

# Infection Control

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# Introduction

## Purpose

Use this section to understand and follow national and Alaska guidelines to

- review the hierarchy of infection control measures and know where to go for further information;
- alert local public health staff to the basic differences between masks and respirators;
- estimate patients' infectiousness and determine when patients are noninfectious;
- determine when to isolate patients, when to discharge them from hospitals, and when to permit them to return to work, school, or other settings;
- review how to implement infection control measures in residential settings, patient care facilities, and transportation vehicles;
- consult with facilities that are implementing infection control measures, including two-step testing.

In the 2005 guidelines, "Controlling Tuberculosis in the United States: Recommendations from the American Thoracic Society, Centers for Disease Control and Prevention, and the Infectious Diseases Society of America," one of the recommended strategies to achieve the goal of reduction of tuberculosis (TB) morbidity and mortality is the identification of settings in which a high risk exists for transmission of *Mycobacterium tuberculosis* and application of effective infection control measures.<sup>1</sup>

As TB continues to decline in most areas of the U.S., it is crucial that state and local public health agencies provide facilities with epidemiological data on TB, as well as education and guidance in developing effective TB infection control programs.

Infection control measures are fundamental to reducing the spread of communicable diseases such as TB. Transmission of *M. tuberculosis* from person to person can occur in many locations, such as home, work, school, and healthcare facilities.<sup>2</sup> It is impossible to prevent all exposure; however, the goal is to reduce the amount of transmission.

Every healthcare setting should have a TB infection control plan that is part of an overall infection control program. Each agency's or facility's program should include a hierarchy of administrative controls, environmental controls, and personal respiratory protection. Because each patient care setting and patient's home is different, each program will incorporate a different combination of control activities. The extent to which each agency or facility implements its control activities is based on the results of its risk assessment. In areas where TB rates are lower, the TB risk is lower, and this should affect which elements of the TB infection control plan are utilized. This section provides an overview

of TB infection control principles and is not designed to replace specific infection control plans in health care facilities.

## **Policy**

Three main areas of infection control that need to be addressed by state and local public healthcare agencies are TB control in

1. healthcare facilities, where persons with infectious TB disease would seek care;<sup>3,4</sup>
2. congregate settings and residential facilities, whose residents are at increased risk for TB disease,<sup>5,6</sup>
3. the patient's home.

To accomplish TB control activities, each local public healthcare agency should do the following:

1. Familiarize staff with the current Centers for Disease Control and Prevention (CDC) infection control guidelines for healthcare providers and settings.
2. Develop an infection control program for the county or state TB staff, focusing on
  - a. assignment of responsibility for program;
  - b. risk assessment;
  - c. persons (if anyone) who need baseline testing, including TB screening and counseling;
  - d. education and training;
  - e. case management (if direct patient care is provided).
3. Designate a staff person to guide facilities that may need to set up TB infection control programs.



For roles and responsibilities, refer to the “Roles, Responsibilities, and Contact Information” topic in the Introduction **1.11**.

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# Hierarchy of Infection Control Measures

There are three types of infection control measures. The first are administrative controls, which are primarily aimed at early identification, isolation, and appropriate treatment of infectious patients. The second are environmental controls, which focus on preventing the spread and reducing the concentration of infectious droplet nuclei in the air.<sup>7</sup> The third is personal respiratory protection, which may provide additional protection for healthcare workers in high-risk settings such as isolation rooms and cough-inducing or aerosol-generating suites.

The activities described below are more relevant to infection control in healthcare or residential facilities. Home settings are discussed separately in the “Residential Settings” topic in this section.

## Administrative Controls

Administrative control measures are the first of three levels of measures designed to reduce the risk of tuberculosis (TB) transmission. Administrative controls are the first level of infection control because they include a variety of activities to identify, isolate, and appropriately treat persons suspected of having TB disease.

**An effective TB infection control plan** contains measures for reducing the spread of TB that are appropriate to the risk of a particular setting.<sup>8</sup> Every healthcare setting should have a TB infection control plan that is part of an overall infection control program.<sup>9</sup> A written TB infection control plan helps to ensure prompt detection, airborne precautions, and treatment of persons who have suspected or confirmed TB disease.<sup>10</sup>

- **In TB infection control programs for settings in which patients with suspected or confirmed TB disease are expected to be encountered**, develop a written TB infection control plan that outlines a protocol for the prompt recognition and initiation of airborne precautions for persons with suspected or confirmed TB disease, and update it annually.<sup>11</sup>
- **In TB infection control program for settings in which patients with suspected or confirmed TB disease are NOT expected to be encountered**, develop a written TB infection control plan that outlines a protocol for the prompt recognition and transfer of persons who have suspected or confirmed TB disease to another healthcare setting. The plan should indicate procedures to follow to separate persons with suspected or confirmed infectious TB disease from other persons in the setting until the time of transfer. Evaluate the plan annually, if possible, to ensure that the setting remains one in which persons who have suspected or confirmed TB disease are not encountered, and that they are promptly transferred.<sup>12</sup>

## Administrative Activities<sup>13</sup>

Key activities to reduce the risk of transmission include the following:

- 1. Assign responsibility** to a specific person for designing, implementing, evaluating, and maintaining a TB infection control program for that facility.
- 2. Conduct a risk assessment.** The risk level of a particular facility will affect the extent of all other activities and will result in each facility having a different plan.
- 3. Develop, implement, and enforce policies and procedures** to ensure early identification, evaluation, and treatment of infectious cases of TB.
- 4. Provide prompt triage** and management in the outpatient setting of patients who may have infectious TB.
- 5. Initiate promptly and maintain TB isolation** for persons who may have infectious TB and are admitted to an inpatient setting.
- 6. Plan effectively for the discharge** of the patient, coordinating between the local public health agency and the healthcare provider.
- 7. Implement environmental controls.** Develop, install, maintain, and evaluate the effectiveness of engineering controls.
- 8. Implement a respiratory protection program.** Develop, initiate, install, maintain, and evaluate the effectiveness of the respiratory protection program.
- 9. Implement precautions for cough-inducing procedures.** Develop, implement, and enforce policies and procedures to ensure adequate precautions when performing cough-inducing procedures.
- 10. Educate and train healthcare workers** about TB.
- 11. Counsel and screen healthcare workers.** Develop and implement counseling and new hire screening program for healthcare workers about TB disease and latent TB infection (LTBI).
- 12. Evaluate promptly possible episodes of TB transmission.**
- 13. Coordinate activities** between the state and local public healthcare agencies.

## Environmental Controls

TB is caused by an organism called *Mycobacterium tuberculosis*. When a person with infectious TB disease coughs or sneezes, tiny particles called droplet nuclei that contain *M. tuberculosis* are expelled into the air.<sup>14</sup> Environmental controls are used to prevent the spread and reduce the concentration of infectious droplet nuclei.<sup>15</sup> Each facility should use different combinations of environmental controls, based on the results of its risk assessment.

It is important to note, however, that without strong administrative controls, environmental controls are ineffective because cases would not be recognized or managed appropriately.

Table 1 describes the three main types of environmental controls.

