Tuberculosis Elimination:
The Role of the Infection Preventionist
Preface: What Happens when Health Care Professionals are not familiar with TB?

- A 15 year old student was diagnosed with highly infectious pulmonary tuberculosis in May 2001.
- Presented to his primary care provider upper respiratory symptoms and a frequent cough.
- A chest x-ray revealed a right upper lobe infiltrate and small cavitary lesion – classic signs of tuberculosis, but his physician did not diagnose TB and instead treated the student for pneumonia.
- **Five months** and at least 10 visits to area health clinics for worsening signs and symptoms passed before a correct diagnosis was made, and treatment was initiated.
- Out of 740 high school students and staff screened for TB infection, 49 were found with latent tuberculosis infection (LTBI) and 1 was diagnosed with active disease (6).
- The **delay** in diagnosis was implicated not only as a contributing factor in the outbreak, but also in the severity of the student’s illness.

1. Know Your Risk
TB Case Rates,* United States, 2017

2017 national average = 2.8 cases per 100,000

*Cases per 100,000.
2017 Texas TB

- 1,127 Cases reported – 4.5 cases/100,000 population (9.8% decrease from 2016)
  - 53% Hispanics
  - 19% African American
  - 20% Asian
  - 9% Caucasian
- 8 cases of MDR TB
- 0 case XDR TB

https://www.dshs.state.tx.us/idcu/disease/tb/statistics/
Table 16: TB Case Count and Rate by Health Service Region, 2013-2017

<table>
<thead>
<tr>
<th>Health Service Region</th>
<th>2013</th>
<th>Rate*</th>
<th>2014</th>
<th>Rate*</th>
<th>2015</th>
<th>Rate*</th>
<th>2016</th>
<th>Rate*</th>
<th>2017</th>
<th>Rate*</th>
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<tr>
<td>HSR 1</td>
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<td>307</td>
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<td>43</td>
<td>2.9</td>
<td>41</td>
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<td>1.8</td>
<td>29</td>
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<td>3</td>
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<td>2.7</td>
<td>70</td>
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<td>118</td>
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<td>3.8</td>
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<td>47</td>
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<td>9.7</td>
<td>166</td>
<td>7.2</td>
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<tr>
<td>TDCJ</td>
<td>13</td>
<td>-</td>
<td>23</td>
<td>-</td>
<td>28</td>
<td>-</td>
<td>29</td>
<td>-</td>
<td>17</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>1221</td>
<td>-</td>
<td>1269</td>
<td>-</td>
<td>1333</td>
<td>-</td>
<td>1250</td>
<td>-</td>
<td>1127</td>
<td>-</td>
</tr>
</tbody>
</table>

https://www.dshs.state.tx.us/idcu/disease/tb/statistics/
Risk Factors Associated with TB Cases Reported in Texas in 2017

- Born Outside of the US: 61.14%
- Diabetes: 18.81%
- Alcohol Abuse: 11.45%
- Correctional Facility Res: 8.34%
- HIV/AIDS: 6.50%
- Homeless: 3.55%

[Link to the source] https://www.dshs.state.tx.us/idcu/disease/tb/statistics/
Number of TB Cases in U.S.-born vs. Foreign-born Persons, United States, 1993–2017*

*Updated as of January 07, 2019
Thirty-Two Texas Border Counties*

*As defined by the La Paz Agreement
TB INCIDENCE RATE: BORDER VS. NON-BORDER
TEXAS, 2000-2010

*Cases per 100,000 population. Population estimates from Texas Vital Web Population

* Excludes TDCJ cases
2. Know your disease
Mycobacterium Tuberculosis

- Tuberculosis is a chronic, granulomatous disease caused by the microorganism *Mycobacterium tuberculosis*

- Tuberculosis is an ancient disease
  - prehistoric human bones show tuberculous damage
  - mummies have been shown to contain AFB
  - drawings from ancient Egyptian times show people with characteristic tuberculous deformities
Mycobacteria

