Global and U.S. Tuberculosis Epidemiology and Principles of Control

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Outline

- Global epidemiology
- U.S. epidemiology
- U.S. principles of control
- Global TB control strategy
Global Importance of TB


<table>
<thead>
<tr>
<th>World</th>
<th>Deaths in millions</th>
<th>% of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary heart disease</td>
<td>7.20</td>
<td>12.2</td>
</tr>
<tr>
<td>Stroke and other cerebrovascular diseases</td>
<td>5.71</td>
<td>9.7</td>
</tr>
<tr>
<td>Lower respiratory infections</td>
<td>4.18</td>
<td>7.1</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>3.02</td>
<td>5.1</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
<td>2.16</td>
<td>3.7</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>2.04</td>
<td>3.5</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1.46</td>
<td>2.5</td>
</tr>
<tr>
<td>Trachea, bronchus, lung cancers</td>
<td>1.32</td>
<td>2.3</td>
</tr>
<tr>
<td>Road traffic accidents</td>
<td>1.27</td>
<td>2.2</td>
</tr>
<tr>
<td>Prematurity and low birth weight</td>
<td>1.18</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Global Epidemiology
Global TB Burden: 2009
WHO Estimates (1)

- 9.4 million new cases
  - Rate 137 per 100,000
- 1.7 million deaths
- 85% of cases are in Southeast Asia, Africa and Western Pacific
- 11% of TB cases are HIV-infected
  - Africa accounts for 80% of HIV-infected cases
Global TB Burden: 2009
WHO Estimates (2)

- 22 high-burden countries account for 81% of cases
- Five countries with highest incidence
  - India (2 million)
  - China (1.3 million)
  - South Africa (490 thousand)
  - Nigeria (460 thousand)
  - Indonesia (430 thousand)
Global TB Trends

• Incident cases slowly increasing
• Incidence rate is slowly decreasing (about 1%) per year
  – Population increasing faster than TB cases
• Mortality also decreasing (about 1/3 since 1990)
Drug-Resistant TB

- Multidrug-resistant (MDR) TB: resistant to isoniazid and rifampin
- Extensively drug-resistant (XDR) TB: MDR TB plus resistance to a fluoroquinolone and any second-line injectable (amikacin, kanamycin, capreomycin)
Mechanisms of Drug-Resistant TB

• Primary: transmission of drug resistant strain from one person to another

• Secondary (acquired): susceptible strain becomes resistant because of improper treatment

• New cases MDR TB: 440,000
• 3.3% of all new cases
• 50% of new MDR TB cases are in China and India
• Highest prevalence in Eastern Europe and Central Asia
• 150,000 deaths from MDR TB
• Much higher in retreatment cases (acquired)
  – As high as 61% in some countries
Global XDR TB Estimates: 2008

• 5.4% of MDR TB cases
• Has been reported in 69 countries
• Estimates based on very limited data
Global distribution of countries reporting at least one XDR-TB case by March 2011
U.S. Epidemiology
Historical Trends in TB, 1953-2009

TB resurgence 1980s-1990s
Reported TB Cases*
United States, 1982–2009

*Updated as of July 1, 2010.
Factors Associated with Resurgence of TB in 1980s-1990s

- HIV epidemic
- Poverty and homelessness
- Drug abuse
- Migration from high prevalence countries
- Emergence of drug-resistant TB
- Decline of HCW expertise
- Decline of public health infrastructure
<table>
<thead>
<tr>
<th>Year</th>
<th>No.</th>
<th>Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>14,836</td>
<td>5.1</td>
</tr>
<tr>
<td>2004</td>
<td>14,499</td>
<td>4.9</td>
</tr>
<tr>
<td>2005</td>
<td>14,064</td>
<td>4.8</td>
</tr>
<tr>
<td>2006</td>
<td>13,734</td>
<td>4.6</td>
</tr>
<tr>
<td>2007</td>
<td>13,280</td>
<td>4.4</td>
</tr>
<tr>
<td>2008</td>
<td>12,906</td>
<td>4.2</td>
</tr>
<tr>
<td>2009</td>
<td>11,545</td>
<td>3.8</td>
</tr>
</tbody>
</table>

*Cases per 100,000, updated as of July 1, 2010.
TB Case Rates,* United States, 2009

- < 3.5 (year 2000 target)
- 3.6–3.8
- > 3.8 (national average)