Table 1: **THREE TYPES OF ENVIRONMENTAL CONTROLS**

<b>Most Effective Control</b>	<p><b>Ventilation</b></p> <ul style="list-style-type: none"> <li>▪ Controls direction of air flow to prevent contamination of air in areas surrounding a person with infectious tuberculosis (TB)</li> <li>▪ Dilutes and removes contaminated air</li> <li>▪ Exhausts contaminated air to the outside</li> </ul>
<b>Supplementary Controls</b>	<p><b>High-efficiency particulate air (HEPA) filtration</b></p> <ul style="list-style-type: none"> <li>▪ Cleans the air of infectious droplet nuclei</li> </ul> <p><b>Ultraviolet germicidal irradiation (UVGI)</b></p> <ul style="list-style-type: none"> <li>▪ Kills or inactivates TB bacilli in the air</li> </ul>

## Personal Respiratory Protection

Although administrative controls and environmental controls are most effective in controlling the spread of TB, they do not eliminate the risk of transmission entirely. Personal respiratory protection, the third level of infection control, is also used in higher-risk settings.

The purpose of a respirator is to reduce exposure by filtering out TB bacilli from the room air before the air is breathed into a person's lungs. Respirators used for TB control should be approved for TB use by the National Institute for Occupational Safety and Health (NIOSH).

It is recommended that healthcare provider staff and visitors use personal respiratory protective equipment in settings that may be at higher risk for TB transmission, such as the following:

- Rooms where infectious TB patients are being isolated
- Areas where cough-inducing or aerosol-generating procedures are performed
- Other areas, which should be identified in the facility's risk assessment, where administrative and environmental controls are not likely to protect persons from inhaling infectious droplet nuclei

It is important to note that the precise level of effectiveness (of respiratory protection) in protecting healthcare workers from *M. tuberculosis* transmission in healthcare settings has not been determined.<sup>16</sup>



Surgical-type masks are to be used by persons who are infectious or are suspected cases of TB disease when they are out of TB respiratory isolation. The purpose of the mask is to reduce transmission by reducing the number of TB bacilli coughed out into the room air. The infectious patient should not wear a respirator. For more information, see Table 2: **Using Masks and Respirators.**

When TB respirators are used, a respiratory protection program should be developed and enforced.<sup>1,17</sup> For more information respiratory protection programs, see the Centers for Disease Control and Prevention's (CDC's) "Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Settings, 2005" (*MMWR* 2005;54[No. RR-17]:75–79) at <http://www.cdc.gov/mmwr/pdf/rr/rr5417.pdf>.

The CDC guidelines recommend that healthcare facilities conduct annual training regarding multiple topics for healthcare workers (HCWs), including the nature, extent, and hazards of TB disease in the healthcare setting. The training can be conducted in conjunction with other related training regarding infectious disease associated with airborne transmission.

In addition, training topics should include the following:

1. Risk assessment process and its relation to the respirator program, including signs and symbols used to indicate that respirators are required in certain areas and the reasons for using respirators
2. Environmental controls used to prevent the spread and reduce the concentration of infectious droplet nuclei
3. Selection of a particular respirator for a given hazard (See “Selection of Respirators” on p. 78 of the CDC guidelines.)
4. Operation, capabilities, and limitations of respirators
5. Cautions regarding facial hair and respirator use
6. Occupational Health and Safety Administration (OSHA) regulations regarding respirators, including assessment of employees’ knowledge

Trainees should be provided opportunities to handle and wear a respirator until they become proficient. Trainees should also be provided with copies or summaries of lecture materials for use as references and instructions to refer all respirator problems immediately to the respiratory program administrator.<sup>18</sup>

A fit test is used to determine which respirator fits the user adequately and to ensure that the user knows when the respirator fits properly. Fit testing provides a means to determine which respirator model and size fits the wearer best and to confirm that the wearer can don the respirator properly to achieve a good fit. Periodic fit testing for respirators used in TB environments can serve as an effective training tool in conjunction with the content included in employee training and retraining.<sup>19</sup>

The CDC recommends that, after a risk assessment to validate the need for respiratory protection, a healthcare facility should perform fit testing during the initial respiratory protection program training and periodically thereafter in accordance with federal, state, and local regulations.<sup>20</sup> The frequency of periodic fit testing should be supplemented by the occurrence of 1) risk for transmission of *M. tuberculosis*, 2) facial features of the wearer, 3) medical condition that would affect respiratory function, 4) physical characteristics of respirator, or 5) model or size of the assigned respirator.<sup>21</sup>

The OSHA also developed its own TB Rule, although it was withdrawn in 2003. However, OSHA has addressed TB in their general respiratory protection requirements, which includes the need for the following:

- Respiratory protection program
- Amended medical evaluation
- Training and recordkeeping
- Annual fit testing
- Fit checking



For regulations in your area, refer to state and local regulations and contact your local OSHA office. A directory of OSHA offices may be found at <https://www.osha.gov/contactus/bystate/AK/areaoffice>

Information about the Alaska State Plan is available at: <https://www.osha.gov/stateplans/ak>

# Who Should Use a Mask or Respirator

Using masks and respirators properly can reduce transmission of *Mycobacterium tuberculosis* and exposure to TB. Refer to Table 2: **Using Masks and Respirators** to determine when to use masks and respirators.

Table 2: **USING MASKS AND RESPIRATORS**<sup>22</sup>

Mask (a regular "surgical" mask*)	Respirator (NIOSH-approved, N-95 or higher*)
<p><b>Purpose</b> To reduce transmission by capturing infectious droplet nuclei that an infectious patient releases before they get into the air.</p>	<p><b>Purpose</b> To reduce exposure by filtering infectious droplet nuclei out of the air, before the wearer breathes the air into their lungs.</p>
<p><b>Who should wear a mask?</b></p> <ul style="list-style-type: none"> <li>▪ Patients with infectious TB or suspected infectious TB</li> </ul>	<p><b>Who should wear a respirator?</b></p> <ul style="list-style-type: none"> <li>▪ Staff</li> </ul> <p><b>Note:</b> Visitors to TB isolation rooms should be restricted. Unless persons have been fit tested, they may not be protected by wearing N-95 masks. Consult your facility's infection control plan for guidance.</p>
<p><b>A patient should wear a mask In a hospital setting when:</b></p> <ul style="list-style-type: none"> <li>▪ Suspected of having infectious TB and not yet placed in respiratory isolation</li> <li>▪ Leaving a respiratory isolation room for any reason</li> </ul> <p><b>Note:</b> Infectious patients should NOT wear masks when in their TB isolation rooms.</p> <p><b>In a health clinic setting when:</b></p> <ul style="list-style-type: none"> <li>▪ Not in a TB isolation room</li> <li>▪ Returning to the clinic for evaluation</li> </ul>	<p><b>A staff person or visitor should wear a respirator In a hospital or clinic setting when:</b></p> <ul style="list-style-type: none"> <li>▪ Entering a TB isolation room</li> <li>▪ Performing cough-inducing or aerosol-generating procedures</li> <li>▪ Unlikely to be protected by administrative or environmental controls</li> </ul>
<p><b>A patient should wear a mask In a transportation setting when:</b></p> <ul style="list-style-type: none"> <li>▪ Traveling in a vehicle with other persons</li> </ul>	<p><b>A staff person or visitor should wear a respirator In some transportation settings when:</b></p> <ul style="list-style-type: none"> <li>▪ Riding in a vehicle with a patient with infectious TB</li> </ul>
<p><b>In the patient's home:</b></p> <p><b>Note:</b> Infectious patients do NOT need to wear a mask when they are in their homes.</p>	<p><b>A staff person should wear a respirator in a patient's home when:</b></p> <ul style="list-style-type: none"> <li>▪ Visiting the infectious patient inside a home/residence</li> </ul> <p><b>Note:</b> There should NOT be any visitors (excluding protected healthcare workers) in the home until the patient is released from TB isolation.</p>
<p>Definition of abbreviations: NIOSH = National Institute for Occupational Safety and Health; TB = tuberculosis.</p> <p>* There are some devices, such as the 3M 1860, which are both N95 respirators and surgical masks.</p>	

Source: CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):38–40.

