Tuberculosis epidemiology: Using data to inform TB control approaches and priorities

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Objectives

• Describe the epidemiology of tuberculosis in the U.S.
• Describe how epidemiologic and population data can be used to inform TB prevention and control activities
Topics

• Epidemiology of TB in the United States
• Death with TB
• Epidemiology of TB in California
• TB prevention cascades in
  ➢ Contacts to infectious TB cases
  ➢ New arrivers with abnormal chest radiographs
Reported Tuberculosis (TB) Cases and Rates
United States, 1993–2018

Percentage of TB Cases by State, United States, 2018

DC, District of Columbia
Tuberculosis Case Rates by Reporting Area
United States, 2018

TB Incidence Rate (per 100,000 persons)

NYC (6.7)
D.C. (5.1)

TB Cases and Rates Among U.S.-Born versus Non-U.S.-Born Persons, United States, 1993–2018

U.S.-born Cases
Non-U.S.-born Cases
U.S.-born Rate
Non-U.S.-born Rate

No. of cases

Cases per 100,000 Population

Year


0 5 10 15 20 25 30 35 40
Countries of Birth Among Non-U.S.–Born Persons Reported with TB, United States, 2018*

- Mexico: 19%
- Philippines: 12%
- India: 10%
- Vietnam: 8%
- China: 6%
- Guatemala: 3%
- Haiti: 2%
- Other countries: 40%

*Percentages are rounded.

Percentage of Non-U.S.–Born TB Cases by Time in the United States at Diagnosis, 2018

- <1 year: 14.6%
- 1–4: 16.6%
- 5–9: 10.8%
- 10–19: 18.6%
- ≥20: 28.0%
- Unknown/Missing: 11.3%
TB Case Rates by Race/Ethnicity,*
United States, 2010–2018

Reported TB Cases by Origin and Race/Ethnicity*,
United States, 2018†

* All races are non-Hispanic; multiple race indicates two or more races reported for a person, but does not include persons of Hispanic/Latino origin.
† Asian race category reporting includes Pacific Islander from 1993–2002; Native Hawaiian/Other Pacific Islander race first reported separately in 2003.
§ Multiple race rates first reported in 2003.

† Percentages are rounded.
§ American Indian/Alaska Native accounted for <1% of cases among non-U.S.–born persons and are not shown.
TB Case Rates by Age Group, United States, 1993–2018

Year

Cases per 100,000 population

Distribution of Sex by Age Group, United States, 2018

Males

Age Group

Females

<5 yrs

5–14 yrs

15–4 yrs

25–44 yrs

45–64 yrs

65+ yrs
U.S. TB Cases by Site of Disease, 2018

*Any pulmonary involvement which includes cases that are pulmonary only and both pulmonary and extrapulmonary. Patients may have more than one disease site but are counted in mutually exclusive categories for surveillance purposes. Note: Percentages are rounded.

National guidance:
Assess pulmonary involvement for any form of TB

For diagnostic purposes, all persons suspected of having TB disease at any site should have sputum specimens collected for an AFB smear and culture, even those without respiratory symptoms from CDC’s Core Curriculum on TB Chapter 4
Isoniazid Resistance Among U.S.-Born versus Non-U.S.-Born Persons, United States, 1993–2018

Cases of MDR TB by History of TB, United States, 1993–2018*

* Based on initial isolates from persons with no prior history of TB; multidrug-resistant TB (MDR TB) is defined as resistance to at least isoniazid and rifampin.
HIV Coinfection by Age Among Persons Reported with TB, United States, 2011–2018

Reported TB Cases by Risk Factor, United States, 2018

Most Common Risk Factors Reported Among TB Patients

- Diabetes Mellitus: 20%
- Contact to Infectious TB: 8%
- Non-HIV immunosuppression: 7%

Comparison of Selected Risk Factors by Origin of Birth

- U.S.-Born: Contact to Infectious TB (16%), Diabetes Mellitus (15%)
- Non-U.S.-Born: Contact to Infectious TB (4%), Diabetes Mellitus (22%)
TB Cases among Residents of Correctional Facilities Ages ≥15, 1993–2018*

*Correctional facilities include federal prisons, state prisons, local jails, juvenile correctional facilities, other correctional facilities, or unknown type of correctional facility.

