TB:
Recognizing it on a Chest X-Ray

Michigan World TB Day April 8, 2016
Dana G. Kissner, MD
Medical Director Wayne State University
Physician Group TB Program
TB Consultant Washtenaw County
Disclosures

• Grant support from Michigan Department of Community Health
  – Despite conflict of interest I still want to:  
    Stop TB in my lifetime
  – There’s enough TB for job security.
Objectives

• You will
  – Be able to identify **major structures** on a normal chest x-ray
  – Identify and correctly name **CXR abnormalities** seen commonly in TB
  – **Recognize chest x-ray patterns** that suggest TB & when you find them you will
Basics of Diagnostic X-ray Physics

• X-rays are directed at the patient and variably absorbed
  – When not absorbed
    • Pass through patient & strike the x-ray film or
  – When completely absorbed
    • Don’t strike x-ray film or
  – When scattered
    • Some strike the x-ray film
Absorption

- Absorption depends on the
  - Energy of the x-ray beam
  - Density of the tissue

Shade / Density

- Whitest = Most Dense
  - Metal
  - Contrast material (dye)
  - Calcium
  - Bone
  - Water
  - Soft Tissue
  - Fat
  - Air / Gas

- Blackest = Least Dense
Normal Frontal Chest X-ray: Posterior Anterior

Note silhouette formed by
• lung adjacent to heart
• lung adjacent to diaphragm

Silhouette Sign

Lifeinthefastlane.com
Normal Lateral Chest X-ray
Normal PA & Lateral X-ray:

**Hilum**

**Hilum** – Major bronchi, Pulmonary veins & arteries, **Lymph nodes** at the root of the lung.
Normal PA & Lateral X-ray: Mediastinum

**Mediastinum** – Central chest organs (not lungs) – Heart, Aorta, Trachea, Thymus, Esophagus, **Lymph nodes**, Nerves

(Between 2 pleuras or linings of the lungs)
Normal PA & Lateral X-ray:
Apex

- Apex of lung
  - Area of lung above the level of the anterior end of the 1st rib
Wink Sign: Apex
Normal PA & Lateral X-ray: Right Paratracheal Stripe

- Paratracheal stripe
  - Seen between the air in the trachea & air in the lung
50 Year Old Iraqi with Fevers

- At Diagnosis LNs
- At End of Treatment
The TB Image Library is a joint project of the Curry International TB Center and Firland Northwest TB Center as an educational resource to share radiographic images related to tuberculosis.

- Individuals may use this site to gain an appreciation for the broad spectrum of presentation TB may have using various imaging modalities.
- The library images are free to download for non-commercial educational purposes only. All images should be credited in the format: CITC/Firland TB Image Library; contributor.
- To contribute images or offer comments/feedback/questions, please email: CurryTBcenter@ucsf.edu

**Basic TB Chest abnormalities and patterns of disease**

- Consolidation/Opacities
- Cavitations/Cysts
- Linear opacities/Fibrosis
- Nodules/Masses
- Miliary pattern
- Lymphadenopathy
- Pleural abnormalities
- Tracheobronchial abnormalities
Consolidation

• Appears as a relatively homogeneous white area on chest x-ray

• Although the terms opacity and density are sometimes used, areas of consolidation are usually translucent; structures such as ribs are visible through the consolidation

• Is caused by filling of airspace with fluid, cells, pus, blood

• Without significant volume loss
Consolidation

- **Air bronchogram** may be visible because air in the bronchus forms a silhouette with fluid in airspace (characteristic of consolidation; not always present).

- **Silhouette sign** occurs when opacity is contiguous with heart or diaphragm, causing loss of normal silhouette.
Consolidation / Opacity / Density

• The initial lesion in primary TB can be in any location in the lung
• In later ("reactivation") TB, location is most frequently in the upper and posterior portions of the lung
  – Apical and posterior segments of the right upper lobe
  – Apical-posterior segment of the left upper lobe
  – Superior segments of the lower lobes
Consolidation, Air Bronchogram
Left upper lobe apical-posterior segment
Consolidation, Air Bronchogram
Left upper lobe apical-posterior segment
Silhouette Sign (no heart) & More
21 year old, severe agoraphobia

Lingula
Nodules / Masses

• Nodule - discrete opacity or density that is 2-30 mm in diameter
• TB nodules can be
  – Solitary
  – Multiple
  – Associated with other chest x-ray abnormalities due to TB
• A common pattern for primary TB is a nodule (the primary focus of infection) plus ipsilateral enlarged mediastinal or hilar lymph node(s)
Nodules / Masses

• TB nodules
  – Can cavitate (form cavities)
  – Calcify when they heal

• A mass is larger than a nodule and is not typical of TB
Screening for TB in High Risk Individuals

- 22 year old, cough for 4 days, contact of case
- OT Student from Taiwan, TB skin test + 3 years ago; no symptoms, no Rx
PET Scans do NOT Differentiate TB from Cancer: This Patient had TB

