TB Program Management
San Antonio, Texas
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Infection Control
Lynelle Phillips, RN, MPH
November 7, 2008

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Objectives

- Describe the components of an effective TB infection control program
  - Goals and principles of infection control
  - Protection for the public health worker in the clinic and field settings
- Explain when a TB patient can be considered non-infectious
  - Determining factors that influence transmission
  - Isolation guidance – assessing when the patient may return to work/school/community

Infection Control

Table 1. HIV-associated multidrug-resistant tuberculosis (MDR-TB) outbreaks in industrialized countries, 1988–1995.

<table>
<thead>
<tr>
<th>Location, date [Reference]</th>
<th>Patients with MDR-TB</th>
<th>Time to death, median, weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total, no. HIV infected, %</td>
<td>Died, %</td>
<td></td>
</tr>
<tr>
<td>Hospital (Florida), 1988–1990 [26]</td>
<td>65</td>
<td>90</td>
</tr>
<tr>
<td>Hospital (New York City), 1989–1990 [28, 27]</td>
<td>51</td>
<td>100</td>
</tr>
<tr>
<td>Hospital (New York City), 1990–1991 [27, 28]</td>
<td>70</td>
<td>95</td>
</tr>
<tr>
<td>Hospital (New York City), 1991–1992 [27, 29]</td>
<td>32</td>
<td>91</td>
</tr>
<tr>
<td>Hospital (Madrid, Spain), 1991–1995 [31]</td>
<td>48</td>
<td>100</td>
</tr>
<tr>
<td>Prison system (New York State), 1990–1991 [33]</td>
<td>42</td>
<td>96</td>
</tr>
</tbody>
</table>

Infection Control in Hospitals

• “These outbreaks were linked to poor infection control practices in hospitals and prisons, where patients with infectious TB and HIV-infected patients were together and where the diagnosis of MDR-TB was delayed.”


Infection Control - International

• “Between 1982 and 1984, only 8 (0.8%) of 1045 nurses employed at the University Teaching Hospital in Lusaka received diagnoses of TB; all were successfully treated.”

• Between 1990 and 1996, 114 nurses died of TB at the same institution.”

Strategies to Reduce Transmission

• Earlier recognition of suspected TB
• Rapid diagnostic confirmation of TB drug resistance
• Infection control
  – Segregation and isolation of patient with TB to well-ventilated areas
  – Critical improvements in facility ventilation
  – UV radiation
  – Appropriate respiratory protection
• Earlier initiation of appropriate treatment
• Promotion of cough hygiene


Fundamentals of TB infection Control

• Early Identification
• Prompt clinical evaluation
• Airborne infection isolation (AII)
• Effective treatment of persons with Active TB

“the greatest risk is from persons with unrecognized TB disease who are not promptly handled with appropriate airborne precautions”
Principles of Control and Prevention of TB in Health Care Settings

• A TB infection control program be established in all TB clinics and health departments (sites that care and manage TB patients)

• Hierarchy of TB infection control
  - Administrative Controls
  - Environmental Controls
  - Respiratory Protection controls

Hierarchy of controls

• Administrative controls
  – managerial measures to reduce the risk of exposure

• Environmental controls
  – mechanical/physical measures prevent spread & reduce concentration of droplet nuclei

• Respiratory Protection controls
  – used where there is higher risk of exposure
  – use of PRP devices (n-95 respirator)
  – doesn’t replace administrative and environmental controls
Administrative - Recognition of Infectiousness ‘think TB’ in health departments and TB clinics

- Mask symptomatic patients (includes when pt is in transport to other parts of the facility, or in waiting areas)
- Schedule these patients for procedures when a minimum number of people are present (staff/other patients)
  - Last patient of the day
- Separate immunocompromised patients from this population

“the undiagnosed patient presents the MOST risk to all in contact”

Isolation

- “Clinics that provide care for patients with suspected or confirmed infectious TB disease should have at least one AII room”
- “All cough-inducing and aerosol-generating procedures should be performed using environmental controls”
  - Allow sufficient time for aerosol clearance before entering booth or AII room

Environmental controls

- Use of exhaust and general ventilation
  - 12 air exchanges/hour, single patient rooms
  - evaluate other high risk areas

- Control of airflow
  - prevent contamination to adjacent areas (Hepa filters)

- Use of UV lights
- Monitor and maintain engineering controls

Respiratory Protection

Health Care Workers who

"provide medical services in the homes of patients with suspected or confirmed infectious TB disease should instruct TB patients to observe strict respiratory hygiene and cough etiquette procedures"

"enter homes of persons with suspected or confirmed infectious TB disease or who transport such persons in an enclosed vehicle should consider wearing at least an N95 disposable respirator."

