TB Nurse Case Management
Albuquerque, New Mexico
July 22-23, 2008

Contact Investigations
Lynelle Phillips, RN, MPH
July 23, 2008

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Lynelle Phillips, RN MPH
Heartland National TB Center
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Objectives

• List the basic principles of conducting an effective TB contact investigation
• Describe the highlights of the CDC’s Contact Investigation Guidelines
• Identify contact investigation challenges and ways to improve outcomes

Contact Investigation Principles

• Meet CDC Objectives!

BOX 2. Recommended objectives for contact investigations, by key indicators

<table>
<thead>
<tr>
<th>Key indicator</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious index patients with at least one contact listed</td>
<td>90%</td>
</tr>
<tr>
<td>Contacts who are evaluated for tuberculosis disease and latent infection</td>
<td>90%</td>
</tr>
<tr>
<td>Infected contacts who begin treatment for latent infection</td>
<td>85%</td>
</tr>
<tr>
<td>Treated contacts who complete treatment for latent infection</td>
<td>75%</td>
</tr>
</tbody>
</table>
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

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 Radiograph

- Abnormalities often seen in apical or posterior segments of upper lobe or superior segments of lower lobe
- May have unusual appearance in HIV-positive persons
- Cannot confirm diagnosis of TB
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>
### HIV-related MDR TB Outbreak Investigations by CDC & Health Departments, USA, 1988–92

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Total Cases</th>
<th>% HIV Infected</th>
<th>% Deaths</th>
<th>Median Wks Dx to Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>65</td>
<td>93</td>
<td>72</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>51</td>
<td>100</td>
<td>89</td>
<td>16</td>
</tr>
<tr>
<td>C</td>
<td>70</td>
<td>95</td>
<td>77</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>29</td>
<td>91</td>
<td>83</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>14</td>
<td>43</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>16</td>
<td>82</td>
<td>82</td>
<td>4</td>
</tr>
<tr>
<td>I</td>
<td>13</td>
<td>100</td>
<td>85</td>
<td>4</td>
</tr>
<tr>
<td>J</td>
<td>28</td>
<td>96</td>
<td>93</td>
<td>4</td>
</tr>
<tr>
<td>Prison</td>
<td>42</td>
<td>98</td>
<td>79</td>
<td>4</td>
</tr>
</tbody>
</table>

### KZN Hospital Background*

- 119 patients in TB/ARV integration study
  - 14 deaths
  - 10 (71%) of 14 with MDRTB
  - 6/10 MDRTB resistant to all tested first and second line drugs (SLD) for TB
    - INH, RIF, EMB, STR, KANA, CIPRO
  - Suggestive of probable extensive drug resistant TB in this hospital

KZN Drug Resistant TB Survey*

• Jan 2005 – Mar 2006 cross-sectional study of patients suspected with active TB in rural district hospital
• Isolates collected for mycobacterial culture (MGIT) and DST on all *M. tuberculosis* cultures – INH, RIF, EMB, STR, KANA, CIPRO
• Chart reviews of patients with strains resistant to all tested drugs (“XDR TB” cases)
• Molecular fingerprinting by spoligotyping on all “XDR TB” isolates

KZN Drug Resistant TB Survey Results*

1539 isolates tested

544 (35%) Cx+ 995 (65%) Cx
*M. tuberculosis* Negative

221 (41%) MDRTB 323 (59%) Susceptible

53 (10%) XDRTB (24% of MDRTB)

  HIV associated Extensively Drug-Resistant TB (XDR-TB) in Rural KwaZulu-Natal
  (South Africa MRC Expert Consultation Sept 8, 2006)
### Characteristics of KZN XDR TB Patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No prior TB Treatment</td>
<td>26 (51)</td>
</tr>
<tr>
<td>Prior TB treatment</td>
<td></td>
</tr>
<tr>
<td>- Cure or Completed treatment</td>
<td>14 (28)</td>
</tr>
<tr>
<td>- Treatment Default or Failure</td>
<td>7 (14)</td>
</tr>
<tr>
<td>HIV-infected (44 tested)</td>
<td>44 (100)</td>
</tr>
<tr>
<td>Dead (Includes 34% on ARV)</td>
<td>52 (98)</td>
</tr>
<tr>
<td>Identical <em>M. tb</em> spoligotype</td>
<td>26/30</td>
</tr>
</tbody>
</table>

