

Case Presentation

Utilizing Precautionary Infection Control Measures

Case History:

An 18-year-old U.S.-born male high school student presented to his cardiologists' office for follow up consultation and scheduled cardiopulmonary stress testing. Previous medical history included severe congenital heart disease and multiple surgical procedures since 1991 with additional surgeries scheduled in the months ahead. During patient evaluation, he revealed the onset of a cough so severe it often caused vomiting. He attributed this cough to his history of marijuana use. Further investigation revealed that the patient also had episodes of hemoptysis associated with the cough. The patient denied any fevers or chills. CT of the chest revealed multiple cavitary lesions and a tree-in-bud appearance within the lingula and right upper lobe. Small non-pathological lymph nodes were present in the mediastinum. The patient denied contact to a TB case or significant travel; a skin test was not placed. He was not able to produce a spontaneous sputum sample so a BAL was performed which was AFB positive. The patient was classified as a TB suspect; antituberculous therapy was started and the treating physician and pulmonologist were advised by the health department to place him on respiratory isolation until sputum smear samples were negative x 3. The patient's graduation was to be held the following day and the treating pulmonologist advocated strongly that the patient be allowed to attend his graduation ceremony with mask usage because he felt the exposure risk was minimal. The sputum sample was later sent for nucleic acid amplification testing (NAA) which was negative for *M. tuberculosis*. Anti-tuberculosis medications had been initiated, but were discontinued once the NAA results were received. The patient was removed from respiratory isolation and the contact investigation was suspended. The patient was allowed to travel via airplane as he had previously planned. Final culture results were pending.

Background:

Infectiousness is directly related to the number of tubercle bacilli the TB patient expels in the air. Patients who expel more bacilli are considered more infectious than those who expel fewer bacilli. The number of bacilli an individual expels is dependent among the following factors:

- Presence of a cough
 - *M. tuberculosis* is carried in airborne particles, or droplet nuclei, generated when a person with pulmonary or laryngeal TB coughs or sneezes. Infection occurs when a susceptible person inhales droplet nuclei containing *M. tuberculosis* bacilli which reach the alveoli of the lungs.¹
- Cavitation on chest radiograph
- Positive acid-fast bacilli (AFB) sputum smear results
- Respiratory tract disease with involvement of the larynx (substantially infectious)
- Respiratory tract disease with involvement of the lung or pleura (exclusive pleural involvement even without visible lung involvement-although less infectious-is associated with a positive culture in 40% of patients)
- Failure to cover the mouth and nose when coughing
- Incorrect, lack of, or short duration of antituberculosis treatment
- Undergoing cough-inducing or aerosol-generating procedures (e.g., bronchoscopy, sputum induction, and administration of aerosolized medications)²
- Virulence of the infecting strain of tuberculosis²

Other factors that increase the likelihood of TB bacilli transmission include environmental factors and host characteristics as listed below.

Environmental Factors³

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

Continued on Page &

Duration of Exposure

- For any specific setting, index patient, and contacts, the optimal cut-off duration is undetermined
- Increasing the intensity and duration of exposure usually increases the likelihood of recent *M. tuberculosis* infection in contacts. Because knowledge is insufficient for providing exact recommendations, cut-off points for duration of exposure are not included; state and local program officials should determine cut-off points after considering published results, local experience, and these guidelines.²

Host Characteristics

The characteristics of the persons exposed to *M. tuberculosis* that may affect the risks of becoming infected are not as well defined:

- Persons who have been infected previously with *M. tuberculosis* are less susceptible to subsequent infection
- In high-prevalence countries, when the risk of new infection is very low, the majority of new adult TB cases results from reactivation of remotely acquired infection
- The effect of human immunodeficiency virus (HIV) infection on the risk of TB infection has not been clearly proven, although HIV is the strongest known risk factor for progression from TB infection to TB disease
- The risk of infection may be increased because of changes in the immune response in the mucosa of bronchi and lung tissue that is affected by silicosis, inhalation of smoke (e.g. tobacco, exposure to cooking fires, industrial exposure)³

The patient featured in this case study was able to be taken out of isolation despite the positive AFB smear once his sputum tested NAA negative. Although, in most individuals with cavitory disease and positive sputum smears, the diagnosis of *M. tuberculosis* would be strongly considered, our patient's past history of multiple surgical and medical interventions for a congenital heart defect coupled with his history of marijuana use made the possibility of a non-tuberculous mycobacterial infection more likely. NAA tests are occasionally falsely negative due to the presence of inhibitors but this is only likely about 3% of the time when smears are AFB positive. If his NAA had been positive, he would have been required to remain in isolation in accordance with the recommendations below.⁴ A surgical mask is inadequate to prevent the transmission of infection and would not have been a reasonable approach in order to allow the patient to attend graduation. Surgical masks decrease the transmission of TB by trapping exhaled respiratory secretions. Masks usually become wet and no longer effective in less than 20 minutes.

