Tuberculosis: Still with us after all these years

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http://www.lung.ca/tb/images/
It is Friday afternoon April 14 at 3:55pm, and the OH office is about to close. You are paged to attend an urgent meeting in 5 minutes……..

• The meeting is attended by Infection Control, Public Health, Quality, members of the NICU team....

• Problem: in the last 24 hours the diagnosis of TB has been made in 2 infants that had been in NICU:
  – Baby A born 15 Dec, died 4 Feb in NICU. Path report today (!) disseminated TB
  – Baby B in NICU 19-26 Jan, admitted with severe pneumonia to pediatric floor 12 April, BAL (nuclear amplification) *Mycobacterium tuberculosis*
Investigation:

(Crockett et al. Nosocomial transmission of congenital tuberculosis in a NICU. CID 2004;39:1719-23.)

• Mom of **Baby A** emigrated from a TB endemic country 20 years ago. Diagnosed with TB as were other family members
• Parents of **Baby B** : no TB initially, but TST converted at 3 months (16 mm and 22 mm TSTs)
• Health care workers, visitors (>8 hours in NICU during Baby A’s stay) assessed by Occ Health or public health: 2 nurses, 1 ward clerk TST pos.
• No other patients, visitors TST positive
• Ventilation met standards
• Reprocessing of resp equipment sub-standard.
Objectives today:

• To be able to answer the question: Is TB a problem in Canada? In the world?
• To understand infection prevention measures by infection prevention and occupational health to prevent transmission of tuberculosis
• To understand the rationale for IC/OH measures to prevent TB transmission and disease
TB 2012, still with us: Outline

• Epidemiology of TB
• Transmission
• Preventing transmission
  – Recognizing the infected health care worker
  – Recognizing the infected patient and interrupting transmission
Tuberculosis

- A range of clinical illnesses caused by *Mycobacterium tuberculosis* (or less commonly *M. bovis, M. microti, M. africanum, M. canetti*)
- Second only to HIV as a cause of death worldwide
- A Gram positive acid-fast bacillus

CDC/Dr. George Kubica
Epidemiology of tuberculosis

• Humans are the only reservoir for *M. tuberculosis*

• Grows slowly (generation time of 15-20 hours); visible growth on solid media in the microbiology lab takes 3 to 10 weeks

• Transmission from one human to another occurs by respiratory droplets and droplet nuclei from the respiratory tract, or by aerosolized droplet nuclei (e.g. wound)
FIGURE 1: How Microorganisms Are Acquired

Direct

Indirect

Droplet

Conjunctiva, mouth, nasal passages

CONTACT

> 1 metre

AIRBORNE

VEHICLE

VECTORBORNE
Epidemiology of infectious disease transmission

• Direct
  – Contact (source and host in physical contact)
  – Droplet ($\geq 5$ micron particles, travel one meter or less from source)

• Indirect
  – Vehicle
  – Airborne ($<5$ microns; evaporated droplets, dust particles, spores)
  – Vector (mechanical, biological)
Transmission of tubercle bacilli

- Droplet nuclei are expelled by singing, talking, sneezing
- Droplet nuclei are inhaled, reach the alveoli
- Multiplication of bacilli

cdc.gov
What increases the risk of infection?

• Infectiousness is related to number of bacilli-laden droplets
  – Sputum smear-positive for acid-fast bacilli or culture positive
• Infected person is coughing
• Cavity in the lung
• Undergoing cough-inducing or aerosol generating procedures
• Poor ventilation, crowding
Possible outcomes of untreated infection with M. tuberculosis in the normal host

- Immune system keeps infection controlled (most common), infection is latent
- Tuberculous infection occurs, e.g. lung, blood, CNS in first 1-2 years after infection (~5%)
- Tuberculous infection occurs later in life, (~5%)
Persons at high risk of developing TB disease if infected

• Immune compromised
  – HIV
  – Primary or secondary (cancer, immunosuppressive therapy etc)

• Children under 5 years of age
Is TB a problem in Canada?

Rate per 100,000

On the above chart and in the table below, one or more values may not show up. This is due to the fact that they are missing (not reported) or too small to provide an accurate comparison.