### Prioritization of multiple investigations

#### Decision to Initiate a TB Contact Investigation

- Site of disease
  - Pulmonary (orosal) positive
  - Pulmonary suspect (fevem, e.g., isolates)
  - Non-pulmonary (extrapulmonary and extrapulmonary involvement used only)

- AFB sputum smear positive
  - NAA positive - not performed
  - NAA negative
    - Contact investigation should always be indicated

- AFB sputum smear negative or not performed
  - Contact investigation not indicated
  - Contact investigation should always be indicated if sufficient resources

- Abnormal CBCT - not consistent with TB
  - Abnormal CBCT not consistent with TB

- Contact investigation should be withheld only in exceptional circumstances

*Note:删减内容*
Prioritization of investigations

Duration and Intensity of Exposure

- High priority contacts - generally those who spend many hours a day with case
- Exposure setting –
  - 1 = the size of a vehicle
  - 2 = the size of a bedroom
  - 3 = the size of a house
  - 4 = a size larger than a house
Exposure Due to Closed Ventilation

• Proven through animal studies in the 1950’s that TB can be transmitted through exposure to shared air.
• Notable outbreaks in closed ventilation systems: ships, school buses, classrooms, and bars, etc

Exposure due to closed ventilation

• “a multidisciplinary team of infectious disease and engineering specialists needs to be rapidly assembled as soon as an airborne infectious disease outbreak is identified.” (Li et al 2007)
Assigning priorities contacts

- Prioritizing contacts identified as:
  - High
  - Medium
  - Low

- Resources should be allocated to complete all investigative steps for high- and medium-priority contacts

- Two ways to assign priorities
  - In smaller investigation – rank each contact individually
  - In larger investigation – rank based on risk groups
Overview of epidemiology

Epidemiology

“The study of the distribution and determinants of health-related states in specified populations, and the application of this study to control health problems.”

http://www.cdc.gov/excite/library/glossary.htm

Relative Risk

• Relative risk – a comparison of the risk of a health problem in 2 groups

• Useful in prioritizing contacts in large investigations and outbreaks
  – High
  – Medium
  – Low
2 x 2 table

<table>
<thead>
<tr>
<th></th>
<th>LTBI/MTB – yes</th>
<th>LTBI/MTB – no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure/risk factor – yes</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Exposure/risk factor – No</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Relative Risk = \( \frac{a}{a+b} \frac{c}{c+d} \)

TB in HS student

- 16 year old high school student presented with upper respiratory symptoms and fever in November 2000.
- CXR revealed upper lobe cavitary disease in early December, 2000
- Diagnosed with bronchitis and treated with “dose-pack”
TB in HS Student (2)

• Between December and May, patient’s health status steadily declined
  – Missed 48 days of school
  – Coughing up blood in class
  – 25 pound weight loss
  – Severe fatigue
• Diagnosed in May, 2001 with active TB
Contact investigation

• Patient’s contacts:
  – Dad – PPD positive – LTBI
  – Mom – PPD positive – cx positive MTB
  – 12 year-old brother – PPD positive - LTBI
  – 9 year-old brother – PPD positive – abn CXR
    – clinical MTB
  – 5-month-old brother – PPD irrelevant – abn
    CXR – tracheobronchial MTB

Data from investigation

<table>
<thead>
<tr>
<th>Persons tested</th>
<th># of students tested</th>
<th># of students TST positive</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students in ≥ 3 classes</td>
<td>13</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td>Students in ≥ 3 classes</td>
<td>13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Students in periods 1,2,5-7</td>
<td>66</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

Data from investigation

<table>
<thead>
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<td></td>
</tr>
<tr>
<td>Students in periods 1,2,5-7</td>
<td>66</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Students in ≥ 1 class</td>
<td>106</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>All students</td>
<td>559</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>


2 x 2 table – high school outbreak

<table>
<thead>
<tr>
<th>EXPOSURE GROUP</th>
<th>TST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>positive</td>
</tr>
<tr>
<td>In class with index case</td>
<td>25</td>
</tr>
<tr>
<td>Not in class with index case</td>
<td>33</td>
</tr>
<tr>
<td>TOTAL TESTED</td>
<td>58</td>
</tr>
</tbody>
</table>