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## Employee Health

All employees, physicians, and volunteers who have potential for exposure to *Mycobacterium tuberculosis* should be screened for tuberculosis at hire, and as needed if there is a TB exposure or ongoing transmission, by tuberculin skin test (TST) or interferon gamma release assay (IGRA), if indicated by the settings' TB infection control policies or TB risk classification, and complete a TB symptom review questionnaire.<sup>23</sup> Annual TB screening of health care workers is no longer required by current CDC guidelines<sup>24</sup>

### Two-Step Tuberculin Skin Testing

Two-step testing is used to improve the interpretation of tuberculin skin tests (TSTs), especially in persons who need to receive serial tests. Two-step testing should be used for the **initial** skin testing of adults who may be retested periodically, such as healthcare workers.<sup>25</sup>

In some persons who are infected with *Mycobacterium tuberculosis*, delayed-type hypersensitivity to tuberculin may wane over the years. When these persons are skin tested many years after their infection, they may have a negative reaction.

However, the skin test may have stimulated (boosted) their ability to react to tuberculin, causing a positive reaction to subsequent tests. This boosted reaction may be misinterpreted as a new infection. The booster phenomenon may occur at any age, but its frequency increases with age and is highest among older persons. Boosted reactions may occur in persons infected with nontuberculous mycobacteria or in persons who have had a prior Bacille Calmette-Guérin (BCG) vaccination.

A positive reaction to the second test should be interpreted as evidence for infection with *M. tuberculosis*. On the basis of this second test result, the person should be classified as previously infected and cared for accordingly. This would not be considered a skin test conversion.

If the first and second test results are negative, the person should be classified as uninfected. In these persons, a positive reaction to any subsequent test is likely to represent new infection with *M. tuberculosis* (a skin test conversion). Schedule appointments for two-step testing as shown below.



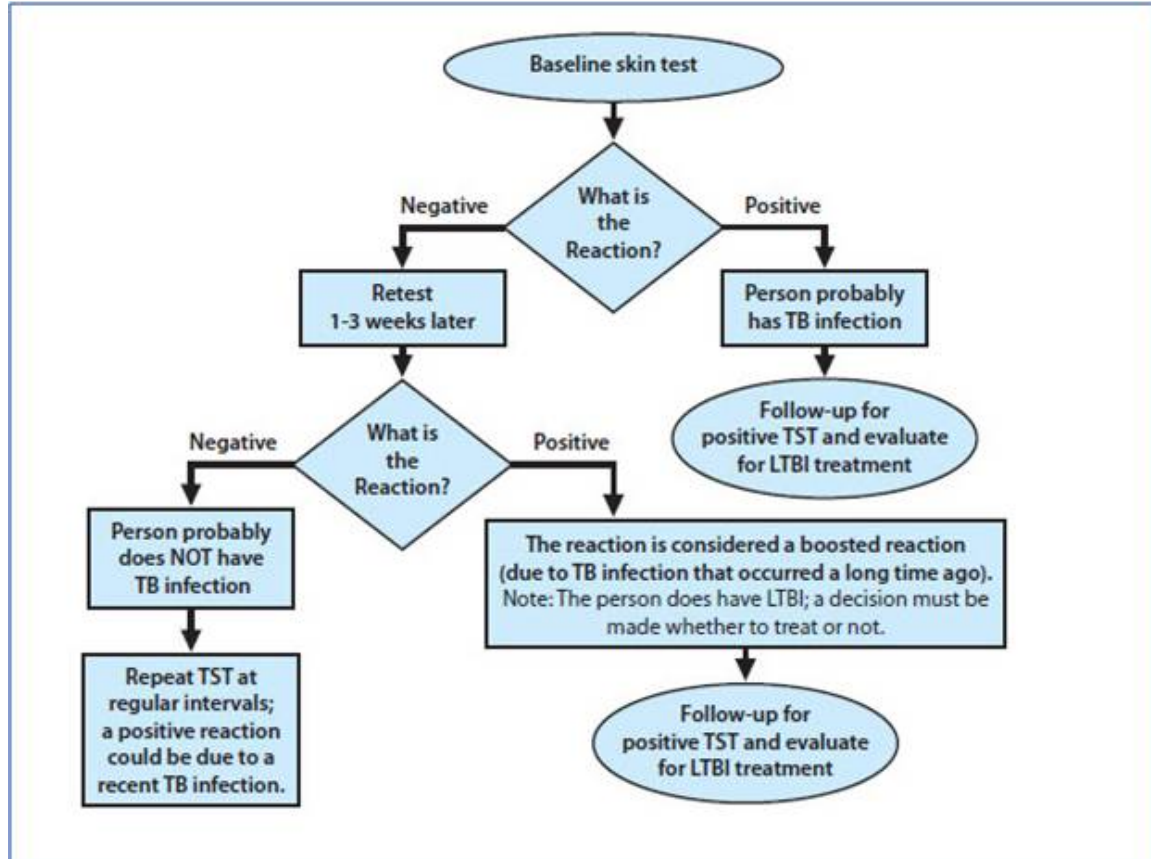
Refer to the topics on administration, measurement, and interpretation of the tuberculin skin test in the section on Diagnosis of Latent Tuberculosis Infection **7.7**.

Table 3: **FOUR APPOINTMENT SCHEDULE FOR TWO-STEP TESTING**

Appointments	Tasks
<b>First appointment</b>	Apply the first tuberculin skin test (TST).
<b>Second appointment</b> 48 to 72 hours after applying the first TST	Measure the reaction. <ul style="list-style-type: none"> <li>▪ If the reaction is negative, schedule a third appointment.</li> <li>▪ If the reaction is positive, do not repeat the TST. Obtain a chest radiograph.</li> </ul>
<b>Third appointment</b> 1 to 3 weeks after measurement of the first TST	Re-apply the TST. <ul style="list-style-type: none"> <li>▪ Use the same dose and strength of tuberculin. Inject the tuberculin on the other forearm, or at least 5 cm from the original test site.</li> <li>▪ If the reaction is negative and the patient returns over a week after the first TST was applied, apply the second TST.</li> </ul>
<b>Fourth appointment</b> 48 to 72 hours after applying the second TST	Measure the reaction. <ul style="list-style-type: none"> <li>▪ If the reaction is negative, classify the individual as uninfected.</li> <li>▪ If the reaction is positive, obtain a chest radiograph.</li> </ul>

\* All TST results should be read and recorded by a trained TST reader other than the person on whom the TST was placed.<sup>26</sup>

Figure 1: **TWO STEP TESTING AND FOLLOW-UP**



For more information on two-step testing, refer to the CDC's "Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Facilities, 2005" (*MMWR* 2005;54[No. RR-17]) at <http://www.cdc.gov/mmwr/pdf/rr/rr5417.pdf>.

