URBAN TUBERCULOSIS AND OUTBREAKS IN THE US

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Outline

- What makes urban special?
- Recent urban outbreaks in the U.S. and the state of TB in US cities.
- Detection of transmission in the urban setting
Research Motivation: Evolution of the urban population

Alirol et al., *Lancet Infect Dis.*, 2011;11(2)
Cities and Health

- What are specific features of cities (that are) causally related to health?

- To what extent are features unique to a particular city?

- To what extent are features of cities modifiable?

TB Control: Two worlds?

“Big Cities”

“Everything else”
TB in Urban Areas

- Well-characterized in Urban areas—
  - TB incidence rates to be higher than the national average among 27 European cities (Hayward)
  - Doubled among urban as compared to rural Danish areas (Horwitz)
  - Four to twenty times the national average in various pockets of New York City (Frieden)

- Few outbreaks in US overall (27 over 7 year period), but expensive—$200,000+ over routine health care service costs (MMWR 2012)

Recent Urban US Outbreaks--1

- The Seattle Homeless Outbreak
  - Single strain identified for 44 (68%) of 65 homeless TB cases diagnosed
  - Concern about recent ongoing transmission among high-risk, mobile populations

An 8-year history of a large tuberculosis outbreak involving persons who are homeless in King County, Washington, Powell K, Oren E, et al., under review.
Recent Urban US Outbreaks--2

- A 54-case cluster in NYC

Perri et al. *Emerg Infect Dis.* 2011;17(3)
Recent Urban US Outbreaks--3

Common Risk Factors/Features

- Prolonged infectiousness
  - Delayed diagnoses
  - Incomplete (source) contact investigations
- US-born persons with reported substance abuse (drug and alcohol)
- Histories of incarceration or homelessness
- Few documented medical risk factors
- Patient within cluster diagnosed within 5 months
- Failure to identify contacts

Mitruka et al., Emerg Infect Dis. 2011 Mar;17(3)
Althomsons et al., PLOS One. 2013 Nov; 7(11)
Driver et al., Am J Epidemiol. 2006 Jul 1;164(1)
Epidemiology of Urban Tuberculosis in the United States, 2000–2007

Eyal Oren, PhD, MS, Carla A. Winston, PhD, Robert Pratt, BS, Valerie A. Robison, DDS, PhD, MPH, and Masahiro Narita, MD

In the next 30 years, nearly two thirds of the world’s population is expected to live in urban areas. Recent publications have emphasized important issues related to urban health, such as population composition, physical and social environment, and availability and access to health services. In terms of health outcomes, the most urban and rural areas are often considerably disadvantaged compared with suburban areas.

Tuberculosis (TB) has been called a social disease. Social conditions affecting urban areas such as homelessness or those that create other marginalized populations—such as the HIV epidemic, high population density, suboptimal access to health care, and declining public health infrastructures—have been closely associated with TB. In addition, the migration of people from highly endemic countries from rural areas

Objectives. We investigated tuberculosis (TB) incidence rates and characteristics of patients with TB in large US cities.

Methods. Using the Centers for Disease Control and Prevention’s National Tuberculosis Surveillance System data, we categorized 48 cities annually from 2000 to 2007 as reporting decreasing or nondecreasing rates with Joinpoint analysis. We compared demographic, clinical, and treatment characteristics of patients with TB using bivariate and multivariate analyses.

Results. We found that 42,448 patients with TB in 48 cities accounted for 36% of all US patients with TB; these cities comprised 15% of the US population. The average TB incidence rate in the 48 cities (12.1 per 100,000) was higher than that in the US excluding the cities (3.8 per 100,000) but decreased at a faster rate. Nineteen cities had decreasing rates; 29 cities had nondecreasing rates. Patient characteristics did not conclusively distinguish decreasing and nondecreasing rate cities.

43 cities in the analysis, USA, 2000-2009


51.1% in 4 states

Date: 9/29/2011
Source: ESRI Data & Maps, ArcGIS 10

Slide courtesy of CDC
TB Incidence in selected cities vs. rest of US, 2000-2009

Winston, CA, Cope S, Miramontes R:
Datos no Publicados, CDC, 2011
## Epidemiologic Profile of Notified Cases in the 43 Cities, 2000-2009