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Preventing tuberculosis

• **Administrative**
  – E.g. More rapid isolation, diagnosis and treatment of patients with active TB

• **Engineering**
  – E.g. improved ventilation in patient care area

• **Personal controls**
  – E.g. Tuberculin skin testing of workers
  – E.g. Use of particulate respirators
  – HCW education
“Routine practices” incorporated into all patient care to prevent infectious disease transmission.
Routine Practices
(July 1999, Health Canada)

- **Hand** washing/ Hand antisepsis
- **Gloves** for contact with blood, body fluids, secretions and excretions, mucous membranes, draining wounds or non-intact skin
- **Masks, eye protection**, face shield, for activities likely to generate splashes or sprays of body fluids
- **Gowns** for activities likely to generate splashes or sprays of body fluids

Transmission based precautions: (Contact, Droplet, Airborne)

• Contact (e.g. wound drainage)
• Droplet (e.g. RSV)
• Airborne (e.g. varicella, tuberculosis)

*in addition to Routine Precautions which are used all the time for all patients
Engineering: Ventilation recommended in various areas in health care facilities

### Ventilation Recommended for Selected Areas in Health Care Facilities

<table>
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<tr>
<th>Area</th>
<th>No. of Mechanical ACH, by Recommending Agency</th>
<th>Direction of Air Movement (all agencies)*</th>
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<tbody>
<tr>
<td>Autopsy suite</td>
<td>CTS: 12, CDC: 12, CSA: 20, ASHRAE: 12</td>
<td>Inward</td>
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<td>Bronchoscopy room</td>
<td>CTS: 9-12, CDC: 12, CSA: 20, ASHRAE: 12</td>
<td>Inward</td>
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<tr>
<td>Emergency department and radiology waiting rooms</td>
<td>CTS: 2, CDC: NS†, CSA: 9, ASHRAE: 12</td>
<td>Inward</td>
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<tr>
<td>Operating room or surgical room</td>
<td>CTS: 15, CDC: 15, CSA: 20, ASHRAE: 15</td>
<td>Outward</td>
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<tr>
<td>Airborne isolation rooms</td>
<td>CTS: 6, CDC: 6, CSA: NS, ASHRAE: NS</td>
<td>Inward</td>
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<td>• Existing buildings</td>
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<td>Inward</td>
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<td>• New buildings</td>
<td>CTS: 2, CDC: NS†, CSA: 6, ASHRAE: 4↓</td>
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<tr>
<td>General patient care, and nonisolation rooms</td>
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*Canadian Tuberculosis Guidelines 2007*
Personal controls: Occupational Health TB programs

- Respirator/mask education
- Tuberculin skin testing
- Management of health care worker exposures
TB Respiratory Protection Program

• training HCW on respiratory protection
• Using personal protective equipment in areas with increased risk exposure
  – Room where aerosol generating procedures done
  – Room/setting where TB patients housed

– ????Fit testing???

Respirators filter 95% of particles 1 micron or larger; have < 10% leak
(Standard surgical masks < 50% effective in filtering droplet nuclei)
Tuberculin skin testing

• Purified protein derivative (PPD), derived from tuberculin, injected intradermally using the Mantoux technique
• Infected person’s immune cells recognize TB proteins in PPD, respond to site, causing wheal to rise
• Takes 2-8 weeks after exposure and infection for the immune system to react to PPD
• Reading and interpretation of TST reaction must be done within 48–72 hours
The two step test

• Used for initial skin testing of adults to be retested periodically, to reduce likelihood that boosted reaction will be misinterpreted as recent infection

• If 1st test positive, consider infected; if negative, give 2nd test 1–3 weeks later

• If 2nd test positive, consider infected; if negative, consider uninfected
Administering the TST (Mantoux test)

• Inject 0.1 ml of PPD (5 tuberculin units) into forearm between skin layers
• Produce wheal (raised area) 6–10 mm in diameter
Reading the Mantoux

• Trained health care worker assesses reaction 48–72 hours after injection
• Palpate injection site to find raised area
• Measure diameter of *induration* across forearm (not redness)
• Record size of induration in millimeters; record “0” if no induration found