*Cases per 100,000.
TB Case Rates* by Age Group
United States, 1993–2009

*Updated as of July 1, 2010.
Reported TB Cases by Age Group, United States, 2009

- <15 yrs (6%)
- 15–24 yrs (11%)
- 25–44 yrs (34%)
- 45–64 yrs (30%)
- ≥65 yrs (20%)
TB Case Rates by Age Group and Sex, United States, 2009

- Cases per 100,000
- Age Groups: <15, 15-24, 25-44, 45-64, ≥65
- Sex: Male (light blue), Female (pink)
TB Case Rates by Race/Ethnicity*
United States, 1993–2009**

*All races are non-Hispanic. In 2003, Asian/Pacific Islander category includes persons who reported race as Asian only and/or Native Hawaiian or Other Pacific Islander only.

**Updated as of July 1, 2010.
Reported TB Cases by Race/Ethnicity*
United States, 2009

- Hispanic or Latino (29%)
- Black or African-American (25%)
- Asian (28%)
- White (16%)
- American Indian or Alaska Native (1%)
- Native Hawaiian or Other Pacific Islander (1%)

*All races are non-Hispanic. Persons reporting two or more races accounted for less than 1% of all cases.
Number of TB Cases in U.S.-born vs. Foreign-born Persons
United States, 1993–2009*

*Updated as of July 1, 2010.
Trends in TB Cases in Foreign-born Persons, United States, 1989–2009*

*Updated as of July 1, 2010.
Reported TB Cases by Origin and Race/Ethnicity,* United States, 2009

*All races are non-Hispanic. Persons reporting two or more races accounted for less than 1% of all cases.
**American Indian or Alaska Native and Native Hawaiian or Other Pacific Islander accounted for less than 1% of foreign-born cases and are not shown.
Percentage of TB Cases Among Foreign-born Persons, United States*

1999

2009

*Updated as of July 1, 2010.
TB Case Rates in U.S.-born vs. Foreign-born Persons
United States, 1993–2009*

Cases per 100,000

*Updated as of July 1, 2010.
Countries of Birth of Foreign-born Persons Reported with TB United States, 2009

- Mexico (23%)
- Philippines (12%)
- India (8%)
- Vietnam (8%)
- China (5%)
- Guatemala (3%)
- Haiti (3%)
- Other Countries (38%)
Percent of Foreign-born with TB by Time of Residence in U.S. Prior to Diagnosis, 2009

Mexico  Philippines  India  Total

* Foreign-born TB patients for whom information on length of residence in the U.S. prior to diagnosis is unknown or missing.
Primary MDR TB
United States, 1993–2009*

*Updated as of July 1, 2010.

Note: Based on initial isolates from persons with no prior history of TB. MDR TB defined as resistance to at least isoniazid and rifampin.
Primary MDR TB in U.S.-born vs. Foreign-born Persons, United States, 1993–2009*

% Resistant

0 1 2 3

1993 1995 1997 1999 2001 2003 2005 2007 2009

U.S.-born  Foreign-born

*Updated as of July 1, 2010.

Note: Based on initial isolates from persons with no prior history of TB. MDR TB defined as resistance to at least isoniazid and rifampin.
Extensively drug-resistant TB (XDR TB) is defined as resistance to isoniazid and rifampin, plus resistance to any fluoroquinolone and at least one of three injectable second-line anti-TB drugs.

†Drug susceptibility test.
*Reported incident cases as of July 1, 2010.
Estimated HIV Coinfection in Persons Reported with TB, United States, 1993–2009*

*Updated as of July 1, 2010.

Note: Minimum estimates based on reported HIV-positive status among all TB cases in the age group.
Associated Conditions for 2009 TB Cases

- HIV infected: 6.1%
- Homelessness: 5.3%
- Correction facility: 4.2%
- Injection drug use: 1.4%
- Non-injection drug use: 7.8%
- Excess alcohol use: 13.0%
Other Associated Conditions Not Currently Available in U.S. Surveillance Data

- Organ transplantation
- Chronic renal failure/dialysis
- Diabetes mellitus
- Treatment with TNF-α antagonists
- Treatment with glucocorticoids
- Silicosis
- Head and neck cancer
- Cigarette smoking
Principles of TB Control in the United States
How is TB Transmitted?

- Airborne: droplet nuclei containing TB bacilli are coughed into the air by a person with active TB and inhaled by susceptible host.