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age group, years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>1 641</td>
<td>3.4</td>
</tr>
<tr>
<td>5-14</td>
<td>1 288</td>
<td>2.7</td>
</tr>
<tr>
<td>15-24</td>
<td>5 163</td>
<td>10.8</td>
</tr>
<tr>
<td>25-44</td>
<td>17 159</td>
<td>35.8</td>
</tr>
<tr>
<td>45-64</td>
<td>14 618</td>
<td>30.5</td>
</tr>
<tr>
<td>≥ 65</td>
<td>8 065</td>
<td>16.8</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>30 015</td>
<td>62.6</td>
</tr>
<tr>
<td>Female</td>
<td>17 914</td>
<td>37.4</td>
</tr>
</tbody>
</table>
Epidemiologic Profile of Notified Cases in the 43 Cities, 2000-2009 (2)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>4932</td>
<td>10.3</td>
</tr>
<tr>
<td>Other (minorities)</td>
<td>42 677</td>
<td>89.7</td>
</tr>
<tr>
<td><strong>Place of Birth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>20 084</td>
<td>41.9</td>
</tr>
<tr>
<td>Outside of US</td>
<td>27 641</td>
<td>57.7</td>
</tr>
<tr>
<td><strong>TB Site of Disease</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary</td>
<td>33 789</td>
<td>70.5</td>
</tr>
<tr>
<td>Extrapulmonary</td>
<td>9 662</td>
<td>20.2</td>
</tr>
<tr>
<td>Both</td>
<td>4 428</td>
<td>9.2</td>
</tr>
</tbody>
</table>
Epidemiologic Profile of Notified Cases in the 43 Cities, 2000-2009(3)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary MDR TB</td>
<td>511</td>
<td>1.4</td>
</tr>
<tr>
<td>Homelessness</td>
<td>3,945</td>
<td>8.2</td>
</tr>
<tr>
<td>HIV+</td>
<td>5,211</td>
<td>10.9</td>
</tr>
<tr>
<td>Incarceration</td>
<td>1,565</td>
<td>3.3</td>
</tr>
<tr>
<td>Excessive alcohol use</td>
<td>7,328</td>
<td>15.3</td>
</tr>
<tr>
<td>Use of illicit drugs</td>
<td>4,236</td>
<td>8.8</td>
</tr>
<tr>
<td>DOT (during any part of treatment)</td>
<td>31,344</td>
<td>80.8</td>
</tr>
<tr>
<td>Treatment Completion</td>
<td>33,113</td>
<td>85.3</td>
</tr>
</tbody>
</table>

Winston, CA, Cope S, Miramontes R: Datos no Publicados, CDC, 2011
Multivariate Logistic Regression Analysis of Factors Association with a decrease in TB incidence in 43 cities, USA, 2000-2009

<table>
<thead>
<tr>
<th>Factor</th>
<th>Adjusted Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24 years of age</td>
<td>1.16</td>
<td>1.03-1.32</td>
</tr>
<tr>
<td>25-64 years of age</td>
<td>1.17</td>
<td>1.04-1.31</td>
</tr>
<tr>
<td>Birth outside US</td>
<td>1.17</td>
<td>1.11-1.23</td>
</tr>
<tr>
<td>Illicit drug use</td>
<td>1.21</td>
<td>1.11-1.31</td>
</tr>
<tr>
<td>Homelessness</td>
<td>0.89</td>
<td>0.82-0.96</td>
</tr>
</tbody>
</table>
Methodological Challenges

- Analysis limited with respect to socio-demographic factors, didn’t take into account important programmatic/policy changes in TB Control Programs
- Lack of sampling frames (mapping each housing unit)
  - Defining neighborhood boundaries
  - Appropriate geography for a city
- High mobility
- Unregistered/undocumented
- Which factors are most relevant to TB?
- How to measure “city-level” characteristics?
Outline

- Urban TB control and recent outbreaks in the U.S.
- Detection of transmission in the urban setting

Clustering and space

Source: E. Oren, unpublished
Early Data from Coast to Coast

Monitoring Urban Trends in SF

An 8-year history of a large tuberculosis outbreak involving persons who are homeless in King County, Washington, Powell K, Oren E, et al., under review.
Note: Circles represent genotype clusters. The size of a circle does not correlate to the number of cases. These data do not necessarily imply spread of King County PCR00001 from Washington State to other areas in the United States.

Source: CDC
Factors predicting cluster growth

- First 2 patients AFB smear positive, cavitary (NYC)
- Rapid initial cluster growth (CDC)
- Homelessness, excess alcohol/drug use, incarceration history (CDC)
- Age <35, urban residence (Holland)

Driver et al., *Am J Epidemiol.* 2006;164(1)
Kik et al., *Am J Respir Crit Care Med.* 2008 Jul 1;178(1)
Factors associated with clustering

Perri et al. *Emerg Infect Dis.* 2011;17(3)
Promise of “Genomic Epidemiology”: Whole-Genome Sequencing

Walker et al., Lancet Infect Dis. 2013;13(2)
Targeted Interventions

- Screening and treatment for LTBI
- Prioritize (novel) contact investigation strategies
- Active case finding and innovative treatment options among marginalized populations
  - Accessible services with diagnostic facilities
- Primary care provider education
- Genotyping results to monitor outbreaks and to inform screening opportunities
So what is the future of the urban city?

“Misery...houselessness...hunger, rages, tempest, and beggary”

~David Copperfield

“Cities are the abyss of the human species.”

~Jean-Jacques Rousseau

“I have an affection for a great city. I feel safe in the neighbourhood of man, and enjoy the sweet security of the streets.”

~Henry Wadsworth Longfellow
Acknowledgments

• Public Health – Seattle & King County
  – Masa Narita
  – David Bibus

• NACCHO
  – James Ransom

• CDC DTBE:
  – Robert Pratt
  – Roque Miramontes
  – Carla Winston
  – Thomas Navin
  – Kenneth Castro
Additional Slides
Genotyping Methods

- **Molecular Cluster** defined as two or more patients with identical TB strains; Primary typing methods PCR-based
- Identical MIRU AND spoligotype = cluster = recent transmission?

**Mycobacterial Interspersed Repetitive Units**

- **Spacer oligonucleotide typing**