• There are >70 species of mycobacteria
• Of these, two are major pathogens:
  – *Mycobacterium tuberculosis* (Koch, 1882)
  – *Mycobacterium leprae* (Hansen, 1874)
• *M. tb* complex (*M. tb, M. bovis, M. africanum, M. microti, M. canetti, M. caprae, M. pinnipedi, and M. mungi*) can cause TB disease
• Majority of TB cases caused by *M. tb*
• The remaining mycobacteria are environmental organisms—collectively known as Non-tuberculous Mycobacteria
  – Some of these organisms are responsible for opportunistic infections, especially in people with AIDS (*M. avium, M. fortuitum, etc.*)
Transmission of *M. tuberculosis*

- *M. tb* spread via airborne particles called droplet nuclei
- Expelled when person with infectious TB coughs, sneezes, shouts, or sings
- Transmission occurs when droplet nuclei inhaled and reach the alveoli of the lungs, via nasal passages, respiratory tract, and bronchi
Probability TB Will Be Transmitted

• Susceptibility of the exposed person
• Infectiousness of person with TB (i.e., number of bacilli TB patient expels into the air)
• Environmental factors that affect the concentration of *M. tb* organisms
• Proximity, frequency, and duration of exposure (e.g., close contacts)
• Can be transmitted from children, though less likely
Pathogenesis

Droplet nuclei containing tubercle bacilli are inhaled, enter the lungs, and travel to the alveoli.

Tubercle bacilli multiply in the alveoli.
Pathogenesis

A small number of tubercle bacilli enter the bloodstream and spread throughout the body. The tubercle bacilli may reach any part of the body, including areas where TB disease is more likely to develop (such as the brain, larynx, lymph node, lung, spine, bone, or kidney).
Pathogenesis

Within 2 to 8 weeks, special immune cells called macrophages ingest and surround the tubercle bacilli. The cells form a barrier shell, called a granuloma, that keeps the bacilli contained and under control (LTBI).

If the immune system cannot keep the tubercle bacilli under control, the bacilli begin to multiply rapidly (TB disease). This process can occur in different areas in the body, such as the lungs, kidneys, brain, or bone.
Latent TB Infection (LTBI)

- Granulomas may persist (LTBI), or may break down to produce TB disease
- 2 to 8 weeks after infection, LTBI can be detected via TST or interferon-gamma release assay (IGRA)
- The immune system is usually able to stop the multiplication of bacilli
- Persons with LTBI are not infectious and do not spread organisms to others
TB Disease

- In some, the granulomas break down, bacilli escape and multiply, resulting in TB disease
- Can occur soon after infection, or years later
- Persons with TB disease are usually infectious and can spread bacteria to others
- Positive *M. tb* culture confirms TB diagnosis
Don’t forget extrapulmonary TB

- Other organs can be involved besides the lung including:
  - Bones and joints
  - Bronchus
  - Cervical lymph nodes
  - Eye
  - Larynx (voice box)
  - Lining of the abdominal cavity
  - Lining of the brain and spinal cord (meninges)
  - Lining of the heart
  - Organs of the urinary and reproductive systems
  - Skin
  - Small bowel
  - Stomach
Sites of Disease

- Lungs (pulmonary): most common site; usually infectious
- Miliary: occurs when bacilli spread to all parts of the body; rare, but fatal if untreated
- Central nervous system: usually occurs as meningitis, but can occur in brain or spine
Sites of Disease (cont.)

- Outside the lungs (extrapulmonary): usually not infectious, unless person has
- Concomitant pulmonary disease,
- Extrapulmonary disease in the oral cavity or larynx, or
- Extrapulmonary disease with open site, especially with aerosolized fluid.
# LTBI vs. TB Disease

<table>
<thead>
<tr>
<th>Person with LTBI (Infected)</th>
<th>Person with TB Disease (Infectious)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has a small amount of TB bacteria in his/her body that are alive, but inactive</td>
<td>Has a large amount of active TB bacteria in his/her body</td>
</tr>
<tr>
<td>Cannot spread TB bacteria to others</td>
<td>May spread TB bacteria to others</td>
</tr>
<tr>
<td>Does not feel sick, but may become sick if the bacteria become active in his/her body</td>
<td>May feel sick and may have symptoms such as a cough, fever, and/or weight loss</td>
</tr>
<tr>
<td>Usually has a TB skin test or TB blood test reaction indicating TB infection</td>
<td>Usually has a TB skin test or TB blood test reaction indicating TB infection</td>
</tr>
<tr>
<td>Radiograph is typically normal</td>
<td>Radiograph may be abnormal</td>
</tr>
<tr>
<td>Sputum smears and cultures are negative</td>
<td>Sputum smears and cultures may be positive</td>
</tr>
<tr>
<td>Should consider treatment for LTBI to prevent TB disease</td>
<td>Needs treatment for TB disease</td>
</tr>
<tr>
<td>Does not require respiratory isolation</td>
<td>May require respiratory isolation</td>
</tr>
<tr>
<td>Not a TB case</td>
<td>A TB case</td>
</tr>
</tbody>
</table>
Drug-Resistant TB