TB patient 

healthy lung

cough

TB bacteria
Pathogenesis of TB

< 30%

Exposure → Primary Infection → LTBI

5-10%

LTBI → Active TB
Pathogenesis of TB

- **LTBI**
  - Uninfected: <10%
  - Active TB: <30%
  - Uninfected: <30%

Exposed
Interventions to Control Spread of TB

1) Isolate and treat active cases

2) “Window prophylaxis” (reserved for high-risk persons: HIV, young children)

3) LTBI treatment (preventive therapy)

Exposure → No → Primary Infection → LTBI → No → Active TB

1) Isolate and treat active cases
U.S. TB Control Priorities

1) Diagnose and treat all persons with active TB
   – Isolate until no longer infectious

2) Conduct contact investigations of persons with infectious TB
   – Detect secondary cases
   – Detect newly infected persons and treat for LTBI

3) Targeted testing and treatment of persons with LTBI at risk for progression to active TB
<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Estimated risk for TB relative to persons with no known risk factor</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk (testing and treatment for LTBI recommended for all ages&lt;sup&gt;1&lt;/sup&gt;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIDS</td>
<td>110–170</td>
<td>9, 10</td>
</tr>
<tr>
<td>HIV</td>
<td>50–110</td>
<td>11, 12</td>
</tr>
<tr>
<td>Transplantation (related to immune-suppressant therapy)</td>
<td>20–74</td>
<td>13–16</td>
</tr>
<tr>
<td>Silicosis</td>
<td>30</td>
<td>17, 18</td>
</tr>
<tr>
<td>Chronic renal failure requiring hemodialysis</td>
<td>10–25</td>
<td>19–22</td>
</tr>
<tr>
<td>Carcinoma of head and neck</td>
<td>16.0</td>
<td>23</td>
</tr>
<tr>
<td>Recent TB infection (&lt;2 years)</td>
<td>15.0</td>
<td>24, 25</td>
</tr>
<tr>
<td>Abnormal chest x-ray—with upper lobe fibronodular disease typical of healed TB infection</td>
<td>6–19</td>
<td>26–28</td>
</tr>
<tr>
<td>TNF-alpha inhibitors</td>
<td>1.7–9.0</td>
<td>29–32</td>
</tr>
<tr>
<td>Moderate risk (testing and treatment for LTBI recommended if age &lt;65 years&lt;sup&gt;1&lt;/sup&gt;)</td>
<td></td>
<td></td>
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<tr>
<td>Treatment with glucocorticoids</td>
<td>4.9</td>
<td>33</td>
</tr>
<tr>
<td>Diabetes mellitus (all types)</td>
<td>2–3.6</td>
<td>34–37</td>
</tr>
<tr>
<td>Young age when infected (0–4 years)</td>
<td>2.2–5</td>
<td>38</td>
</tr>
<tr>
<td>Slightly increased risk (testing and treatment for LTBI recommended if age &lt;50 years&lt;sup&gt;1&lt;/sup&gt;)</td>
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<tr>
<td>Underweight (&lt;90% ideal body weight; for most persons, this is a BMI ≤ 20)</td>
<td>2–3</td>
<td>39</td>
</tr>
<tr>
<td>Cigarette smoker (1 pack/day)</td>
<td>2–3</td>
<td>40, 41</td>
</tr>
<tr>
<td>Abnormal chest x-ray—granuloma</td>
<td>2</td>
<td>27, 42</td>
</tr>
<tr>
<td>Low risk (testing and treatment for LTBI recommended if age &lt;35 years&lt;sup&gt;1&lt;/sup&gt;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infected person, no known risk factor, normal chest x-ray (‘low-risk reactor’)</td>
<td>1</td>
<td>43</td>
</tr>
<tr>
<td>Very low risk (treatment of LTBI not usually recommended)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person with positive two-step (booster), no other known risk factor, and normal chest x-ray</td>
<td>0.5</td>
<td>Extrapolated from&lt;sup&gt;43&lt;/sup&gt; and&lt;sup&gt;44&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Global TB Control Strategy
Core Strategy: DOTS

- Developed for low-income, high-burden countries
- Focused on detection and treatment of most infectious cases
  - Use of smear microscopy and standardized treatment regimens
  - Culture and drug-susceptibility testing not routinely done
- Has limitations especially for HIV/TB and MDR TB
Revised Stop TB Strategy

- Expand and enhance high quality DOTS
- Scaling up of integrated TB/HIV activities (e.g., intensified case find, preventive therapy, antiretroviral therapy)
- Scaling up of MDR TB diagnosis and treatment
- Strengthen infection control measures
- Address needs of TB contacts
- Implementation is highly variable from country to country
Questions?