The determination of any patient's infectiousness is directly related to each of the factors listed above and each of these factors should be taken into consideration when implementing infection containment procedures including respiratory isolation. TB suspects and cases should be maintained on respiratory isolation until they are cleared and further determined to be non-infectious or an alternative diagnosis is made and TB excluded. TB patients are deemed non-infectious when all of the factors below are present:

- Have received at least two weeks of a standard multi-drug TB regimen² (and HNTC *Guidelines for Home and Hospital Isolation of TB Patients*, in this newsletter, pages (!))
- When there has been clinical improvement
- Have at least three negative sputum smears collected at least 8 hours apart with a minimum of one early morning specimen.
- Have no risk factors for drug resistance (HNTC *Guidelines for Home and Hospital Isolation of TB Patients*, in this newsletter, pages (!))

Hierarchy of Infection Control

Generally any patient suspected or confirmed as having TB disease should be considered infectious until otherwise noted. The patient should be placed on AII (Airborne Infection Isolation) with surgical mask usage and advised against visiting public places until cleared. The risk of exposure to the public, no matter how minimal, should be taken into consideration when a patient's infectiousness is unknown or questionable.

Case Presentation continued from Page &

When referencing to the term "infection control", one must be familiar with the current hierarchy of control measures; see below for definitions.

Administrative Controls:

The first and most important level of the hierarchy, administrative measures, affects the largest number of persons and is intended primarily to reduce the risk of uninfected persons exposed to persons who have TB disease.

Environmental Controls:

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

Respiratory Protective Equipment:

The third level of the hierarchy is the use of respiratory protective equipment in situations that pose a high risk of exposure to *M. tuberculosis*. Use of respiratory protection equipment can further reduce risk for exposure of health care workers (HCWs) to infectious droplet nuclei that have been expelled into the air from a patient with infectious TB disease.⁵

Also note that within diverse environments, e.g. hospitals, home, clinics, and emergency departments, there are numerous infection control procedures that vary within each setting. Remember, no single infection control plan as it relates to tuberculosis control is considered the gold standard. Clinical assessment and judgment should always be applied with each individual patient. (HNTC *Guidelines for Home and Hospital Isolation of TB Patients*, in this newsletter, pages (!))

Teaching Points

- As long as there are viable bacilli that the patient is expelling, there is a possibility for transmission (Dr. Barbara Seaworth, HNTC)
 - Cultures remain the "Gold Standard" for laboratory confirmation of TB and are required for isolating bacteria for drug susceptibility testing and genotyping⁴
 - The relative contagiousness of patients with smear-negative pulmonary results is unknown, but indirect evidence suggests that smear negative disease and even culture negative disease is responsible for transmission⁶
 - Smoking increases the risk and complications of TB
 - Infection control measures reduce but do not eliminate the risk of transmission
 - A contact investigation is recommended if sputum smear has AFB on microscopy, unless the result from an approved NAA test for *M. tuberculosis* is negative⁷
 - MDR and XDR confirmed TB cases are subject to different standards for discontinuance of respiratory isolation including (HNTC *Guidelines for Home and Hospital Isolation of TB Patients*, in this newsletter, pages (!)):
 - Receiving and tolerating appropriate multi-drug anti-TB regimen for at least 2 weeks
 - Demonstrated adherence to DOT (Directly Observed Therapy)
 - Demonstrated clinical improvement
 - Have 3 consecutive negative AFB cultures*
- * *Expert opinion varies; some experts are satisfied with negative smears*

Continued with HNTC **Guidelines for Home and Hospital Isolation of Infectious Tuberculosis Patients** on Pages (&).

Researched and written by: Alisha Blair, LVN; Catalina Navarro, RN; Debbie Onofre, RN.

Footnotes continued on Page *.