RR = 25/106 = 3.2 (CI = 1.26-4.93)  
33/453
Data from investigation

<table>
<thead>
<tr>
<th>Persons tested</th>
<th># of students tested</th>
<th># of students TST positive</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
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<td>7</td>
<td>5.7</td>
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<td>25</td>
<td>3.2</td>
</tr>
<tr>
<td>All students</td>
<td>559</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>


High, medium, low risk contacts

Index case

In ≥ 2 classes
RR = 5.7

In classes 1,2,5,6,7
RR = 4.2

In ≥ 1 class
RR = 3.2
Source case investigations

- Reverse of a contact investigation
- Recommended for cases of children under 5 years old
  - Yield varies, typically less than 50% of source cases are found
- Searching for unexplained LTBI is generally not recommended and if done should be limited to LTBI in children younger than 2.

Case Study – source case investigation

- 4 month old Guatemalan twins
- Recurrent pneumonia
- Abnormal CXRs
- Negative bacteriology
- Symptoms/CXR improved on treatment
- Source case investigation
Source Case Investigation

Household Contacts

Results - initial

Household Contacts
Results – 3 month follow up

Household Contacts

2
25f

23m

18m

17f

25f

25f

Summary so far

• List the basic principles of conducting an effective TB contact investigation (CI)
  – Transmission of TB
  – Prioritizing multiple investigations
  – Prioritizing contacts
    • Individual host factors
    • Risk groups/environmental factors
  – Assessing and expanding contact investigations
  – Source case investigations
• Medical Evaluation
Medical evaluation

- Diana Fortune, TB nurse, Missouri

Initial Assessment of Contacts

First Encounter: Within 3 days
- High risk = TST within 7 days
- Medium risk = TST within 14 days
Follow-up testing

- Repeat testing done 8 – 10 weeks after initial test and/or after exposure has ceased
  - Change from 3 months follow-up testing

Diagnosis of LTBI

- Based on following information:
  - TST or QFT results
    - Signs/symptom screening (Use Standardized form)
  - CXR
  - History and Physical examination
  - Sputum examinations – if indicated

- TB disease must be RULED OUT before starting treatment for LTBI
Testing for LTBI

- **Tuberculin skin Test**
  - Admin intradermally
  - Measures delayed hypersensitivity
  - After infected the reaction is detectable within 2-8 weeks
  - Read within 48-72 hrs

- **Quantiferon TB Gold Test**
  - Measures immune reactivity to M. TB
  - Blood specimens mixed with antigens, incubated for 16-24 hrs
  - FDA approved 2005

Interpreting the TST Reaction

- A reaction of 5mm or more of induration is considered positive in:
  - Recent Contact to infectious TB case!!
  - HIV infected person
  - Persons with fibrotic changes on CXR consistent with prior TB disease
  - Organ transplant recipients
  - Other immunosuppressed persons
    - 15mg/day or more prednisone
    - Taking Remicaid, Enbrel, Humira
Symptom Assessment

• Screen for signs/symptoms of TB even if TST neg
  – Use standard screening form

• Assessing a contact is not just placing a TST

CXR

• Obtain CXR for all +TST
  • May be indicated in some TST Neg patients
• Adults at minimum should have AP CXR
• Person with nodular or fibrotic lesions consistent with old TB are high priority for treatment
• Persons with calcified granulomas are low risk for progression to TB disease
CXR

• Routine follow-up CXRs are NOT indicated

• Even if treatment not taken/completed
  – except in unusual circumstances
  – Contact to MDR cases (will cover later)

Physical Examination

• Obtain:
  – Medical history including previous +TSTs
    • Written documentation of previous positive TST is required
      – verbal history is not sufficient
      – Do not defer TST for verbal history of positive TST
  – Risk assessment for liver disease
  – Physical exam by clinician-
    • rule out pulmonary or extrapulmonary disease
Sputum collection

• Collect sputum samples if:
  – Positive TST and abnormal CXR
  – Presence of respiratory symptoms even if normal CXR