## **Screening for persons with previously positive TST, IGRA or completion of treatment for LTBI or active TB**

Employees, physicians, and volunteers who have written documentation of a previous positive TST result may be required to have a baseline chest x-ray at hire or provide written documentation of a normal chest x-ray taken no more than 12 months prior to hire. The chest x-ray will be repeated only if the employee develops signs or symptoms of TB or when the attending physician decides a repeat chest x-ray is needed. Rescreening is conducted, only if there is a TB exposure or ongoing transmission, via a TB symptom review questionnaire instead of TST or IGRA for previously positive employees. If the symptom screen reveals signs or symptoms of TB, the employee will be excluded from the workplace. A new chest x-ray and physical assessment is then required.<sup>27</sup>



A sample TB symptom review questionnaire can be found in the Curry International Tuberculosis Center's 2007 Tuberculosis Infection Control: A Practical Manual for Preventing TB [1-171]. Available at:

[http://www.currytbcenter.ucsf.edu/products/product\\_details.cfm?productID=WPT-12CD](http://www.currytbcenter.ucsf.edu/products/product_details.cfm?productID=WPT-12CD)

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# Isolation

To reduce disease transmission, a patient with tuberculosis (TB) disease may need to be isolated or have activities restricted.

**Isolation:** Isolation is used when people are ill. Isolation of people who have a specific illness separates them from healthy people and restricts their movement to stop the spread of that illness. Isolation allows for the focused delivery of specialized health care to people who are ill, and it protects healthy people from getting sick. People in isolation may be cared for in their homes, in hospitals, or at designated healthcare facilities. Isolation is a standard procedure used in hospitals today for patients with TB and certain other infectious diseases. In most cases, isolation is voluntary; however, many levels of government (federal, state, and local) have the basic legal authority to compel isolation of sick people to protect the public.<sup>28</sup>

**Restricted Activities:** Until determined to be noninfectious, the patient is not permitted to return to work, school, or any social setting where the patient could expose individuals to airborne bacteria.

**Quarantine:** Although TB control programs have used the word “quarantine” interchangeably with “isolation” and “restricted activities,” the word “quarantine” properly used is not a term applicable to TB control. Quarantine applies to people who have been exposed and may be infected but are not yet ill. Separating exposed people and restricting their movements is intended to stop the spread of illness. Quarantine is not an appropriate TB control measure for asymptomatic, exposed individuals.<sup>29</sup>



For information on diagnosis and laboratory tests, refer to the sections on diagnosis of tuberculosis disease and latent tuberculosis infection. For information on guidelines for infection control in the patient’s residence, group settings, and during transportation of a patient, see the subtopics that follow.

## Estimating Infectiousness

In general, patients who have suspected or confirmed TB disease and who are not on antituberculosis treatment should be considered infectious if characteristics include the following:

- Presence of cough
- Cavitation on chest radiograph
- Positive acid-fast bacilli (AFB) sputum smear result
- Respiratory tract disease with involvement of the lung or airways, including larynx
- Failure to cover the mouth and nose when coughing
- Undergoing cough-inducing or aerosol-generating procedures (e.g., sputum induction, bronchoscopy, airway suction)<sup>30</sup>

If a patient with one or more of these characteristics is on standard multidrug therapy with documented clinical improvement, usually in connection with smear conversion over several weeks, the risk of infectiousness is reduced.<sup>31</sup>

## Determining Noninfectiousness

Use the following criteria as general guidelines to determine when during therapy a patient with pulmonary TB disease has become noninfectious. Decisions about infectivity of a person on treatment for TB should depend on the extent of illness and the specific nature and circumstances of the contact between the patient and exposed persons. These guidelines can and should be modified on a case-by-case basis by a qualified public health officer or health officer.

- Patient has negligible likelihood of multidrug-resistant TB (no known exposure to multidrug-resistant tuberculosis and no history of prior episodes of TB with poor compliance during treatment).
- Patient has received standard multidrug antituberculosis therapy for at least two weeks.
- Patient has demonstrated complete adherence to treatment (e.g., is receiving directly observed therapy).
- Patient has demonstrated evidence of clinical improvement (e.g., reduction in the frequency of cough or reduction of the grade of the AFB sputum smear result).
- All close contacts of the patient have been identified, evaluated, advised, and, if indicated, started on treatment for latent TB infection. This criterion is critical, especially for children younger than 5 years of age and persons of any age with immunocompromising health conditions such as human immunodeficiency virus (HIV) infection.



Table 4: **CRITERIA FOR PATIENTS TO BE CONSIDERED NONINFECTIOUS**

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

1. They have three consecutive AFB-negative sputum smear results from specimens collected eight to 24 hours apart, with at least one being an early morning specimen.
2. They have demonstrated clinical improvement (for example, they are coughing less and they no longer have fever); **and**
3. They have received at least two weeks of standard multidrug antituberculosis therapy

While in hospital for any reason, patients with pulmonary TB should remain in airborne infection isolation until they meet the criteria in Table 4 above.

Hospitalized patients returning to a congregate setting (e.g., a homeless shelter or detention facility) should have three consecutive AFB-negative smear results of sputum specimens collected more than eight hours apart before being considered noninfectious.<sup>32</sup>

# Airborne Infection Isolation in a Healthcare Facility

In airborne infection isolation (AII), the patient is placed in an AII room, usually within a hospital or healthcare facility. The main characteristics of an AII room (for new or renovated buildings) are that it has negative air pressure relative to the hall and **12 or more air exchanges per hour**, of which at least two exchanges are outside air. For existing structures, six or more air exchanges per hour are acceptable.

See Table 5 : **Air changes per hour (ACH) and time required for removal efficiencies of 99% and 99.9% of airborne contaminants\*** <sup>33</sup> for information on estimating the time necessary to clear the air of airborne *Mycobacterium complex* after the source patient leaves the area or the aerosol-producing procedures are complete.

Table 5 : **Air changes per hour (ACH) and time required for removal efficiencies of 99% and 99.9% of airborne contaminants\*** <sup>34</sup>

Air changes per hour (ACH) and time in minutes required for removal efficiencies of 99% and 99.9% of airborne contaminants* <sup>35</sup>		
ACH	99%	99.9%
2	138	207
4	69	104
6	46	69
12	23	35
15	18	28
20	14	21
50	6	8
400	<1	1

\*Time in minutes to reduce airborne concentration by 99% or 99.9%.

The decisions to initiate and discontinue isolation should be made in consultation with the Infection Preventionist. Isolation decisions should be made on a case-by-case basis.

## When to Initiate Airborne Infection Isolation

Suspected cases of laryngeal or pulmonary TB should be isolated immediately, before AFB sputum smear results are available.

Initiate TB All precautions for any patient who meets the criteria in Table 6.

Table 6: **INITIATION OF AIRBORNE INFECTION ISOLATION**<sup>36</sup>

Criteria for Initiation of Airborne Infection Isolation		
The patient has signs or symptoms of pulmonary, laryngeal, or multidrug-resistant tuberculosis (MDR-TB) disease	OR	<ul style="list-style-type: none"><li>▪ The patient has documented infectious pulmonary, laryngeal tuberculosis (TB) disease or MDR-TB disease</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has not completed treatment</li></ul>

Source: CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005. *MMWR* 2005;54(No. RR-17):16, 44.



Patients with suspected or confirmed MDR-TB should remain in an All room throughout their hospitalization or until culture conversion is documented, regardless of sputum smear results.