Guidelines for Home and Hospital Isolation of Infectious Tuberculosis Patients***

TB Patient Characteristics at Diagnosis	Current Isolation and Release Criteria	Guidelines for Adults and Children with Adult Type Disease*
Sputum Acid Fast Bacilli (AFB) smear positive	Hospitalized under inpatient airborne isolation or home isolation and being released to: <ul style="list-style-type: none"> • General hospitalization, or • Outpatient congregate setting, or • Home or setting with high-risk contacts 	Discharge from airborne isolation patient <i>must</i> meet all the following criteria: <ol style="list-style-type: none"> 1. Have received standard multidrug anti-TB therapy for at least 2 weeks if original AFB smear positive OR on therapy for 5-7 days if original AFB smear was negative 2. Demonstrated adherence to treatment (DOT) 3. Demonstrated clinical improvement 4. Have 3 consecutive negative AFB smears collected at least 8 hours apart with at least 1 early morning specimen 5. Have no risk factors for drug resistance
Sputum AFB smear negative and TB is not suspected or confirmed by NAA testing, another diagnosis is likely	Hospitalized under inpatient airborne isolation and being released to: <ul style="list-style-type: none"> • General hospitalization • Return to school, or • Return to work, or • Travel on public transportation 	Discharge from airborne isolation patient <i>must</i> meet all the following criteria: <ol style="list-style-type: none"> 1. Have 3 consecutive negative AFB smears collected at least 8 hours apart with at least 1 early morning specimen 2. TB is not likely and another diagnosis is identified
Sputum AFB smear negative and TB is suspected or confirmed initially through NAA testing	Hospitalized under inpatient airborne isolation or home isolation and being released to return to normal activities including: <ul style="list-style-type: none"> • General hospitalization • Return to school, or • Return to work, or • Travel on public transportation 	Discharge from home isolation patient <i>must</i> meet all the following criteria: <ol style="list-style-type: none"> 1. Have received standard multidrug anti-TB therapy for ≥ 5-7 days 2. Demonstrated adherence to treatment (DOT) 3. Demonstrated clinical improvement 4. Have 3 consecutive negative AFB smears collected at least 8 hours apart with at least 1 early morning specimen 5. Have no risk factors for drug resistance
TB MDR/ or XDR confirmed infection	Hospitalized under inpatient airborne isolation or home isolation and being released to return to normal activities including: <ul style="list-style-type: none"> • Return to school, or • Return to work, or • Allowed to travel on public transportation 	Discharge from home isolation patient <i>must</i> meet all the following criteria: <ol style="list-style-type: none"> 1. Receiving and tolerating appropriate multidrug anti-TB regimen for 2 weeks 2. Demonstrated adherence to treatment (DOT) 3. Demonstrated clinical improvement 4. Have 3 consecutive negative AFB cultures* <p><i>*Expert opinion varies; some experts satisfied with negative smears</i></p>

A TB suspect or case may be released from hospital to home setting if there are no high risk individuals in the home even if they do not meet the criteria for release from isolation. Clinical judgment and consultation with public health is needed.

<p>Frequently Asked Questions</p> <p>My patient is on home isolation. He has asked if he can go out as long as he wears a mask. What should I say? Patients should stay home unless they have a medical appointment then they should wear a mask. Patients may engage in outdoor activities such as walking.</p> <p>What if the patient cannot produce sputum – how do we tell if the patient has converted to smear or culture negative? Every effort should be made to obtain sputum including induced sputum through respiratory therapy. However, a few patients cease to produce sputum before conversion to smear or culture negative can be confirmed. For these patients, you will need to use clinical judgment such as symptom resolution and CXR improvement.</p> <p>What if the patient is non adherent with home isolation but is adherent with DOT? Most states have legislation to obtain a legal order that covers both isolation and adherence to treatment. If the patient is documented non adherent with home isolation, check the legal authority you have in your jurisdiction to enforce isolation.</p> <p>What if the patient remains smear positive but cultures come back negative? As long as <u>cultures</u> are negative the specimens contain nonviable organisms. The mycobacteria are dead and not capable of spreading disease. The patient may be released from isolation.</p>	<p>Factors that Predict Likely Transmission of TB</p> <p>Release from isolation may involve judgment calls on the part of the public health authority. These are the factors to take into account when considering whether or not a patient is non-infectious:</p> <p>Anatomical site Pulmonary, laryngeal or pleural TB disease - infectious; laryngeal tends to be the most infectious</p> <p><u>Sputum bacteriology</u> Positive culture and AFB smear indicates more efficient transmission than if positive culture and negative smear</p> <p>Radiographic findings Cavities on chest radiographs and extensive infiltrates are associated with more transmission than noncavitary chest radiographs and limited disease</p> <p><u>Behaviors that increase transmission</u> Frequent coughing Singing Poor cough etiquette Behavior such as shouting High sociability of the index patient</p> <p><u>Age</u> Children aged < 10 years old are unlikely to transmit TB unless the CXR is similar to adult type disease (especially cavitary)</p> <p><u>HIV status</u> HIV positive patients are as infectious as non-HIV positive patients</p> <p><u>Administration of effective treatment/Adherence to treatment and DOT</u> The exact rate of decrease in viable mycobacterial organisms cannot be predicted. Some patients with severe disease will remain smear and culture positive after several weeks of treatment. Treatment with both isoniazid and rifampin is associated with a more rapid conversion of smears and cultures to negative.</p>	<p>References</p> <p><i>Guidelines for the Investigation of Contacts of Persons with Infectious Tuberculosis: Recommendations from the National Tuberculosis Controllers Association and CDC.</i> Centers for Disease Control and Prevention. MMWR: December 16, 2005; Volume 54 (RR-15); p1-37.</p> <p><i>Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Settings.</i> Centers for Disease Control and Prevention. MMWR: December 30, 2005; Volume 54 (RR17).</p> <p>Heartland National TB Center 2303 SE Military Drive San Antonio, Texas 78223 1-800-TEX-LUNG (1-800-839-5864) www.HeartlandNTBC.org</p> <p><small>THE UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT TYLER</small> HEARTLAND <i>NATIONAL TB CENTER</i> <small>A PARTNERSHIP OF UT HEALTH SCIENCE CENTER AND TCID</small></p>
---	--	--