• Sputum samples may be collected 8 hours apart with at least one specimen collected in the morning

Treatment of LTBI

• Isoniazid 300mg daily for 6 - 9 months
  – 9 months is the preferred regimen
  – 180 doses/9mos or 270 doses/12 mos

• Isoniazid 900mg (DOT) twice weekly
  – 53 doses/9 months

• Rifampin 600mg daily for 4 months
  – 120 doses/6months

• Rifampin/PZA –Contraindicated!!!!
Special Considerations

- Window Prophylaxis
- HIV + persons
- Other immunocompromised person
- Infants and Children
- Boosted reaction, conversion, two step
- BCG Vaccine
- Pregnancy/Breastfeeding
- Re-treatment
- Attitudes, beliefs/behaviors that can impact treatment

Window Prophylaxis

- Time period after exposure to infectious TB case when TST may remain negative.
  - Retest in 8 weeks

- Treatment during “window” phase
  - susceptible and vulnerable contacts to prevent rapidly emerging disease
Window Prophylaxis

- Children less than 5 years of age
- HIV+ persons
- Persons taking immunosuppressive therapy
  - Organ transplants
  - Person taking TNF antagonists
    - Remicaid, Enbrel, Humira
  - Persons who take greater than 15mg per day of prednisone
    - Risk is less clear – but treatment recommended

Retest in 8 – 10 weeks – after exposure ceased
  - If TST Positive - recommended treatment for LTBI
    - If TST Negative:
      - Children – no further treatment recommended
      - For HIV + and other immunocompromised consider continuing treatment for LTBI
        - Frequency, duration and intensity of exposure
        - Evidence of transmission among other contacts
Major Changes in CDC Guidelines

<table>
<thead>
<tr>
<th>OLD</th>
<th>NEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brief guidance</td>
<td>More comprehensive and thoroughly referenced</td>
</tr>
<tr>
<td>Use concentric circle</td>
<td>Use high, medium, low prioritization</td>
</tr>
<tr>
<td>TST follow-up at 12 weeks</td>
<td>TST follow-up at 8 weeks</td>
</tr>
<tr>
<td>Expand based on circle conversions</td>
<td>Expand according to analysis</td>
</tr>
<tr>
<td>No priority criteria for investigation selection</td>
<td>Investigation selection prioritized</td>
</tr>
</tbody>
</table>

CDC objectives - evaluation

- No contact investigation (13%)
- Contacts missed (12%)
- Contacts lost to follow-up (27%)
- Contacts not treated/incomplete treatment (approx. 50%)
  - Refused
  - MDR/XDR
  - Do not complete treatment

Contact investigation challenges and ways to improve outcomes

• New tools
  – Blood assay testing
  – Genotyping
  – Social networking
• Environmental controls
• Surveillance/data management
• Lessons learned

Blood assay tests
Blood Assay Tests (2)

• “CDC recommends that QFT-G can be used in all circumstances in which the TST is currently used, including contact investigations”
  – A positive QFT-G result should prompt the same public health and medical interventions as a positive TST result.

BCG-vaccinated contacts

Table 1: Demographic and behavioral characteristics of the study participants

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of contacts (years) – mean (± SD)</td>
<td>28.5 ± 10.5</td>
</tr>
<tr>
<td>Previous BCG vaccination</td>
<td>157 (59.8%)</td>
</tr>
<tr>
<td>Origin (Foreign/German)</td>
<td>84 (27.1%) / 225 (72.9%)</td>
</tr>
<tr>
<td>Residence time (weeks) – mean (± SD)</td>
<td>515.4 ± 394</td>
</tr>
<tr>
<td>Exposure time (hours) – mean (± SD)</td>
<td>221 ± 27</td>
</tr>
<tr>
<td>Previous contact tracing TST results</td>
<td>9 / 1 TST-positive</td>
</tr>
<tr>
<td>No. of contacts per source – mean (± SD)</td>
<td>28 ± 13</td>
</tr>
<tr>
<td>Foreign place of birth</td>
<td>25</td>
</tr>
</tbody>
</table>


Figure 1: Application of the QFT-G test in a population of close contacts.
From Diel et al

- “The QFT-G assay was unaffected by BCG vaccination status, unlike the TST. In close contacts who were BCG-vaccinated the QFT-G assay appeared to be a more specific indicator of LTBI that the TS, and similarly sensitive in unvaccinated contacts.”
- “…In BCG-vaccinated close contacts…[blood assay tests] should be recommended as a basis for the decision on whether to [diagnosis LTBI].”