## When to Discontinue Airborne Infection Isolation



Prior to discontinuing isolation, call the Infection Preventionist. High-risk patients should be carefully evaluated before discontinuing isolation. Hospitalized patients with suspected or confirmed MDR-TB should remain in an All room throughout their hospitalization.

### Suspected Tuberculosis Disease

For patients placed in All due to suspected infectious TB disease of the lungs, airway, or larynx, All can be discontinued when the criteria in Table 7 are met.

Table 7: **DISCONTINUATION OF AIRBORNE INFECTION ISOLATION OF SUSPECTED CASES OF TUBERCULOSIS**<sup>37</sup>

Criteria for Discontinuing Airborne Infection Isolation: Suspected Case of Tuberculosis of the Lungs, Airway, or Larynx		
Infectious tuberculosis (TB) disease is considered unlikely	AND	<p>Either</p> <ul style="list-style-type: none"> <li>Another diagnosis is made that explains the clinical syndrome</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>The patient has 3 negative acid-fast bacilli (AFB) sputum smear results* has been on treatment delivered as directly observed therapy for at least 2 weeks, and has demonstrated clinical improvement</li> </ul>
<p>* Each of the 3 sputum specimens should be collected 8 to 24 hours apart, and at least 1 should be an early morning specimen (because respiratory secretions pool overnight). Generally, this will allow patients with negative AFB sputum smear results to be released from All in 2 days.<sup>38</sup></p>		
<p> While in the hospital for any reason, patients with pulmonary TB should remain in airborne infection isolation until they (1) are receiving standard multidrug antituberculosis therapy; (2) have demonstrated clinical improvement; and (3) have had 3 consecutive AFB-negative smear results of sputum specimens collected 8 to 24 hours apart, with at least 1 being an early morning specimen.<sup>39</sup></p>		
<p> Because patients with TB disease who have negative AFB sputum smear results can still be infectious, patients with suspected disease who meet the above criteria for release from All should not be released to an area where other patients with immunocompromising conditions or children &lt;5 years are housed.<sup>40</sup></p>		

Sources: CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005. *MMWR* 2005;54(No. RR-17):16, 43; ATS, CDC. Controlling tuberculosis in the United States: recommendations from the American Thoracic Society, CDC, and the Infectious Diseases Society of America. *MMWR* 2005;54(No. RR-12):9

## Confirmed Tuberculosis Disease

A patient with drug-susceptible TB of the lung, airway, or larynx who is on standard multidrug antituberculosis treatment and who has had a significant clinical and bacteriologic response to therapy (e.g., reduction in cough, resolution of fever, and progressively decreasing quantities of AFB on smear results) is probably no longer infectious. However, because culture and drug susceptibility results are not usually known when the decision to discontinue All is made, all patients with confirmed TB disease should remain in All while hospitalized until all the criteria in Table 8 are met.<sup>41</sup>

Table 8: **DISCONTINUATION OF AIRBORNE INFECTION ISOLATION OF CONFIRMED CASES OF TUBERCULOSIS**<sup>42</sup>

<b>Criteria for Discontinuing Airborne Infection Isolation: Hospitalized Patients with Confirmed, Drug-Susceptible Tuberculosis of the Lungs, Airway, or Larynx</b>
<ul style="list-style-type: none"><li>▪ The patient has had 3 consecutive negative acid-fast bacilli (AFB) sputum smear results collected 8 to 24 hours apart, with at least 1 being an early morning specimen</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has received at least 2 weeks of standard multidrug antituberculosis treatment by directly observed therapy (DOT)</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has demonstrated clinical improvement</li></ul>

Source: CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005. *MMWR* 2005;54(No. RR-17):43.

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## Hospital Discharge

The decisions to discharge an AFB sputum smear-positive patient or an MDR-TB patient should be made in consultation with Infection Preventionist, the Alaska Tuberculosis Program, local Public Health Nurse (PHN), and the primary care provider.



Use the *Tuberculosis Discharge Planning Checklist* to guide discharge planning. It is available in the Forms section of the manual **18.1**.

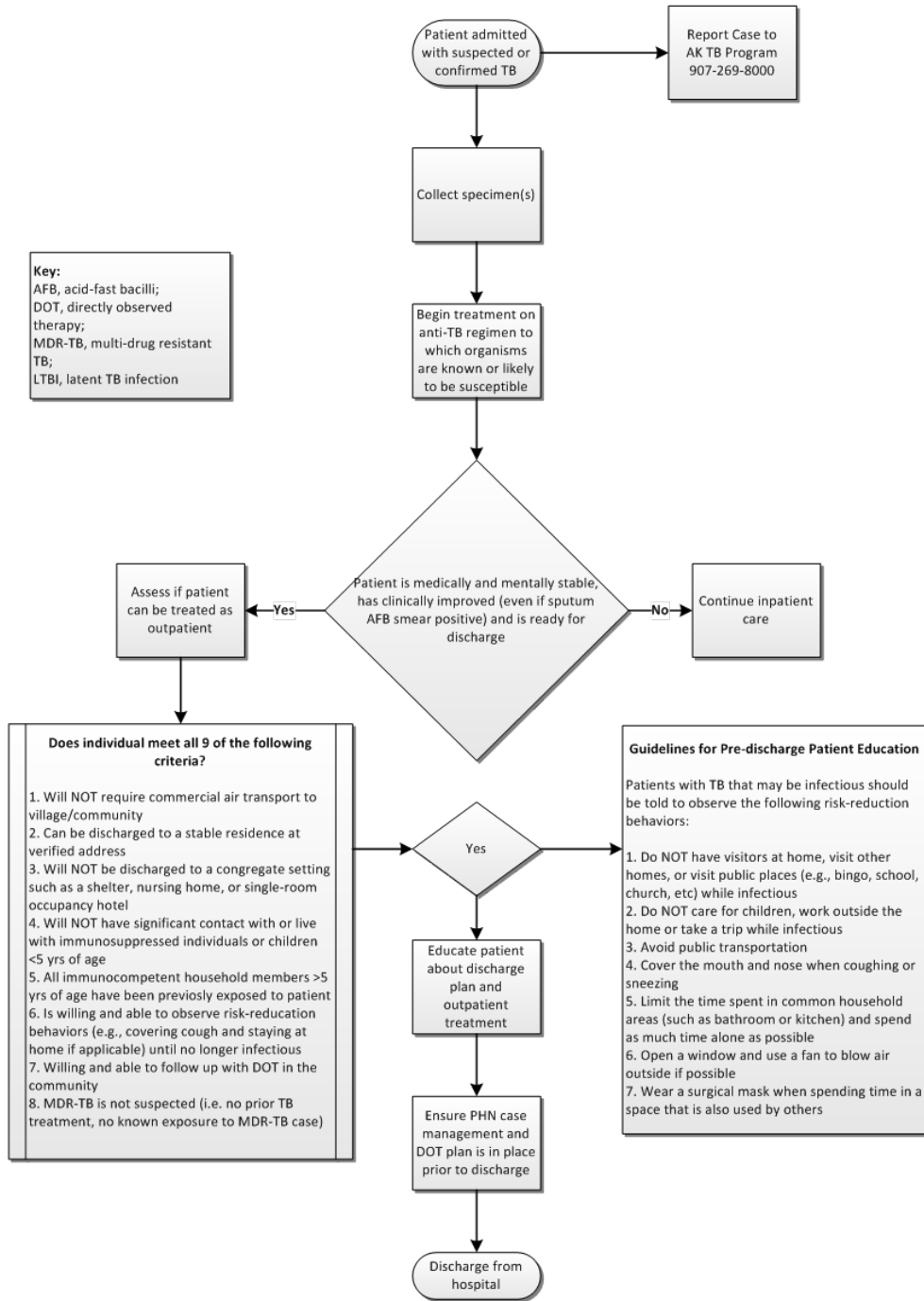


Call the Alaska TB Program for consultation regarding discharge planning and coordination with the local PHN – 907-269-8000.

