has not been able to contact him since that time. Mr. Martin returned to the TB clinic today, August 2, and is coughing.**

Mr. Martin may have been noninfectious in May, but it appears that he may be infectious again. He is coughing and has not been receiving adequate treatment since June 4th. At this point, Mr. Martin should be considered infectious. He should be evaluated for infectiousness and nonadherence to treatment.

5.2 You are checking patients into the TB clinic. An elderly man comes to the desk and says he was told to come and get checked because one of his friends has TB. You notice that he looks sick and is coughing frequently. The waiting room is full of patients, and you know it will probably be more than an hour before the physician can see him.

- **What should you do?**

You should suspect that this man has infectious TB. You should work with the clinical staff to ensure that he is evaluated for TB quickly. In the meantime, the man should be given a surgical mask, instructed to keep it on, and asked to cover his mouth and nose when coughing or sneezing. He should be placed in an area away from other patients right away.



5.3 You are sent to deliver directly observed therapy to a woman who started treatment last week for suspected pulmonary TB. Her sputum smear results are not back yet. You are asked to collect another sputum specimen while you are at the woman's home.

■ **What precautions should you take?**

First, you should instruct the patient to cover her mouth and nose when she coughs or sneezes. Second, because the patient may be infectious, you should wear a personal respirator when visiting her home. Third, you should collect the sputum specimen in a well-ventilated area (preferably outdoors), away from other household members. (Ideally, sputum specimens should be collected in a special AII room or booth.) Fourth, because you visit TB patients at home as part of your job, you should participate in a TB testing and prevention program through your employer.