Genotyping

- Use of PCR to identify genotype of tuberculosis isolates
  - Made universal in US in 2004
  - Carried out at two centers (CA, MI)
- Has led to identification of clusters and epi-links not previously recognized by traditional outbreak investigation methods

http://www.cdc.gov/nchstp/tb/genotyping/toc.htm
Benefits of Genotyping

- Understand Transmission Patterns Better
- Identify Lab Cross Contamination
- Learn About Unsuspected Relationships and Non-Traditional Settings for Transmission
- Detect and Investigate Outbreaks Sooner
- Focus and Prioritize Contact Investigations
- Evaluate Intervention Effectiveness
- Discern Exogenous Reinfection vs Relapse

**GENOTYPING FLOW**

New isolate \(\xrightarrow{\text{Spoligo MIRU}}\) Result

- Compare with prior results for same TB program
  - Clustered
  - No match
ClustClusteed isolates (Spoligotype + MIRU)

Known link confirmed

Correlate with patient and contact information

Unsuspected transmission?

Patterns match, cluster confirmed

IS6110

RFLP

Patterns differ, no cluster

Genotyping

May be used to rule out Presumed outbreaks


Suspected relationship/ location of transmission | Number of misleading epidemiologic links
---|---
Homeless shelter | 11
Household members | 5
Workplace | 4
Friends/social contacts | 3
Non-household family members | 2
Total | 25

Table 2.1. Relationship or location of presumed transmission for 25 patients with suspected epidemiologic links detected during contact investigations that were not confirmed by subsequent genotyping results — Massachusetts, 1996–2000.
RFLP Analysis

- Lanes 1-3: school outbreak
- Lanes 4-6: sewer workers outbreak
- Lanes 7-9: family outbreak
- Lanes 10,11: family outbreak

Goal of Cluster Investigation

Uncover Previously Unrecognized Epidemiologic Links Between Persons in a Genotyping Cluster and; Take Appropriate Action Steps
Investigation of TB in homeless-Kansas City MO

- Conducted chart reviews on the individuals in the cluster.
  - Positive or negative AFB sputum smear
  - Symptom onset dates
  - Homeless or correctional facility use
  - Foreign born
  - Other significant findings of interest
- Identified all TB cases in KC that presented with history of homelessness and requested genotyping of their isolates (added 7 to the cluster)
- Obtained incarceration histories on individuals within the cluster through the Jackson County Detention Center
- Obtained shelter histories from the City Union Mission database

Kansas City KS/MO cases by year
Steps to address outbreak

• Seeking grant funding from Western Missouri Foundation for Health
  – Administrative controls:
    • Full-time nurse to conduct communicable disease prevention and control
  – Engineering controls at the largest shelter
• Social networking project
Genotype clusters – risk groups for transmission Missouri 2004 – 2006 (some historical genotypes included)

<table>
<thead>
<tr>
<th>Genotype cluster (5 or greater in the cluster with epidemiological link)</th>
<th># matches</th>
<th>Epidemiological link</th>
</tr>
</thead>
<tbody>
<tr>
<td>MO-016</td>
<td>7</td>
<td>Bar – St. Genevieve</td>
</tr>
<tr>
<td>MO-006</td>
<td>14</td>
<td>Homeless shelter – St. Louis</td>
</tr>
<tr>
<td>MO-007</td>
<td>13</td>
<td>Homeless shelter – St. Louis/Greenwood MS</td>
</tr>
<tr>
<td>MO-030</td>
<td>7</td>
<td>Jail – Jasper County</td>
</tr>
<tr>
<td>MO-009</td>
<td>8</td>
<td>Homeless shelters - KC</td>
</tr>
<tr>
<td>MO-010</td>
<td>20</td>
<td>Homeless shelters – KC</td>
</tr>
<tr>
<td>MO-027</td>
<td>5</td>
<td>Bar – St. Louis County</td>
</tr>
</tbody>
</table>

Social Network Analysis

- Social Network – linkage of persons and places where *M. tuberculosis* is spread via shared air space.