## Drug-Susceptible Tuberculosis Disease

If a hospitalized patient who has suspected or confirmed drug-susceptible TB disease is deemed medically stable (including patients with positive AFB sputum smear results indicating pulmonary TB disease), the patient can be discharged from the hospital before converting AFB sputum smear results to negative if all the criteria in Figure 2 are met.<sup>43</sup>

Figure 2. **Criteria for Discharging Patients with Suspected or Confirmed Tuberculosis from the Hospital**



Adapted from: New York Department of Health and Mental Hygiene, Bureau of Tuberculosis Control, Clinical Policies and Protocols, 4<sup>th</sup> Edition. March 2008.

Table 9: **HOSPITAL DISCHARGE OF DRUG-SUSCEPTIBLE CASES OF TUBERCULOSIS**<sup>44</sup>

<b>Criteria for Hospital Discharge to Home: Patients with Suspected or Confirmed Drug-Susceptible Tuberculosis</b>
<ul style="list-style-type: none"><li>▪ A specific plan exists for follow-up care with the local PHN and Alaska TB Program</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has been started on a standard multidrug antituberculosis treatment regimen and directly observed therapy (DOT) has been arranged</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ No children aged &lt;5 years or persons with immunocompromising conditions are present in the household</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ All immunocompetent household members have been previously exposed to the patient</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient is willing to not travel outside the home except for healthcare-associated visits until the patient has negative acid-fast bacilli (AFB) sputum smear results</li></ul>

Source: CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005. *MMWR* 2005;54(No. RR-17):43–44.



## Multidrug-Resistant Tuberculosis Disease

Patients with suspected or confirmed MDR-TB disease should remain in the hospital in All until they meet all three of the criteria in Table 10.

Table 10: **HOSPITAL DISCHARGE OF MULTIDRUG-RESISTANT CASES OF TUBERCULOSIS**

<b>Criteria for Hospital Discharge to Home: Patients with Suspected or Confirmed Multidrug-Resistant TB</b>
<ul style="list-style-type: none"><li>▪ The patient has had 3 consecutive negative acid-fast bacilli (AFB) sputum smear results collected 8 to 24 hours apart, with at least 1 being an early morning specimen</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ An appropriate treatment regimen has been devised and at least 2 weeks of multidrug therapy has been given by directly observed therapy (DOT)</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has demonstrated clinical improvement</li><li>▪ Suitable arrangements have been made so that the regimen can be continued and properly monitored on an outpatient basis, specifically by (DOT)</li></ul>

## Release Settings

Patients with suspected or confirmed infectious TB disease should not be released to healthcare settings or homes where the patient can expose others who are at high risk for progressing to TB disease if infected, such as HIV-infected persons or young children.<sup>45</sup> Hospitalized patients returning to a congregate setting (e.g., a homeless shelter or detention facility) should have three consecutive AFB-negative smear results of sputum specimens collected more than eight hours apart before being considered noninfectious.<sup>46</sup>

Patients who have positive AFB sputum smear results should **not** be directly discharged from the hospital to **any** of the following living environments:

- Congregate living site (e.g., shelter, nursing home, jail, prison, group home, another hospital)
- Living situation where infants and young children also reside
- Living situation where immunosuppressed persons (e.g., HIV-infected persons or those taking cancer chemotherapy) also reside
- Living situation where home health aides or other social service providers will be present in the home for several hours a day to care for the person or family member

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## Residential Settings

Patients suspected of having infectious tuberculosis (TB) either are diagnosed during an outpatient workup, or if admitted to a hospital, are often sent home after starting treatment. Patients are sent home, even though they may still be infectious, because they are most likely to transmit TB to household members **before** TB has been diagnosed and treatment has started. However, TB patients and members of their household can take steps to prevent the spread of TB in their home until the patient becomes noninfectious.<sup>47,48</sup>

### Administrative Controls in the Patient's Home

Have a policy and procedure for managing infectious patients at home. To standardize care, the following information should be included:

1. **Definition of key terms:** Infectious case and noninfectious case
2. **Treatment of cases at home whenever possible:** Treat patients at home if their condition does not otherwise require hospitalization.
3. **Window period treatment policy:** Ensure that candidates for window period treatment in the home have completed their evaluation and are on medication before they are discharged home (or as soon as possible if they were not hospitalized).
4. **Education:** Educate infectious patients, family, care providers, and close contacts regarding the purpose of isolation, their responsibility to adhere to the isolation requirements, and the consequences of not voluntarily complying with isolation.
5. **Home isolation agreements:** Have infectious cases in isolation sign a home isolation agreement. This document should include any legal consequences should they fail to voluntarily comply.



The *Tuberculosis Treatment Contract* may be used to document plans for home isolation. It can be found in the Forms section of the manual **18.1**.

## Environmental Controls in the Patient's Home

Generally, there are no special engineering recommendations. However, patients and their families can be advised to do the following:

- Have tissues available for patients to cover their mouths and noses when coughing or sneezing.
- Keep windows and doors open (weather permitting) to increase the ventilation and dilution of infectious droplet nuclei in the house.
- If a sputum sample needs to be collected at home, do so in a well-ventilated area away from other residents (e.g., bathroom with an exhaust fan). If possible, collect the sputum in an outdoor area away from open windows or doors.

## Respiratory Protection in the Patient's Home

### Patient: Mask

- Patients do not need to wear masks at home.
- Give patients regular surgical-type masks and advise them to wear them at medical appointments until they are no longer infectious.
- Do not give patients respirators (N-95 or higher).



For more information on the criteria for noninfectiousness, see the “Determining Noninfectiousness” topic in this section **17.16**.

### Healthcare Worker: Respirator

- Healthcare workers should wear respirators when entering the home or a closed area to visit with infectious patients.
- The respirators should be National Institute for Occupational Safety and Health (NIOSH)-approved (N-95 or higher).
- Healthcare workers should be provided with respirators after appropriate education and fit testing.

## **Other Residential Settings**

### **Motels**

Homeless persons with infectious TB may be housed in a motel that has outside access to rooms (not via hallways).

The motel manager must be advised of the following:

1. The patient is in respiratory isolation.
2. The manager should report to local public health agency staff if the manager becomes aware that the patient does not stay in the room or has guests.
3. The manager should advise motel staff that they are not to enter the room while the patient resides at the motel. (Arrangements should be made that once a week, the patient sets out linens that need to be replaced. The staff can knock on the door and leave the linens for the patient to make his or her own bed.)
4. Upon release from isolation, the room should be aired out for one day before staff enter to clean. Afterwards, routine cleaning done between guests is sufficient, and there are no additional special cleaning requirements.
5. Local public health agency staff will be delivering medication to the patient (specify the frequency).
6. Arrangements have been made for food delivery to the patient.

