TB Infection Control in Healthcare Settings

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Objectives

- Understand the epidemiology of TB in health care settings and risk factors for transmission
- Review the elements of a TB infection control program
- Understand the implementation of different aspects of environmental and respiratory controls
How contagious is tuberculosis?

- Factors in influencing TB transmission
  - Source case (*AFB smear status, treatment status, frequency of cough)
  - The environment
    - Among household contacts of smear-positive cases, the rates of tuberculin positivity are 30-50% above those among age-matched community controls
  - Duration and intensity of exposure
  - The contact
  - The tubercle bacillus

Sepkowitz, KA, 1996
How contagious is tuberculosis?

- Smear positive cases expectorate $10^8$-$10^{10}$ bacilli daily (or about $10^6$-$10^7$ AFB/ml sputum)
- Smear negative sputum contains < $10^3$ bacilli/ml of sputum
- Treatment decreases contagiousness, regardless of smear and culture status by decreasing the number of bacilli expectorated + introduces antibiotic into the infectious droplet nuclei
TB Transmission

- Person-to-person transmission of TB occurs via inhalation of droplet nuclei (airborne particles 1-2 microns in diameter – approximately 1/100^{th} the width of a human hair)
- Droplet nuclei can remain airborne in room air for a long period of time (until removed by natural or mechanical ventilation)
- Persons with active pulmonary or laryngeal TB are contagious (especially if a cavity is present or when the sputum is acid-fast-bacilli (AFB) smear positive)
- Coughing, sneezing, singing, shouting, talking or breathing
TB Transmission

- Patients with sputum that is smear negative but culture positive pulmonary TB are still contagious
- Procedures associated with the dissemination of droplet nuclei have been associated with an increased risk of TB (ET, bronchoscopy, sputum induction, aerosol treatments, irrigation of abscess, autopsy)
- Most exposed persons do not become infected
Environmental Factors That Increase Risk for Transmission

- Exposure in small, enclosed spaces
- Inadequate ventilation
- Recirculating air containing infectious droplets
- Inadequate cleaning and disinfection of equipment
- Improper specimen-handling procedures
TB Transmission

Source patient
- Infectious TB of lungs or larynx
- Smear positivity

Susceptible host
- Inhales droplet nucleii containing TB

TB Exposure
- Disease
- Infection
TUBERCULOSIS ROBS YOU
PUBLIC HEALTH PROTECTS YOU
CHRISTMAS SEALS FINANCE THE CAMPAIGN AGAINST TUBERCULOSIS
TB Infection versus TB Disease

- Latent TB infection (LTBI) is identified with a tuberculin skin test (TST) or interferon gamma release assay (IGRA) blood test
- LTBI does not cause a person to be sick and there are no symptoms
- Persons with LTBI are not infectious
Latent Tuberculosis Infection

LTBI progresses to TB disease in

- Small number of persons soon after infection
- 5%–10% of persons with untreated LTBI sometime during lifetime
- About 10% of persons with HIV and untreated LTBI per year
TB Infection versus TB Disease

- High risk persons for progression from LTBI → TB disease
  - HIV infected persons, diabetes, renal conditions (dialysis), immune compromised persons
  - Infection with *M. tuberculosis* within the last 2 years
  - Infants and children < 4 years old
  - Immune compromising situations (cancer therapy, prolonged steroid use)
  - History of untreated or inadequately treated TB
TB in Healthcare workers: risk

- Varies by healthcare setting
- Occupational group
- Prevalence of TB in the community
- Patient population
- Effectiveness of TB infection control measures
- Procedures
A Case

- 62 year old Vietnamese male with a long history of smoking presents to pulmonary clinic in December (12/2) for an outpatient evaluation of a L hilar mass and LUL consolidative area (5.8x5.3 cm) with a cavitary lesion. Daughter present as translator.

- Presenting symptoms included dyspnea on exertion, dry cough, poor appetite x 4 months, weight loss. No history of hemoptysis. No night sweats endorsed on initial visit. Spirometry obtained. Labs.

- Multiple tests ordered and scheduled after initial visit.

- Patient returns January 4 for ABG, walk oximetry, PFTs, PET CT.