TB Cases Ages ≥15 with Other Selected Risk Factors, 2018
Risk factors for TB

- Born in a non-US country where TB is endemic
- Living with HIV, diabetes, other immunosuppression
- Experiencing homelessness
- Using substances (e.g. injection drugs)
- Living in certain institutional settings
TB treatment outcomes

The majority of TB patients complete their treatment within 12 months
Few TB patients are lost to followup
TB patients who move may be provided with continuity of care
Almost 10% of TB patients die while on treatment

TB Cases by Reason Therapy Stopped, 2016*

Outcomes for patients that did not complete treatment

*Data available through 2016 only.
Death with TB

Reported Tuberculosis (TB) Deaths* and Rates
United States, 1993–2017

*National Vital Statistics System Multiple Causes of Death (accessed from CDC Wonder)
TB Surveillance data is more accurate than Vital Statistics data for TB patients who die

We have reviewed the characteristics of the population who has TB
Now let’s review what we know about persons who die with TB

Although TB is a preventable and curable disease, approximately 10% of persons with TB die with TB
Why?
Can we prevent death with TB?
TB Epidemiologic Studies Consortium
Mortality Study Objectives

Assess the frequency of TB-related deaths
Identify risk factors for TB-related death
Methods

- Reviewed deaths of TB cases reported 2005-2006
  - Inpatient and outpatient medical records
  - Laboratory records
- Used standardized and piloted algorithm to determine TB-relatedness
- Trained data abstractors
  - 2 reviewers per case (at least 1 TB clinician)
  - 3rd reviewer to resolve disagreements
- Classification
  - Definitely or probably TB-related
  - Definitely not or unlikely TB-related
  - Unclassifiable

TB relatedness and timing of deaths

1,304 adults who died

- 272 (21%) TB-unrelated deaths
- 942 (72%) TB-related deaths
- 90 (7%) could not be classified

705 (75%) TB-related deaths during treatment

- 329 (47%) TB-related deaths within 30 days of diagnosis
- 371 (53%) TB-related deaths ≥31 days after diagnosis

237 (25%) TB-related deaths before treatment
**Time to death**

![Graph showing the time to death for TB-related and TB-unrelated cases. The graph indicates a significant difference in survival probability between the two groups, with a Logrank p < 0.01.]

**Study algorithm vs. Death certificate**

<table>
<thead>
<tr>
<th>Study algorithm/Death cert</th>
<th>TB was not an immediate, underlying, or contributing cause of death</th>
<th>TB was an immediate, underlying, or contributing cause of death</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not TB-related death</td>
<td>185 (75)</td>
<td>61 (25)</td>
<td>246 (23)</td>
</tr>
<tr>
<td>TB-related death</td>
<td>378 (45)</td>
<td>469 (55)</td>
<td>847 (77)</td>
</tr>
<tr>
<td>Total*</td>
<td>563 (52)</td>
<td>540 (48)</td>
<td>1093 (100)</td>
</tr>
</tbody>
</table>

Kappa = 0.21 (0.16, 0.26)

Sensitivity of death certificate=55.4% (51.9,58.7)
Specificity of death certificate=75.2% (69.3, 80.5)

*Death certificates were not available for 10% of decedents
Risk factors for TB-related death

- Delayed diagnosis
- Extensive TB disease
- Immune suppression
- Comorbidities
- Started anti-TB treatment as inpatient

TBESC study conclusions

- 72% TB deaths were TB-related
- Death certificates were not reliable
  - and underestimate TB-related death
- Need information from medical/hospitalization charts
- Increased death risk when TB was diagnosed in hospital
What do we know about TB deaths in CA?