- Caused by organisms resistant to one or more TB drugs
- Transmitted same way as drug-susceptible TB, and no more infectious
- Delay in detecting drug resistance may prolong period of infectiousness because of delay in starting correct treatment
- MDR TB caused by bacteria resistant to best TB drugs, isoniazid and rifampin
- XDR TB caused by organisms resistant to isoniazid and rifampin, plus fluoroquinolones and ≥1 of the 3 injectable second-line drugs
Drug-Resistant TB

- Drug resistance develops in two ways:
  - Primary resistance develops in persons initially infected with resistant organisms
  - Secondary (acquired) resistance develops during TB therapy
"Totally drug-resistant" tuberculosis strain worries Indian doctors

By CBS News Staff  Topics News, Disease

January 16, 2012 2:16 PM

Mohammed Shamim Sheikh, who suffers from multi-drug-resistant tuberculosis, listens to a social worker at his home in a slum on the outskirts of Mumbai, India, Monday, Jan. 16, 2012. (Credit: AP)

(CBS/AP) Totally drug-resistant tuberculosis? That's what doctors are calling the long-feared and virtually untreatable form of the killer lung disease that's striking people in India.
Methods for Detecting *M. tb* Infection in U.S.

- Mantoux tuberculin skin test (TST)
- IGRAs:
  - QuantiFERON-TB Gold In-Tube (QFT-GIT)®, and
  - T-Spot.*TB*®
- These tests **do not** exclude LTBI or TB disease
- Decisions about medical/public health management should include other info/data, and not rely only on TST/IGRA results
# Factors that May Affect the Skin Test Reaction

<table>
<thead>
<tr>
<th>Type of Reaction</th>
<th>Possible Cause</th>
</tr>
</thead>
</table>
| False-positive   | • Nontuberculous mycobacteria  
|                  | • BCG vaccination  
|                  | • Problems with TST administration  |
| False-negative   | • Anergy  
|                  | • Viral, bacterial, fungal coinfection  
|                  | • Recent TB infection  
|                  | • Very young age; advanced age  
|                  | • Live-virus vaccination  
|                  | • Overwhelming TB disease  
|                  | • Renal failure/disease  
|                  | • Lymphoid disease  
|                  | • Low protein states  
|                  | • Immunosuppressive drugs  
|                  | • Problems with TST administration  |
3. Know what to do.
Prompt Triage

Think TB!

• Primary TB risk to HCWs is patient with undiagnosed or unrecognized infectious TB

• Promptly initiate All precautions and manage or transfer patients with suspected or confirmed TB
  – Ask about and evaluate for TB
  – Check for signs and symptoms
  – Mask symptomatic patients (barrier mask)
  – Separate immunocompromised patients
Criteria for Initiating All Precautions

- Patient has symptoms or signs of TB disease

Or

- Patient has documented infectious TB disease and has not completed anti-TB treatment

- You won’t know if you don’t ask!
Clinical Diagnosis

- Obtain medical history and physical exam
- Place patients with suspected or known infectious TB disease under Airborne Precautions until determined to be noninfectious
- Evaluate persons with extrapulmonary TB for concurrent pulmonary TB disease
- Although normally not infectious, children should be evaluated for infectiousness
Medical Evaluation for TB

• Chest radiography

• Evaluation of specimens
  – Smear
  – Culture
  – Drug susceptibility testing

• Recommend against using bronchoscopy because of risk of transmission
Medical Evaluation for TB
Bacteriologic Examination of Specimens