- Returns in February to discuss test results. Induced sputums ordered at February 9 visit.
Fundamental Control Measures

- Designating responsibility for TB infection control
- It should be part of a comprehensive infection control plan (ICP)
- Having a written infection control plan
- Infection control efforts coordinated with local health departments
- All healthcare workers need to be educated regarding TB epidemiology, symptoms, transmission, and prevention
Appropriate signage should be posted providing instructions for appropriate respiratory hygiene/cough etiquette
Fundamentals of TB infection control

- **Administrative controls**
  - Reduce the risk of exposure to persons who might have TB disease

- **Environmental controls**
  - Prevent the spread and reduce the concentration of infectious droplet nuclei in ambient air

- **Respiratory-infection controls**
  - Use of respiratory protective equipment in situations that pose a high risk for exposure
What did we learn from prior “nosocomial” or health care associated outbreaks?

- Outbreaks in the 1980’s – 1990’s paralleled the increase in the prevalence of HIV and TB co-infection
- Lapses in infection control practices
- Delays in diagnosis and treatment of persons with infectious TB
- The appearance and transmission of MDR TB strains
- Mirrored the overall increase in TB
Outbreak: MDR-TB-AIDS (NYC)

N=18, Attack rate = 6%, Incubation 50-180d (1989-90)

Transmission in healthcare facilities

- Contributing factors for nosocomial transmission
  - Deterioration of public health infrastructure
  - Human immunodeficiency virus (HIV epidemic)
  - Inadequate infection control measures
Outbreak: Failures

- Failure to isolate
- Failure to separate AIDS and TB patients
- No negative pressure rooms
- No respirators

Risk Factors for Active Pulmonary Tuberculosis

- History of Pulmonary Tuberculosis
- Prior positive tuberculin skin test (TST) or interferon-gamma assay
- Emigration from a country with an increased prevalence of TB
- Homelessness
- Prior incarceration
- Immune suppression (including HIV) with cough>2 weeks, hemoptysis, fevers, night sweats, weight loss
Recognize possible signs and symptoms of Tuberculosis. Early diagnosis and treatment reduces spread. Contact your Health Department or physician for more information.
Outpatient and Emergency Room Management

- Patients with active TB may frequently present in an outpatient setting or Emergency Department
- Ask about signs of symptoms of TB and know the risk factors
- It is imperative that these patients be promptly identified and evaluated to minimize exposure to others
- Patients with known or suspected TB should be placed in an airborne infection isolation (AII) room (previously referred to as negative pressure isolation rooms)
- If an isolation room is not available, the patient should be placed in an enclosed area with a surgical mask in place
Ambulatory Care Settings

- Contact with immune compromised patients should be avoided
- The patient should be instructed to cover the mouth and nose with tissues when sneezing or coughing
- If an area other than an airborne infection isolation room is used, it should not be used again for one hour after the patient has left
- Contact the infection preventionist or the designee who is knowledgeable in managing these issues
- Avoid unnecessary aerosol-inducing procedures on these individuals
Back to our case....

- Sputum results come back.....
- 1+ AFB smear positive
- Friday afternoon
Administrative Controls

- Infection control program and plan
  - Administrative commitment, infrastructure
- Annual TB risk assessment: low, medium or potential for ongoing transmission
- Monitoring and re-evaluation
TB Risk Classifications

- All healthcare settings should perform risk classification as part of risk assessment to determine need for and frequency of an HCW testing program, regardless of likelihood of encountering persons with TB disease.
TB Risk Classifications

- **Low risk** – Persons with TB disease not expected to be encountered; exposure unlikely
- **Medium risk** – HCWs will or might be exposed to persons with TB disease
- **Potential ongoing transmission** – Temporary classification for any settings with evidence of person-to-person transmission of *M. tuberculosis*
# TB Risk Classifications

## Inpatient Settings

<table>
<thead>
<tr>
<th>Inpatient Settings</th>
<th>Low</th>
<th>Medium</th>
<th>Potential Ongoing Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;200 beds</td>
<td>&lt;3 TB patients/yr</td>
<td>≥3 TB patients/yr</td>
<td>Evidence of ongoing transmission, regardless of setting</td>
</tr>
<tr>
<td>≥200 beds</td>
<td>&lt;6 TB patients/yr</td>
<td>≥6 TB patients/yr</td>
<td></td>
</tr>
</tbody>
</table>
## TB Risk Classifications