Reviewed recent surveillance data for 2 types

- Dead at diagnosis
- Died during treatment

Report of Verified Case of Tuberculosis
Was TB a cause of death?
1. Dead at diagnosis
CA TB surveillance data 2010-2016
Dead at diagnosis

2% (n=304) TB cases dead at diagnosis
• 30% TB-related
• 40% not TB-related
• 30% unknown relatedness

Report of Verified Case of Tuberculosis
Was death related to TB disease or TB therapy?
2. Died during treatment
CA TB surveillance data 2010-2016
Died during treatment

8.4% (n= 1267) TB cases died on treatment

- 36% related to TB disease
- 1.6% related to TB therapy
- 41% not TB-related
- 21% unknown

Deaths on treatment for select local TB programs
CA TB surveillance data 2010-2016

<table>
<thead>
<tr>
<th>LHJ</th>
<th>Unrelated to TB disease</th>
<th>Related to TB disease</th>
<th>Related to TB therapy</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>40%</td>
<td>21%</td>
<td>0.5%</td>
<td>39%</td>
</tr>
<tr>
<td>b</td>
<td>43%</td>
<td>47%</td>
<td>2.8%</td>
<td>7%</td>
</tr>
<tr>
<td>c</td>
<td>24%</td>
<td>56%</td>
<td>1.9%</td>
<td>19%</td>
</tr>
<tr>
<td>d</td>
<td>55%</td>
<td>16%</td>
<td>0</td>
<td>29%</td>
</tr>
<tr>
<td>e</td>
<td>19%</td>
<td>70%</td>
<td>0</td>
<td>12%</td>
</tr>
</tbody>
</table>

Large range of responses across CA
Why the difference in TB-related death
TBESC study (72%) vs.
CA surveillance (38%)?

- Diversity of responses to RVCT questions in CA
- Variability in methods to ascertain TB-relatedness?
- Role for independent review?

TB programs should review every death using a standardized approach that includes medical and hospital records

- To identify potential missed prevention opportunities
- To monitor trends
- To identify areas for working with partners
Consider using algorithm developed in CA for review of deaths

How do TB Cases Occur in California?

- **TB in new arrivers**: TB within 6 months of arrival in US 2015-2017
  - 6%

- **Recent Transmission**: RT recipient 2014-2016
  - 12%

- **Reactivation**: of remote infection. Cases not from importation or recent transmission
  - 82%

2,000 TB cases/yr
The Long View: Dramatic Progress
California Tuberculosis Epidemic 1930-2018

The Medium View: Dramatic Progress
California Tuberculosis Epidemic 1991-2018
The Medium View: Slowing Progress
California Tuberculosis Epidemic 1991-2018

Progress Stalled
California Tuberculosis Epidemic 2014-2018
Progress Stalled
California Tuberculosis Epidemic 2014-2018

Number of TB Cases
0 500 1,000 1,500 2,000 2,500
2014 2015 2016 2017 2018

Case Rate per 100,000
0 1 2 3 4 5 6 7 8 9 10

TB Rate

Progress Stalled
California Tuberculosis Epidemic 2014-2018

Number of TB Cases
0 500 1,000 1,500 2,000 2,500
2014 2015 2016 2017 2018

Case Rate per 100,000
0 1 2 3 4 5 6 7 8 9 10

TB Rate
Match the TB program strategy to the TB mechanism

TB in recent arrivers  ➔  • Overseas screening and treatment  
                         • Domestic evaluation and treatment

Recent transmission  ➔  • Outbreak investigation  
                      • Contact investigation

Reactivation of LTBI ➔  • Risk assessment  
                      • LTBI testing  
                      • LTBI treatment
83% of cases in people born outside U.S.
TB Cases by country of birth California, 2018
Cases from >120 countries
Country of origin of TB cases 2014-2018, California

TB Incidence by Country of Birth,
California, 2001–2016
Large disparity by place of birth
TB case rate by nativity California 2009-2018

Disparity by place of birth increasing
TB case rate by nativity California 2009-2018
20x-60x higher rates among non-U.S.-born minorities compared with U.S.-born whites
TB rate by race/ethnicity and nativity, 2018