Respiratory Protection

- Field staff –
  - If the TB case or suspect infectious – N95 mask
  - Avoid closed/congregate setting
  - “When you are interacting with people who are not infectious, masks and personal respirators should not be used as they may compromise confidentiality as well as jeopardize rapport and trust.”

  - New Jersey Medical School National Tuberculosis Center. Tuberculosis Field Investigation: A Resource for the Health Care Worker. 2004 (p. 24).

Reducing Your Risk
(transporting Tb infectious patients)

- Open as many windows as possible in vehicle

- Set ventilation controls to fresh air or vent setting; do not use recirculation setting; set any fan to high setting

- Leave vehicle unoccupied with windows open for at least an hour after the trip
**Respiratory Control**

- Respiratory protection program
  - settings with a high risk of TB spread
- Use of special masks to filter out droplet nuclei (n-95)
- Oral hygiene (ie; cover your cough)

**Surgical Masks vs. Respirators**

- **Surgical Masks**
  - protect the sterile field from contaminants generated by the wearer
- **Respirators**
  - protect the wearer from airborne contaminants generated by nearby sources (patients, procedures, etc.)
Decision to initiate a contact investigation

- Factors that predict likely transmission of TB (host)
  - Bacteriology
  - Radiographic findings
  - Behaviors of the patient
  - Age
  - HIV status
  - Effective treatment
AFB smear – make sure you get *sputum* smear results!

AFB (shown in red) are tubercle bacilli

**AFB Smear Status**

- Defined as the amount of *M. tuberculosis* bacilli appearing on an acid-fast bacilli slide
- Relative infectiousness has been associated with positive sputum culture results and is highest when the smear results are also positive
- Significance of results from respiratory specimens other than sputum is undetermined, regard as equivalent
### Generation of Infectious Particles

<table>
<thead>
<tr>
<th>TB Scenario</th>
<th>AFB per 1000 ft³</th>
<th>AFB per hour</th>
<th>Time to get infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>pulmonary</td>
<td>0.08</td>
<td>1.25</td>
<td>133 d</td>
</tr>
<tr>
<td>laryngeal</td>
<td>4</td>
<td>60</td>
<td>67h</td>
</tr>
<tr>
<td>bronchoscopy</td>
<td>14</td>
<td>250</td>
<td>10-20h</td>
</tr>
<tr>
<td>autopsy</td>
<td>285</td>
<td>2000</td>
<td>2-3h</td>
</tr>
</tbody>
</table>

### Chest Radiographs

- Abnormalities often seen in apical or posterior segments of upper lobe or superior segments of lower lobe
- Patients who have cavitary lesions are typically more infectious than patients without cavities
- May have unusual appearance in HIV-positive persons
  - 3% of AFB smear positive HIV patients had normal CXRs
Coughing, Singing or Speaking

• Cough frequency (predictive?)
• Singing
• “sociability” of the index patient
### Indices of infectiousness of patients with TB for household contacts

<table>
<thead>
<tr>
<th>Source-case variables</th>
<th>Tuberculin Reactors (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiographic extent of disease</td>
<td></td>
</tr>
<tr>
<td>Minimal</td>
<td>16</td>
</tr>
<tr>
<td>Moderately advanced</td>
<td>28</td>
</tr>
<tr>
<td>Far advanced</td>
<td>62</td>
</tr>
<tr>
<td>Bacteriological status</td>
<td></td>
</tr>
<tr>
<td>Negative culture</td>
<td>14</td>
</tr>
<tr>
<td>Positive culture/negative smear</td>
<td>21</td>
</tr>
<tr>
<td>Positive smear</td>
<td>43</td>
</tr>
<tr>
<td>Mean 8-hour overnight cough count</td>
<td></td>
</tr>
<tr>
<td>&lt; 12</td>
<td>28</td>
</tr>
<tr>
<td>12 - 48</td>
<td>32</td>
</tr>
<tr>
<td>&gt; 48</td>
<td>44</td>
</tr>
</tbody>
</table>

(Loudon (1969))

### Age of Host: Children

- Transmission from children < 10 years is unusual – watch for “adult-like” TB
  - 50% of childhood cases are asymptomatic and are found through contact investigations
  - 50% of symptomatic cases have negative skin tests
  - Children less than 6 months of age will likely be anergic.
  - Children less than five years old should receive infection treatment for 3 months after exposure ends
HIV status of host

- Have CXRs not typical of pulmonary TB
- Delayed diagnosis leads to increased transmission
- Can be just as infectious as non-HIV
- Watch for HIV-infected contacts