- Social Network Analysis – methodology of visualizing and quantitating the relative importance of members in a social network.

- Social Network Analysis assumes there is some detectable patterning of the TB cases and their contacts in a community.
Social Network Analysis (cont.)

- Offers an effective way to list TB contacts and assign priorities.

- Analysis of the network can help identify important contacts (i.e., those most likely to be infected).

- Real-time monitoring of network growth may facilitate early detection of outbreaks.
"Drinkin' buddy" outbreak

- 1989
- 1991
- 1993
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002

RFLP testing

- 1989
- 1991
- 1993
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002

Corrections

- Cx confirmed
- Clinical case
- Confirmed epi link
- Suspect link
- Inside DOC
- Outside DOC
Environmental investigation

- Available through the Division of TB Elimination
  - Contact program consultant
  - Initial review – Dr. Paul Jensen
  - NIOSH referral
Clinical Status - Index Case

Lodging: Home  Hostel  Home
Hospitalized at Facility: C  C  B  B  A
Sputum TB Culture:
Chest X-Ray: Normal  +/-  Progressive Noncavitary Pneumonia
Cough: Absent cough  Mild  Moderate to Severe Cough

Figure 4 - Clustering of TB cases and Persons with LTBI at the Hostel Second Floor October 1 - November 19, 2001

- Patient, TB infected
- Visitor, TB infected
- Index Case
St. Louis City Homeless Shelter

12

Illuminating a need

by Shelene Scarborough

New state-of-the-art technology at the St. Louis, Mo., Harbor Light Center is helping to prevent the spread of tuberculosis (TB) among the homeless in the city.

The center unveiled its newly installed bacteria-killing ultraviolet (UV) lights to the public at a special ceremony. Through a combination of UV light and forced air movement, the lights kill airborne bacteria and viruses, including those associated with TB.

A total of 48 UV lights have been installed throughout the center, which is believed to be the first shelter in the United States to utilize the new technology, according to Ted Misselbeck of the St. Louis Health Department.

Ted Misselbeck of the St. Louis Health Department gives a presentation on the Harbor Light’s newly installed bacteria-killing UV lights.

Ted’s teamwork that took place to provide this service to Harbor Light," said Captain Beverly Best, Harbor Light administrator. "It’s a real relief to
Always look back!
Lessons learned/After action reviews

Evaluation of a large scale TB contact investigation in the Netherlands

• In November 2004, a 25-year old male Dutch–born full-time supermarket employee…was diagnosed with sputum smear-positive cavitary TB after a 12 month history of cough
  – 12 close contacts – 3 MTB / 7 LTBI
  – 80 supermarket co-workers – 1 MTB / 46 LTBI

Results of expanded contact investigation

Table 4. Yield and effectiveness of screening for tuberculosis infection by tuberculin skin testing among 13,343 supermarket customers, by reported frequency of visits to the supermarket.

<table>
<thead>
<tr>
<th>Frequency of supermarket visits</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52/week</td>
</tr>
<tr>
<td>Number of TST£</td>
<td>3664 (28%)</td>
</tr>
<tr>
<td>TBI diagnosed (prevalence)</td>
<td>107/2654 (4.9%)*</td>
</tr>
<tr>
<td>Expected age-adjusted prevalence of remote TBI</td>
<td>1.4%</td>
</tr>
<tr>
<td>Sensitivity TST [10]</td>
<td>79.8%</td>
</tr>
<tr>
<td>Specificity TST [10]</td>
<td>98.8%</td>
</tr>
<tr>
<td>Remote TBI</td>
<td>40/167 (24%)</td>
</tr>
<tr>
<td>Recent TBI, tuberculin-positive</td>
<td>5/167 (3%)</td>
</tr>
<tr>
<td>Recent TBI, skin-positive</td>
<td>52/167 (31%)</td>
</tr>
<tr>
<td>Prevalence of true recent TBI</td>
<td>63/3664 (2.2%)</td>
</tr>
<tr>
<td>Proportion of all true recent infections £</td>
<td>52/167 (31%)</td>
</tr>
<tr>
<td>Incremental yield</td>
<td>43/167 (26%)</td>
</tr>
</tbody>
</table>