Most People with TB have been U.S. residents for many years
Years in U.S. at TB diagnosis California, 2014-2018

>50% in US >18 yrs
**Half of TB cases are older than 55**

*Age at Report of TB, 2018*


2018: Born outside US=57 years  US-born=36 years

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**More TB Cases are Older**

*% of TB Cases Aged 65+, 1993-2018*

- 1993: 18%
- 2008: 23%
- 2018: 34%
More TB Cases are Older
% of TB Cases Aged 65+, 1993-2018

Decreasing TB in youngest kids
Pediatric Cases <5yrs, California, 2009–2018
Correctional cases increased in 2018
Cases Diagnosed in a Correctional Facility, 2009-2018

Cases increased most in local jails and others*
Type of Correctional Facility, 2017-2018

* Includes ICE detention centers
Low education associated with high TB rate
TB rate by % of adults in census tract with HS education

Lower SES associated with higher TB rate.
TB Rate by SES Level and Country of Birth
2018 CA TB Epi Highlights Summary

Stall in decline confirmed
Similar epi patterns continue: disparities
High TB rate in older age groups
Falling number of peds cases reason for optimism
Cases in local jails and other facilities bears monitoring
TB is associated with lower socioeconomic status!
(even in California and after accounting for country of birth)

Contacts Care Cascade: Evaluation
ARPE Data California, 2016–2017

<table>
<thead>
<tr>
<th>Number of contacts</th>
<th>Contacts to Smr+</th>
<th>Evaluated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23,589</td>
<td>19,204</td>
</tr>
</tbody>
</table>

NTIP data for California based on ARPE reporting for cohorts reported in 2016 and 2017
TB prevention cascade among Contacts to infectious TB, California, 2016-2017

NTIP data based on ARPE California data, 2016-2017

<table>
<thead>
<tr>
<th>Contacts with LTBI</th>
<th>Started treatment</th>
<th>Completed treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,117</td>
<td>2,125</td>
<td>1,510</td>
</tr>
</tbody>
</table>

68% 71%

With LTBI

Started treatment

Completed treatment

Improving treatment completion

Contacts Completing LTBI Treatment (of those who start)

<table>
<thead>
<tr>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>62%</td>
<td>62%</td>
<td>73%</td>
<td>69%</td>
<td>72%</td>
<td>70%</td>
</tr>
</tbody>
</table>

ARPE data reported to California 2012-2017
<50% of contacts with LTBI complete treatment
ARPE Data California, 2012-2017

New legal permanent resident evaluations: B-notification
Potential room for program improvement?

- Only 42% of contacts with LTBI completed treatment
- Only 22% of B1 arrivers with LTBI completed treatment
TB programs are responsible for at least 2 populations at risk of TB: Contacts and New arrivers with B-notifications

Improved evaluation and treatment to prevent TB

Contacts for California TB programs

- CDPH TB Branch 510-620-3865
- Program Liaisons
  - Lisa True
  - Stephanie Spencer
  - Leslie Henry
  - Anne Cass
  - Michael Joseph
- Epi Liaisons
  - Lisa Pascopella
  - Melissa Ehman
  - Adam Readhead
  - Phil Lowenthal
  - Varsha Hampole
- TB Registry Chief
  - Janice Westenhouse
- Surveillance and Epidemiology Section Chief
  - Pennan Barry
- Program Development Section Chief
  - Kristen Wendorf
- You can reach me at lisa.pascopella@cdph.ca.gov
National and California resources

Division of Tuberculosis Elimination
National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention
Centers for Disease Control and Prevention
http://www.cdc.gov/tb/
• National data slideset
• Core curriculum on TB

Tuberculosis Control Branch
Division of Communicable Disease Control
Center for Infectious Diseases
California Department of Public Health
• https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TBCB.aspx
• https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/TBCB-Program-Liaison-Epi-Assignments.pdf
• https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/TBCB-RVCT-Death-Algorithm-v1.0.pdf

Acknowledgements

CDC DTBE slideset
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