<table>
<thead>
<tr>
<th>Outpatient Settings</th>
<th>Low</th>
<th>Medium</th>
<th>Potential Ongoing Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB treatment facilities, medical offices, ambulatory care settings</td>
<td>&lt;3 TB patients/yr</td>
<td>&gt;3 TB patients/yr</td>
<td>Evidence of ongoing transmission, regardless of setting</td>
</tr>
</tbody>
</table>
## TB Risk Classifications

<table>
<thead>
<tr>
<th>Nontraditional Facility-based Settings</th>
<th>Low</th>
<th>Medium</th>
<th>Potential Ongoing Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency medical service (EMS), medical settings in correctional facilities, outreach care, long-term care facilities</td>
<td>Only patients with LTBI treated</td>
<td>Settings where TB patients are expected to be encountered</td>
<td>Evidence of ongoing transmission regardless of setting</td>
</tr>
<tr>
<td></td>
<td>No cough-inducing procedures are performed in setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>System to detect/triage persons with TB symptoms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Administrative Controls

1. Triage
2. Isolate
3. Diagnose
4. Treat
Sensitivity of AFB Smear

<table>
<thead>
<tr>
<th>Test</th>
<th>Specimen no.</th>
<th>No. of patients*</th>
<th>% of times the test was first positive</th>
<th>Cumulative yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smear</td>
<td>1st test</td>
<td>499</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>2nd test</td>
<td>349</td>
<td>17</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>3rd test</td>
<td>217</td>
<td>10</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>4th test</td>
<td>64</td>
<td>7</td>
<td>98</td>
</tr>
</tbody>
</table>

Sensitivity of AFB Smear

Table 2. AFB smear sensitivity in culture-confirmed PTB cases*

<table>
<thead>
<tr>
<th>Smear</th>
<th>Overall N = 425</th>
<th>HIV negative N = 239</th>
<th>HIV positive N = 142</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>67%</td>
<td>75%</td>
<td>57%</td>
</tr>
<tr>
<td>2</td>
<td>71%</td>
<td>79%</td>
<td>61%</td>
</tr>
<tr>
<td>3</td>
<td>72%</td>
<td>80%</td>
<td>62%</td>
</tr>
</tbody>
</table>

Infectiousness of AFB smear-negative disease

- Estimated 17% of transmission events due to smear negative case
- Compared to smear positive cases, 22% as likely to transmit TB

<table>
<thead>
<tr>
<th>Source-Case Variables</th>
<th>Tuberculin Reactors (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteriologic status</td>
<td></td>
</tr>
<tr>
<td>Smear –, culture –</td>
<td>14.3</td>
</tr>
<tr>
<td>Smear –, culture +</td>
<td>21.4</td>
</tr>
<tr>
<td>Smear +, culture +</td>
<td>44.3</td>
</tr>
</tbody>
</table>

Loudon RG. ARRD 1969;99:109; presentation of data shown in this slide courtesy of Charles Daley and Robert Belknap
Behr MA et al, Lancet 1999; 353: 444–49
Discontinuation of Airborne Precautions-Suspected TB

- TB disease is considered unlikely, and
  - Alternative diagnosis explaining the clinical syndrome has been established
  - 3 consecutive, negative AFB sputum smears
  - Demonstration of 2 negative sputum Xpert MTB/RIF results (serial sputum collection for mycobacterial culture is still necessary because Xpert doesn’t detect all patients with pulmonary TB and recovery of organism is needed for drug susceptibility testing)

- Continue if suspicion for TB remains

CDC 2005.
Discontinuation of Airborne Precautions-Confirmed TB

- Response to therapy
  - Clinical improvement (4-7 days)
  - 3 consecutive, negative AFB smears or one negative Xpert and two negative sputum smears
  - Patients with < 7 days of treatment
  - Some favor at least 2 weeks of TB treatment for patients with positive AFB smears prior to discontinuation of isolation
- Continue until discharge or negative culture for MDR-TB