£ or 167 persons (4.3%), including 19 with positive TST; no exposure data were available
TST = tuberculin skin test. TBI = tuberculous infection, including both latent infections and infections with active disease. Remote TBI: number of cases calculated as (expected age-adjusted prevalence of remote TBI) x (number of TST).
Incremental yield: proportion of true recent infections that was identified additionally by screening contacts in the exposure category indicated.
*Significantly different from expected age-adjusted prevalence of remote infections (1.5%).
£Number of subjects needed to test by tuberculin skin testing to identify one true-positive case of recent tuberculosis infection

Lessons learned

**need reference

- Cost-benefit
  - 500,000 Euros spent on the investigation
  - In order to detect 1 case of active TB – 1293 customers had to be tested
- 56-58% of the detected TBI cases were due to remote infection and most likely unrelated
- Prioritizing
  - If skin testing had been limited to shoppers who shopped at least once a week, more than half of the customers would not have been tested while 83% of MTB and 89% of true LTBI would have been detected.
  - Blood assay testing would have improved predictive value in BCG-vaccinated shoppers
  - Awareness raising among local GPs could have been an alternative to mass screening
- The Netherlands are currently developing a “structured protocol” for large-scale investigations
Prioritization for approx. 350 contacts
(who were released from jail and did not want to be found!)

- Priority 1: Cell mate to either index case or a pod mate to case B in the 2 months prior to diagnosis.
- Priority 2: Pod mate to case B any other time
- Priority 3: Pod mate to case A or employee
Aggregated Report of Program Evaluation

• Analysis of outbreak investigation

<table>
<thead>
<tr>
<th></th>
<th>Priority 1</th>
<th>Priority 2</th>
<th>Priority 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>sought</td>
<td>94</td>
<td>60</td>
<td>196</td>
</tr>
<tr>
<td>evaluated</td>
<td>58</td>
<td>62%</td>
<td>30</td>
</tr>
<tr>
<td>TST positive</td>
<td>24</td>
<td>50%</td>
<td>4</td>
</tr>
<tr>
<td>previous positive</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>started treatment</td>
<td>25</td>
<td>74%</td>
<td>5</td>
</tr>
<tr>
<td>completed</td>
<td>10</td>
<td>40%</td>
<td>2</td>
</tr>
<tr>
<td>started treatment</td>
<td>25</td>
<td>74%</td>
<td>5</td>
</tr>
<tr>
<td>completed</td>
<td>10</td>
<td>40%</td>
<td>2</td>
</tr>
<tr>
<td>moved</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>lost</td>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>refused</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>still on</td>
<td>9</td>
<td>36%</td>
<td>2</td>
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</tbody>
</table>
Aggregated Report of Program Evaluation

• Analysis of outbreak investigation

<table>
<thead>
<tr>
<th></th>
<th>One’s</th>
<th>Two’s</th>
<th>Three’s</th>
<th>Employees only</th>
</tr>
</thead>
<tbody>
<tr>
<td>sought</td>
<td>94</td>
<td>50</td>
<td>196</td>
<td>65</td>
</tr>
<tr>
<td>evaluated</td>
<td>58</td>
<td>62%</td>
<td>30</td>
<td>60%</td>
</tr>
<tr>
<td>TST positive</td>
<td>24</td>
<td>50%</td>
<td>4</td>
<td>14%</td>
</tr>
<tr>
<td>previous positive</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>started treatment</td>
<td>25</td>
<td>74%</td>
<td>5</td>
<td>83%</td>
</tr>
<tr>
<td>completed</td>
<td>10</td>
<td>40%</td>
<td>2</td>
<td>40%</td>
</tr>
<tr>
<td>moved</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>lost</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>refused</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>lost on</td>
<td>9</td>
<td>36%</td>
<td>2</td>
<td>40%</td>
</tr>
</tbody>
</table>

TST positive

- One’s: 24 (50%)
- Two’s: 4 (14%)
- Three’s: 16 (32%)
- Employees only: 7 (37%)