### **Healthcare Facilities or Residential Settings**

1. Patients with infectious TB should be in appropriate respiratory isolation (airborne infection isolation rooms) when housed in healthcare facilities or residential settings.
2. If a facility does not have the capability to provide appropriate respiratory isolation, the patient should be transferred to a facility that can accommodate respiratory isolation until the patient is noninfectious. Once noninfectious, the person may return to the original facility.

## Return to Work, School, or Other Social Settings

The decision of when to allow a patient to return to work, school, or other social settings should be made in consultation with the Alaska TB Program and/or the local PHN.

The decision to permit a patient to return to work, school, or other social settings is based on the following:

- The characteristics of the patient with TB disease (e.g., whether the patient is likely to adhere to the regimen and follow treatment instructions)
- The characteristics of the TB disease itself (e.g., multidrug-resistant versus drug-susceptible TB, AFB sputum smear-positive versus smear-negative, cavitory versus noncavitory)
- The duration of current treatment (e.g., the patient has received standard multidrug antituberculosis therapy for two-to-three weeks or, if the patient AFB sputum smear that are negative or rarely positive, the threshold for treatment is four-to-seven days)<sup>49</sup>
- The environment(s) to which the patient will be returning



Prior to notifying a patient that he or she is able to return to work or school, call the Alaska TB Program at 907-269-8000 for consultation.

## Drug-Susceptible Tuberculosis Disease

Patients with drug-susceptible TB are no longer considered infectious if they meet all the criteria in Table 11.

Table 11: **RETURN TO WORK, SCHOOL, AND OTHER SETTINGS OF DRUG-SUSCEPTIBLE CASES OF TUBERCULOSIS**<sup>50</sup>

<b>Criteria for Return to Work, School, or Other Social Settings: Patients with Suspected or Confirmed Drug-Susceptible Tuberculosis</b>
<ul style="list-style-type: none"><li>▪ The patient is on adequate therapy for at least 2 weeks <b>AND</b></li><li>▪ The patient has had a significant clinical response to therapy <b>AND</b></li><li>▪ The patient has had 3 consecutive negative acid-fast bacilli (AFB) sputum smear results collected 8 to 24 hours apart, with at least 1 being an early morning specimen</li></ul>

Source: CDC. Module 5: Infectiousness and Infection control. *Self-Study Modules on Tuberculosis* [Division of Tuberculosis Elimination Web site]. 2016. Available at: <https://www.cdc.gov/tb/education/ssmodules/pdfs/Module5.pdf>

## Multidrug-Resistant Tuberculosis (MDR-TB) Disease

Regardless of their occupation, patients known or likely to have pulmonary MDR-TB may be considered for return to work or school only if they meet all four of the criteria in Table 12.

Table 12: **RETURN TO WORK, SCHOOL, AND OTHER SETTINGS OF MULTIDRUG-RESISTANT CASES OF TUBERCULOSIS**

<b>Criteria for Return to Work, School, or Other Social Settings: Patients with Suspected or Confirmed Multidrug-Resistant TB</b>
<ul style="list-style-type: none"><li>▪ The resolution of fever and the resolution, or near resolution, of cough has occurred</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient is on current treatment with an antituberculosis regimen to which the strain is known or likely to be susceptible for at least 2 weeks</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has had 3 consecutive negative acid-fast bacilli (AFB) sputum smear results collected 8 to 24 hours apart, with at least 1 being an early morning specimen</li></ul> <p style="text-align: center;"><b>AND</b></p> <ul style="list-style-type: none"><li>▪ The patient has had a negative culture for <i>Mycobacterium tuberculosis</i></li></ul>
<p>*In addition, directly observed therapy (DOT) should be strongly encouraged for patients with MDR-TB.</p>

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# Tuberculosis Infection Control in Patient Care Facilities

Patients with suspected tuberculosis (TB) may present for care in many different settings. The Centers for Disease Control and Prevention (CDC) has written a comprehensive set of guidelines for TB infection control in acute care hospitals and other medical settings.<sup>51</sup> In addition to the CDC guidelines, various professional organizations or state regulations may have guidelines for managing TB patients.

The main focus in establishing a TB infection control program at a patient care facility is to:

1. assign responsibility for managing the program to a designated staff position;
2. perform and establish a TB risk assessment for the facility; and
3. develop the TB infection control plan based on the level of TB risk identified in the assessment.

The main purpose for having an effective TB infection control plan in a facility is to assure that the activities necessary for TB control are addressed and that policies and procedures are developed to protect the healthcare workers, other patients, and visitors in the facility.

Table 13: **Guidelines for Tuberculosis Infection Control** lists references that provide the information needed to conduct a TB risk assessment and write a TB infection control plan to establish policies and procedures for TB control activities inpatient care facilities.



Call the Alaska TB Program at 907-269-8000 if you have any questions when consulting with institutions on infection control measures.

Table 13: **GUIDELINES FOR TUBERCULOSIS INFECTION CONTROL**

### Guidelines for Tuberculosis Infection Control

The following settings are addressed in the “Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Facilities, 2005” (MMWR 2005;54[No. RR-17]) at <http://www.cdc.gov/mmwr/pdf/rr/rr5417.pdf>

Some settings have additional guidelines as noted below.

#### **Inpatient Settings**

- Emergency departments and urgent care settings
- Intensive care units
- Surgical suites
- Laboratories
- Bronchoscopy suites
- Sputum induction and inhalation therapy rooms
- Autopsy suites and embalming rooms

#### **Outpatient Settings**

- Tuberculosis (TB) treatment facilities
- Medical settings in correctional facilities: Prevention and Control of Tuberculosis in Correctional Facilities. (ACET) (MMWR 1996;45[No. RR-8]) at <http://www.cdc.gov/MMWR/PDF/rr/rr4508.pdf>
- Medical offices and ambulatory care settings
- Dialysis units

#### **Nontraditional Facility-Based Settings**

- Homeless shelter clinics: Prevention and Control of Tuberculosis Among Homeless Persons (ACET) (MMWR 1992;41[No. RR-5]) at <http://www.cdc.gov/mmwr/preview/mmwrhtml/00019922.htm>
- Emergency medical services
- Home-based healthcare and outreach settings
- Long-term care facilities (e.g., hospices, skilled nursing facilities): Prevention and Control of Tuberculosis in Facilities Providing Long-Term Care to the Elderly (MMWR 1990;39[No. RR-10]) at <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001711.htm>

#### **Other References**

- Curry International Tuberculosis Center, 2007: Tuberculosis Infection Control: A Practical manual for Preventing TB [1-171]. Available at: [http://www.currytbcenter.ucsf.edu/products/product\\_details.cfm?productID=WPT-12CD](http://www.currytbcenter.ucsf.edu/products/product_details.cfm?productID=WPT-12CD)



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## Transportation Vehicles

To prevent the transmission of *M. tuberculosis* while transporting patients, follow the respiratory precautions identified below.