CDC 2005.
Discharge to Home: Smear Positive

- Public health follow-up and DOT
- Household members previously exposed
- No household members <4 years old or immunocompromised
- Patient will remain home
- Must wear a surgical mask with visitors or when leaving home

CDC 2005.
Screening for TB in HCWs

- Baseline 2-step TST or IGRA
- Annual symptom screen and testing (medium risk facility)
- CXR and treatment if positive test
- Investigate conversions

CDC 2005.
Elements of Infection Control

- **1st Priority**: Administrative Controls
- **2nd Priority**: Environmental Controls
- **3rd Priority**: Respiratory Protection

Environmental Controls

- Isolation room (patients with risk factors for active pulmonary TB should be placed in airborne infection isolation (AII) rooms)
- Airborne Infection Isolation (AII) rooms employ negative pressure to prevent escape of droplet nuclei
- Doors must remain closed to maintain negative pressure (should be verified daily)
Environmental Controls

- 6 air exchanges per hour are acceptable in pre-existing rooms
- 12 are required for new construction or renovation
- Air should be exhausted to the exterior removed from intake vents
- If recirculation is not avoidable, High-Efficiency Particulate Air (HEPA) filters must be installed in exhaust ducts
Environmental Controls

- Anterooms are often employed for maintaining negative pressure
- The door to the anteroom and the door to the AI should not be open at the same time
- If the patient must leave the room, he or she must wear a surgical mask
- All individuals entering the room must wear appropriate respiratory protection
General Ventilation

CDC 2005.
Negative Pressure

CDC 2005.
HEPA Filters

CDC 2005.
Elements of Infection Control

- **1\textsuperscript{st} Priority** Administrative Controls
- **2\textsuperscript{nd} Priority** Environmental Controls
- **3\textsuperscript{rd} Priority** Respiratory Protection

THE NEXT TO GO

FIGHT TUBERCULOSIS!
Red Cross Christmas Seal Campaign
Respiratory Protection

- All healthcare workers who work in situations that pose a high risk for exposure should be trained in the use of respiratory protection.
- Individuals entering the rooms of a patient with suspected or known TB must wear appropriate respiratory protection.
- This may include an N95 mask or a PAPR.
Respiratory Protection

Protection must also be worn by persons present during procedures for patients with known or suspected TB that induce coughing or aerosolization:
- Bronchoscopy
- Induced sputum collection
- Administration of aerosolized medications and by individuals in closed spaces with patients with known or suspected TB (transport vehicles)
Respiratory Protection

N95

PAPR
N95 Masks

- These masks filter particles > 1 micron in diameter with at least 95% efficiency with flow rates up to 50 liters/minute
- The mask must fit to a person’s face with less than 10% seal leakage
- Masks should be available outside all rooms in several sizes to ensure optimal fit and usage
N95 Masks

- All healthcare workers should be fit tested prior to usage in order to determine appropriate fit and mask size.
- Healthcare workers unable to use an N95 mask due to poor fit (facial structure or beards which may prevent a tight seal) should use a PAPR.
Respiratory Protection: Patients

- Patients with known or suspected TB should not wear N95 masks (designed to filter air before it is inhaled).
- Patients should wear a surgical mask as these are designed to prevent respiratory secretions of the persons wearing the mask from entering the environment.
Our case...

- Exposure investigation conducted by employee health and infection prevention
- HCWs potentially exposed identified and screened
- No conversions
- Re-examined lines of communication and staff education
TB Surveillance

- Periodic risk assessment is important and should include a review of TB incidence and affected groups
- Cases over the last 5 years should be assessed
- Lapses in infection control should be identified and rectified
- Annual screening requirements are based on a facilities risk assessment
References

- Sepkowitz KA. How Contagious is Tuberculosis? Clinical Infectious Diseases. 1996; 23;954-62
- Taylor Z, Nolan C et al. Controlling Tuberculosis in the United States Recommendations from the American Thoracic Society, CDC, and the Infectious Diseases Society of America. MMWR November 4, 2005 / 54(RR12);1-81