TST positive previous positive

- One’s: 10
- Two’s: 2
- Three’s: 4
- Employees only: 1

Relative risks

<table>
<thead>
<tr>
<th>Priority</th>
<th>Sought</th>
<th>Evaluated</th>
<th>LTBI (Latent TB infection)</th>
<th>TBD suspect or case</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>93</td>
<td>48(52%)</td>
<td>20(43%)</td>
<td>2 (4%)</td>
<td>3.63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(p&lt; .001)</td>
</tr>
<tr>
<td>Medium</td>
<td>51</td>
<td>25(49%)</td>
<td>4(16%)</td>
<td>0</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(p&gt;.05)</td>
</tr>
<tr>
<td>Low*</td>
<td>172</td>
<td>111(65%)</td>
<td>12(11%)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Implement control measures

- Administrative controls
  - Targeted testing
  - Case finding
  - Surveillance

- Environmental controls
  - Enhanced ventilation
  - UV light intervention

- Personal protective equipment
  - Isolation/masks
- Health professions education

I. Background:

II. The Outbreak:

III. Initial Screening at Time of Patient 1’s Diagnosis:

<table>
<thead>
<tr>
<th>Time of Patient 1’s Diagnosis</th>
<th>POD A</th>
<th>POD B</th>
<th>POD C</th>
<th>GYM</th>
<th>POD D</th>
<th>POD E</th>
<th>POD F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 2</td>
<td>0%</td>
<td>14%</td>
<td>10%</td>
<td>21%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Patient 1</td>
<td>5%</td>
<td>21%</td>
<td>0%</td>
<td>21%</td>
<td>21%</td>
<td>21%</td>
<td>21%</td>
</tr>
</tbody>
</table>

IV. The Jail:

V. Patient 2’s CXR:

VI. The Challenges:

VII. The Prioritization Scheme:

VIII. The Results:

IX. The Conclusions:

- By evaluating our prioritization scheme during the outbreak response, we showed that high priority contacts were over three times as likely to have a positive tuberculin skin test (TST).
- We successfully directed limited resources to contacts most at risk.
- Employees had a greater than expected rate of LTBI – Airflow issues - Requested NIOSH assistance – No routine TST screening program previous to this outbreak.
- Now:
  - Binannual TSTs for 3 years or until no new conversions
  - Inmate screening – symptom screening for all at intake
  - Inmates incarcerated > 2 weeks undergo TST testing
  - UV lighting installed in the air handling system

- Patient 1 incarcerated 10 weeks + Patient 2 incarcerated 20 weeks = 321 discharged inmates to find for contact testing.
- We needed to prioritize these 321 discharged inmates plus 62 employees. They were prioritized high, medium and low based on characteristics of their disease, exposure, and results of initial TST results of currently incarcerated contacts.
- After the initial investigation, we needed to evaluate the prioritization scheme to assure that contacts were prioritized correctly and those most at risk were evaluated.

Contact investigation guidelines:

- “For optimal efficiency, priorities should be assigned to contacts, and resources should be allocated to complete all investigative steps for high- and medium-priority contacts.”

- Two patients with TB disease (TBD) were diagnosed in the same month in a rural MO jail.
- There were 230 inmates in six pods in the 167-inmate capacity jail.
- There was no TB screening program in this jail, nor was there a computerized inmate log.

III. Initial Screening at Time of Patient 1’s Diagnosis:

The low priority group included low risk inmates and all employees.

- Low risk inmates:
  - Sought = 115
  - Initially Evaluated = 52 (45%)
  - TST+ = 6 (10%)
  - TBD = 0

- Employees:
  - Sought = 62
  - Initially Evaluated = 62 (100%)
  - TST+ = 8 (12%)
  - TBD = 0

The low risk priority group included low risk inmates and all employees.

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    - Isolation/masks
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MMWR December 16, 2005/Vol.54/No.RR-15

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    - Targeted testing
    - Case finding
    - Surveillance
  - Environmental controls
    - Enhanced ventilation
    - UV light intervention
  - Personal protective equipment
    - Isolation/masks
    - Health professions education
Looking back – you’ll be glad you did!

- Regroup and document what worked and what did not work
  - All participants
- Lessons learned - implement change for the next investigation

References


References (2)


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


References (3)