### CXR in TB – AIDS vs Non-AIDs

<table>
<thead>
<tr>
<th></th>
<th>AIDS Pts</th>
<th>Non-AIDs pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Adenopathy</td>
<td>10 (59%)</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>Infiltrates (mid/lower zone)</td>
<td>5 (29%)</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>Infiltrates (upper zone)</td>
<td>3 (18%)</td>
<td>29 (97%)</td>
</tr>
<tr>
<td>Diffuse interstitial/miliary</td>
<td>3 (18%)</td>
<td>0</td>
</tr>
<tr>
<td>Cavitation</td>
<td>0</td>
<td>20 (67%)</td>
</tr>
<tr>
<td>No infiltrate</td>
<td>6 (35%)</td>
<td>0</td>
</tr>
</tbody>
</table>
Transmission Factors

Aerobiology
Environmental stresses

Organism
Treatment
number
viability

Virulence

Host
resistance

Pathogenesis

Take off
Source
strength
disease

Temperature and humidity
oxygen
radiation

Landing

infection

Riley experimental TB ward, 1958-62
AIR, Experimental Plan
Guinea Pig Air Sampling

A
Odd days

B
Even days

CVGI or other intervention
3 patient rooms
Plus common areas
Intervention on/off on alternative days

Guinea Pig
TB RFLP

Pt. TB
RFLP
Repeated testing of the animals found a stepwise progressive increase in infection rate of the guinea pigs over a four-month period – Dr. Ed Nardell

MDR TB infectious?

• “So, those who have the notion that MDR-TB wasn’t very infectious need to pay attention to the fact that at least for guinea pigs there was a remarkable degree of transmission from patients on therapy in the MDR ward.”
Isolation I

• Patient characteristics -
  – Sputum smear AFB positive
  – Sputum smear AFB negative and TB is likely or confirmed initially through NAA testing

• Scenario -
  – Hospitalized under inpatient airborne isolation and being released to:
    – General hospitalization, or
    – Outpatient congregate setting, or
    – Home or setting with high-risk contacts
Guidelines I

• To be discharged from hospital airborne isolation the patient must meet the following criteria:
  – receiving standard multi-drug TB therapy
  – have demonstrated clinical improvement
  – 3 consecutive negative smears collected at least 8 hours apart with at least 1 being early morning

Isolation II

• Patient characteristics
  – AFB positive
  – and TB is suspected or confirmed initially through NAA testing

• Scenario
  – Home isolation and being allowed to return to normal activities including:
    • Return to school, or
    • Return to work, or
    • Allowed to travel on public transportation
Guidelines II

• To be discharged from home isolation the patient must meet the following criteria:
  – receiving standard multidrug anti-TB therapy for at least 2 weeks
  – have demonstrated adherence to treatment (i.e. DOT)
  – have demonstrated clinical improvement
  – have 3 consecutive negative smears

Isolation III

• Patient characteristics
  – AFB negative
  – and TB is suspected or confirmed initially through NAA testing

• Scenario
  – Home isolation and being allowed to return to normal activities including:
    • Return to school, or
    • Return to work, or
    • Allowed to travel on public transportation
Guidelines III

• To be discharged from home isolation the patient must meet the following criteria:
  – receiving standard multidrug anti-TB therapy for at least 5-7 days
  – have demonstrated adherence to treatment (i.e. DOT)
  – have demonstrated clinical improvement
  – have 3 consecutive negative smears

Isolation IV

• Patient characteristic
  – MDR/XDR confirmed

• Scenario
  – Home isolation and being allowed to return to normal activities including:
    • Return to school, or
    • Return to work, or
    • Allowed to travel on public transportation
    • Run off to Greece and get married
Guidelines IV

• To be discharged from isolation the patient must meet the following criteria:
  – received and tolerating anti TB regimen for 2 weeks
  – demonstrated adherence (i.e. DOT)
  – demonstrated clinical improvement
  – culture negative in 3 consecutive sputum samples

Summary - CDC Isolation Recommendations

Patients are not considered infectious if they meet the following criteria:

• Adequate therapy for 2 or 3 weeks
• Favorable clinical response
• Sputum smear negative x 3….
  - Culture negative x 3 for MDR-TB

Many patients released from isolation after 2 – 3 weeks isolation
(cough resolved, energy improved, pan-susceptible organism)
Acknowledgements

• Maria Robles, RN BSN, Nurse Educator/Consultant – HNTC
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References


Loudon RG, Spohn SK Cough frequency and infectivity in patient with pulmonary TB. Am Rev Resp Dis 99:109, 1969