Specimen collection, processing, and review

• All persons suspected of TB disease should have sputum cultured

• Collect at least 3 sputum specimens at 8- to 24-hour intervals, at least 1 in the morning

• Follow infection control precautions during specimen collection

• Collection methods include coughing, sputum induction, bronchoscopy, gastric aspiration
Direct Detection Using Nucleic Acid Amplification (NAA)

• NAA tests rapidly identify a specimen via DNA and RNA amplification

• Benefits may include
  – Earlier lab confirmation of TB disease
  – Earlier respiratory isolation and treatment initiation
  – Improved patient outcomes; interruption of transmission

• Perform at least 1 NAA test on each pulmonary TB suspect

• A single negative NAA test does not exclude TB
Culture

- Remains gold standard for confirming diagnosis of TB
- Culture all specimens, even if smear or NAA negative
- Results in 4–14 days when liquid medium systems used
- Culture monthly until conversion, i.e., 2 consecutive negative cultures
Colonies of *M. tuberculosis* Growing on Media
Infectiousness

- Directly related to number of bacilli-laden droplets expelled into the air
- Infection occurs when person inhales droplets, which travel to alveoli
- Young children with TB less likely to be infectious, but can transmit *M. tb*
- Infectiousness usually declines rapidly with treatment
  - However, some remain infectious for weeks or months
Infectiousness (cont.)

Patient factors associated with infectiousness:

• Coughing
• Cavity in the lung
• Sputum smears positive for acid-fast bacilli (AFB)
• TB disease of the lungs, airway, or larynx
• Undergoing cough-inducing or aerosol-generating procedures
• Not receiving adequate therapy
• Culture positive
Transmission in Smear-negative TB

- Smear-negative, culture positive TB accounted for
  - 17% of transmission in San Francisco
    - Behr M et al, Lancet 1999; 353:444
  - 17-22% of transmission in Vancouver, B.C.
Criteria to Be Considered Noninfectious

Patients no longer considered infectious if:

• They have 3 consecutive negative sputum smears,

• Their symptoms have improved, and

• They are adhering to an adequate treatment regimen for at least 2 weeks
Environmental Factors that Enhance Risk of Transmission

- High concentration of droplet nuclei in the air
- Exposure in small, enclosed spaces
- Poor ventilation that inadequately dilutes or removes droplet nuclei
- Recirculation of air containing droplets
- Improper specimen handling procedures
- Positive air pressure in patient’s room causing flow to other areas
TB Infection Control Measures

• TB infection control (IC) measures should be based on TB risk assessment for the setting

• The goals of IC programs are
  – Detect TB disease early and promptly
  – Isolate persons with known/suspected TB
  – Start treatment in persons with known/suspected TB
Detection of TB Disease

• Primary risk in health-care settings: unsuspected persons with TB disease
• Protocols for detecting, isolating, and managing TB suspects should be implemented
• Staff admitting patients should be trained to know signs/symptoms of TB
Collaborate with Health Department

- Seek state or local TB program assistance in planning and implementing TB control activities.

- State or local health department must be notified about suspected or confirmed TB disease such that follow-up, community contact investigation, and completion of therapy can be ensured.
Airborne Precautions

• Separate and isolate persons with TB signs/symptoms
  – Preferably use airborne infection isolation (AII) room
    • Single-patient room with private bathroom
    • Negative pressure relative to hallway
    • Air sent outdoors or through HEPA filter
    • Six or more air changes per hour (in some settings 12 or more air changes per hour are recommended)
    • Visitors should use N95 respirator

• Continue precautions until 3 negative smears, 2 weeks therapy, and improved symptoms

• Start TB patients/suspects on standard TB therapy
Discharge to Home

• Patient can be discharged without 3 negative sputum smears if
  – Follow-up plan has been made with local TB program
  – Patient is on standard treatment and directly observed therapy (DOT) is arranged
  – No person in home <4 years old or immunocompromised
  – All in household previously exposed
  – Patient willing to stay home until sputum results negative

• Do not release if high-risk persons will be exposed – Maybe unrealistic.
4. Do it.
Core Curriculum on Tuberculosis: What the Clinician Should Know

Sixth Edition 2013
What You should know about Tuberculosis

Questions?