*Cavitary infiltrate
Clinical assessment and judgment should always be applied with each individual patient
***Individuals who are returning to work or live in environments with immunocompromised individuals (neonates, HIV+, transplant recipients, etc.) should be considered individually. More conservative measures should be considered.

Case Presentation continued from Page (

Footnotes:

1. University of North Carolina at Chapel Hill Environment Health and Safety. *Tuberculosis and Infection Control*. 2003. http://ehs.unc.edu/training/self_study/tb.shtml
2. Centers for Disease Control and Prevention. *Controlling Tuberculosis in the United States: Recommendations from the American Thoracic Society, CDC, and the Infectious Disease Society of America*. MMWR 2005; 54 (No. RR-12); pages 7 and 29.
3. World Health Organization. *Guidelines for the Prevention of Tuberculosis in the Healthcare Facilities in Resource Limited Settings*. 1999. http://www.who.int/tb/publications/who_tb_99_269.pdf
4. Centers for Disease Control and Prevention. *Updated Guidelines for the Use of Nucleic Acid Amplification Tests in the Diagnosis of Tuberculosis*. MMWR 2009; 58 (01); pages 7-10.
5. Centers for Disease Control and Prevention. *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Settings, 2005*. MMWR 2005; 54 (No. RR-17).
6. Sepkowitz, Kent A. *Tuberculosis Control in the 21st Century*. *Emerging Infectious Diseases*. 2001; 7 (No.2): pages 259-262.
7. Centers for Disease Control and Prevention. *Guidelines for the Investigation of Contacts of Persons with Infectious Tuberculosis: Recommendations from the National Tuberculosis Controllers Association and CDC*. MMWR 2005; 54 (No. RR-15, 1-37); page 5.

Heartland National TB Center provides a **Medical Consultation Line** that is staffed Monday to Friday, 8:00 AM to 5:00 PM (CST). After business hours, voice mail is available and will be returned in one business day:

Toll Free Telephone Number: 1-800-TEX-LUNG (1-800-839-5864)



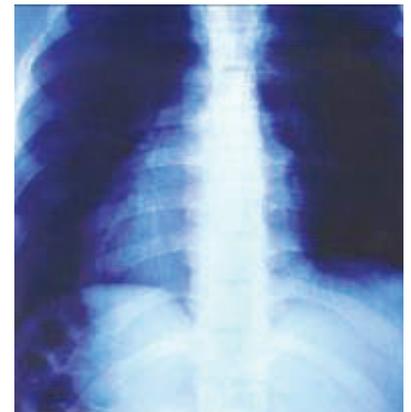
THE UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT TYLER

HEART *Land*
NATIONAL TB CENTER

A PARTNERSHIP OF UT HEALTH SCIENCE CENTER AND TCID

• Expertise • Excellence • Innovation

**2303 SE Military Drive
San Antonio, Texas 78223**



The MISSION of the Heartland National TB Center is to build capacity with our partners. We will share expertise in the treatment and prevention of tuberculosis by: developing and implementing cutting-edge trainings, delivering expert medical consultation, providing technical assistance, and designing innovative educational and consultative products.