### Patient Self-Transport

1. The car windows should be opened, and any recirculating air controls should be turned off.
2. If possible, only household members should accompany the patient. Any members of the patient's household who accompany the patient do not need to wear surgical masks.
3. If the only source for transport is a friend or relative who is not a member of the patient's household:
  - a. The patient should sit in the back seat and wear a surgical mask.
  - b. The car windows should be opened, and any recirculating air controls should be turned off.
  - c. The person accompanying the patient should be given a mask to wear during transport (due to the confined space and lack of ongoing exposure).
4. The patient should wear a surgical mask after leaving the vehicle.<sup>52</sup>

### Transport by Healthcare Workers

1. Healthcare workers should wear respiratory protection (N-95) while in the vehicle.
2. The patient should wear a surgical mask and sit in the back seat.
3. The car windows should be opened, and any recirculating air controls should be turned off.<sup>53</sup>

### Transport by Emergency Medical Services

Emergency medical services staff have specialized vehicles that may have the ability to separate the driver's compartment from the transport compartment and rear exhaust fans. Recommendations for these vehicles and staff are addressed in the Centers for Disease Control and Prevention (CDC) "Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Facilities, 2005" (*MMWR* 2005;54[No. RR-17]:25–26, 88, 127) at <http://www.cdc.gov/mmwr/pdf/rr/rr5417.pdf> .

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# Resources and References

## Resources

- CDC. “Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-care Settings, 2005” (*MMWR* 2005;54[No. RR-17]) at <http://www.cdc.gov/mmwr/pdf/rr/rr5417.pdf>
- CDC. “Guidelines for Environmental Infection Control in Health-care Facilities” (*MMWR* 2003;52[No. RR-10]) at <http://www.cdc.gov/mmwr/PDF/rr/rr5210.pdf>
- CDC. *Interactive Core Curriculum on Tuberculosis* 2011 at <http://www.cdc.gov/tb/education/ce/interactive-corecurr.htm>
- CDC. “Respiratory Protection in Health-Care Settings” (*TB Elimination Fact Sheet* April 2010) at <http://www.cdc.gov/tb/publications/factsheets/prevention/rphcs.pdf>
- CDC. Module 4: “Treatment of TB Infection and Disease” (*Self-Study Modules on Tuberculosis 2008*) at <http://www.cdc.gov/tb/education/ssmodules/pdfs/Module4.pdf>
- CDC. Module 5: “Infectiousness and Infection Control” (*Self-Study Modules on Tuberculosis 2008*) at <http://www.cdc.gov/tb/education/ssmodules/pdfs/Module5.pdf>
- NIOSH. “Respiratory Protection” [ Web page] at <http://www.cdc.gov/niosh/topics/respirators/>
- OSHA. “Tuberculosis: OSHA Standards” [Web page] at <http://www.osha.gov/SLTC/tuberculosis/index.html>
- Curry International Tuberculosis Center, 2007: Tuberculosis Infection Control: A Practical Manual for Preventing TB [1-171]. Available at: [http://www.currytbcenter.ucsf.edu/products/product\\_details.cfm?productID=WPT-12CD](http://www.currytbcenter.ucsf.edu/products/product_details.cfm?productID=WPT-12CD)
- Curry International Tuberculosis Center, 2009: Practical Solutions for TB Infection Control: Infectiousness and Isolation. Available at: [http://www.currytbcenter.ucsf.edu/products/product\\_details.cfm?productID=ONL-13](http://www.currytbcenter.ucsf.edu/products/product_details.cfm?productID=ONL-13)

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- <sup>1</sup> ATS, CDC, IDSA. Controlling tuberculosis in the United States: recommendations from the American Thoracic Society, CDC, and the Infectious Diseases Society of America. *MMWR* 2005;54(No. RR-12):15.
- <sup>2</sup> CDC. Module 5: Infectiousness and Infection control. *Self-Study Modules on Tuberculosis* [Division of Tuberculosis Elimination Web site]. 2016. Available at: <https://www.cdc.gov/tb/education/ssmodules/pdfs/Module5.pdf>
- <sup>3</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):1–2.
- <sup>4</sup> CDC. Prevention and control of tuberculosis in facilities providing long-term care to the elderly. *MMWR* 1990;39(No. RR-10).
- <sup>5</sup> CDC. Prevention and Control of tuberculosis in U.S. communities with at-risk minority populations and prevention and control of tuberculosis among homeless: recommendations of the Advisory Council for the Elimination of Tuberculosis. *MMWR* 1992;41(No. RR-5).
- <sup>6</sup> CDC. Prevention and control of tuberculosis in correctional facilities. (ACET) *MMWR* 1996;45(No. RR-8).

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- <sup>7</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005. *MMWR* 2005;54(No. RR-17):7.
- <sup>8</sup> CDC. Essential components of a tuberculosis prevention and control program: screening for tuberculosis and tuberculosis infection in high-risk populations. *MMWR* 1995;44(No. RR-11):3.
- <sup>9</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):8.
- <sup>10</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):7.
- <sup>11</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):8.
- <sup>12</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):9.
- <sup>13</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):8.
- <sup>14</sup> CDC. Module 1: Transmission and Pathogenesis of Tuberculosis. (*Self-Study Modules on Tuberculosis* 2016). Available at: <https://www.cdc.gov/tb/education/ssmodules/pdfs/Module1.pdf>
- <sup>15</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):7.
- <sup>16</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):75.
- <sup>17</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):77.
- <sup>18</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):78.
- <sup>19</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):39.
- <sup>20</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):39.
- <sup>21</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):39.
- <sup>22</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):38–40.
- <sup>23</sup> Curry International Tuberculosis Center, 2007: Tuberculosis Infection Control: A Practical manual for Preventing TB [58]. Available at: [http://www.currytbcenter.ucsf.edu/products/product\\_details.cfm?productID=WPT-12CD](http://www.currytbcenter.ucsf.edu/products/product_details.cfm?productID=WPT-12CD)
- <sup>24</sup> Sosa LE, Njie GJ, Lobato MN, et al. Tuberculosis Screening, Testing, and Treatment of U.S. Health Care Personnel: Recommendations from the National Tuberculosis Controllers Association and CDC, 2019. *MMWR Morb Mortal Wkly Rep* 2019;68:439–443. DOI: [https://www.cdc.gov/mmwr/volumes/68/wr/mm6819a3.htm?s\\_cid=mm6819a3\\_w](https://www.cdc.gov/mmwr/volumes/68/wr/mm6819a3.htm?s_cid=mm6819a3_w)
- <sup>25</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):28.
- <sup>26</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):85.
- <sup>27</sup> Curry International Tuberculosis Center, 2007: Tuberculosis Infection Control: A Practical manual for Preventing TB [61]. Available at: [http://www.currytbcenter.ucsf.edu/products/product\\_details.cfm?productID=WPT-12CD](http://www.currytbcenter.ucsf.edu/products/product_details.cfm?productID=WPT-12CD)
- <sup>28</sup> CDC. Public Health Measures in Response to SARS: Isolation, Quarantine, and Community Control. *Severe Acute Respiratory Syndrome Fact Sheet*. September 11, 2003:1.
- <sup>29</sup> CDC. Public Health Measures in Response to SARS: Isolation, Quarantine, and Community Control. *Severe Acute Respiratory Syndrome Fact Sheet*. September 11, 2003:1.
- <sup>30</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):43
- <sup>31</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):43
- <sup>32</sup> ATS, CDC, IDSA. Controlling tuberculosis in the United States: recommendations from the American Thoracic Society, CDC, and the Infectious Diseases Society of America. *MMWR* 2005;54(No. RR-12):9.
- <sup>33</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):37.
- <sup>34</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):37.
- <sup>35</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):20
- <sup>36</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):16, 44
- <sup>37</sup> CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 2005. *MMWR* 2005;54(No. RR-17):16, 43.

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