[Image of a person's arm with a tuberculin test and a ruler for measurement]

www.cdc.gov
≥10 mm induration is classified as positive in:

- Recent arrivals from high-prevalence countries
- Injection drug users
- Residents and employees of high-risk congregate settings
- Mycobacteriology laboratory personnel
- Persons with conditions that increase risk for progressing to TB
- Children <4 years of age, or children and youth exposed to adults at high risk
Interpreting the TST: $\geq 5$mm diameter

$\geq 5$ mm induration is classified as positive in

• HIV-infected persons
• Recent contacts of infectious TB
• Persons with fibrotic changes on chest radiograph consistent with prior TB
• Patients with organ transplants and other immunosuppressed patients
≥15 mm is classified as positive in

- Persons with no known risk factors for TB
**Interferon Gamma Release Assay (IGRA)**

- IGRAs detect *M. tb* infection by measuring immune response in blood
- Cannot differentiate between TB and LTBI; other tests needed
- May be used for surveillance/screening, or to find those who will benefit from treatment
BCG vaccine

- No longer used in North America
- TST or IGRA not contraindicated for BCG-vaccinated persons
- Results used to support or exclude diagnosis of infection
- In BCG-vaccinated, interpret TST with same criteria used for non BCG vaccinated
- Booster phenomenon may occur in BCG-vaccinated persons
<table>
<thead>
<tr>
<th>False positives</th>
<th>False negatives</th>
</tr>
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<tbody>
<tr>
<td>• Nontuberculous mycobacteria</td>
<td>• Anergy</td>
</tr>
<tr>
<td>• BCG vaccination</td>
<td>• Viral, bacterial, fungal coinfection</td>
</tr>
<tr>
<td>• Problems with TST administration</td>
<td>• Recent TB infection</td>
</tr>
<tr>
<td></td>
<td>• Very young age; advanced age</td>
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<tr>
<td></td>
<td>• Live-virus vaccination</td>
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<tr>
<td></td>
<td>• Overwhelming TB disease</td>
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<tr>
<td></td>
<td>• Renal failure/disease</td>
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<tr>
<td></td>
<td>• Lymphoid disease</td>
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<tr>
<td></td>
<td>• Low protein states</td>
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<tr>
<td></td>
<td>• Immunosuppressive drugs</td>
</tr>
<tr>
<td></td>
<td>• Problems with TST administration</td>
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Diagnosis

• Medical history
• Physical examination
• Test for TB infection
• Chest radiograph
• Bacteriologic examination
Why find people with latent TB?

• Treatment of LTBI essential to controlling and eliminating TB disease
• Reduces risk of LTBI to TB disease progression
Advances in TB treatment

• Directly observed therapy (DOTS)
  – Decreases resistance
  – Improves cure rates

• Vaccine

• Therapy: 4 first-line drugs considered standard treatment:
  – Isoniazid (INH)
  – Rifampin (RIF)
  – Pyrazinamide (PZA)
  – Ethambutol (EMB)
Multidrug-Resistant (MDR) and Extensively Drug-Resistant (XDR) TB

- **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

*Often resistant to additional drugs

**Resistant to any fluoroquinolone and at least one of three injectable second-line drugs (i.e., amikacin, kanamycin, or capreomycin

cdc.gov
Resources

• Public Health Agency of Canada: http://www.phac-aspc.gc.ca/tbpc-latb/
• Stop TB: http://www.stoptb.org/
• History of TB in Canada: http://www.lung.ca/tb/tbhistory/
• US Centers for Disease Control: http://www.cdc.gov/tb/
# TB Classification System

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<th>Class</th>
<th>Stage of Disease</th>
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<td>0</td>
<td>No exposure, no infection</td>
</tr>
<tr>
<td>1</td>
<td>Exposure, no evidence of infection</td>
</tr>
<tr>
<td>2</td>
<td>TB infection, no disease</td>
</tr>
<tr>
<td>3</td>
<td>TB, clinically active</td>
</tr>
<tr>
<td>4</td>
<td>TB, not clinically active</td>
</tr>
<tr>
<td>5</td>
<td>TB suspect</td>
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Latency