“FDG avid pulmonary nodule in the right middle lobe, along with two FDG avid lymph nodes involving the right hilum and subcarinal region. Findings suspicious for malignancy.”
Cavities

• Most common in advanced disease (reactivation TB)
• Highly contagious, contain many actively multiplying organisms
• Endobronchial spread to other areas of lung
• Higher risk of developing drug resistance
• May take longer to treat
• Wall thickness thin to medium
• Significant air / fluid levels are rare
Cavities: Think Swiss Cheese
Young Man from Vietnam: Negative TB skin test, T-Spot, and QFT
Multiple Findings on CT Scan

- Cavities, consolidation with air bronchograms, nodules, “tree-in-bud” densities
Tree-in-Bud Opacities
Young Woman Treated for Pneumonia And 6 Months Later
Miliary TB

- Disseminated disease
- *Usually* occurs during initial (primary) infection with hematogenous spread of MTB
- Uniformly distributed nodules ~ 2 mm. in size
- May progress to septic shock and acute respiratory failure
- After infection, miliary TB &/or meningitis occur in ~ 10-20% of babies < 1 year old
Miliary Pattern

- 15 year old with disseminated MDR TB
- Substance abuser, treated with prednisone for misdiagnosis of sarcoidosis
TB Pleural Effusions and Other Abnormalities

- Small to very large, can loculate
- Usually unilateral
- Primary (or post primary disease)
- Fluid can be serous, thick & congealing, or bloody – not frank pus unless complicated
- Exudate – high protein and LDH, white cells predominantly lymphocytes
- ↑ Adenosine deaminase and IFN-γ levels
- Bronchopleural fistulas can occur
44 Year Old Man: Homeless Shelter Outbreak

• Note meniscus sign, silhouette sign, less translucency than consolidation
40 Year Old with Known Exposure to Contagious Case 1-2 Months Ago

- IV dye helps distinguish lung from pleural fluid
Lymphadenopathy

• Frequent in primary disease
• In children can be massive and compress airways
• Rim enhancement with dye and low attenuation centrally suggests TB
Recent Contact with TB Case:
PET Scan Shown Before

Ghon Complex
Frank Netter
15 Year Old Boy with Cough
Contact to Aunt with MDR TB

- Sputum culture + for MDR TB
15 Year Old Somali Boy. Chest pain, Difficulty Eating
Linear Shadows / Fibrosis

- Can be old healed TB or active chronic TB
- Often seen with immigrants labeled B1
- Can be associated with volume loss
Treated TB:
Note Volume Loss
Tracheobronchial TB

• Airways can be compressed by large lymph nodes
• TB can be endobronchial
• Bronchiectasis and bronchostenosis are common sequelae
• Atelectasis or collapse of the lung beyond an obstructing lesion can occur (similar to lung cancer)
Homeless Man
Who can name the 2 surgical procedures performed on this patient?

Alice Neel (1900-1984) TB Harlem
And The Names Are:

- Right plombage
- Left thoracoplasty
Conclusion: You can Learn to Recognize TB When You See It!

Ed Neuhauser and Ben Felson
World TB Day Conference
Migration & TB

TB Testing
Requirements for Licensed Facilities

Bureau of Community & Health Systems (BCHS)

Presenters
Larry Horvath
Teri Dyke, MSN, RN
Tom Bissonnette, MS, RN
Disclosures Oversight

• None of the speakers or planners involved in this activity has any relevant conflict of interest.

• Approval status does not imply endorsement by the provider, ONA, MSMS, or any products displayed in conjunction with an activity.

• The use of trade names and commercial sources during this presentation is for identification only, and does not imply endorsement.

• No commercial support has been received for this program.
Regulatory Oversight

Bureau of Community & Health Systems (BCHS) - Effective July 6, 2015 Provides:

• State Licensing
  – Health Facilities & Agencies (including Homes for the Aged)
    • Life Safety Code Inspections of Long Term Care Facilities
  – Substance Use Disorder Programs
  – Child Care Homes & Centers
  – Adult Foster Care Homes
BCHS Also Provides:

- Federal Certification of Providers and Suppliers on Behalf of the Centers for Medicare and Medicaid Services (CMS)
- Plan Review/Construction Permits for State Licensed Health Facilities
- Workforce Background Checks
- Nurse Aide Training Program/Nurse Aide Registry (February 1, 2016)
BCHS Organizational Overview

Larry Horvath
Bureau Director

Steve Gobbo
Deputy Bureau Director

Mark Jansen, Director
Child Care Licensing Division

Jay Calewarts, Director
Adult Foster Care & Camps Division

Teri Dyke, Director
Health Facility Licensing, Permits, and Support Division

Michelle Roepke, Director
Federal Survey & Certification Division

State Licensed
- Child Care Group Homes/Centers

State Licensed
- Adult Foster Care Homes
- Adult Foster Care/Child Camps
- Homes for the Aged
- Complaint Intake (AFC, HFA, Child Care, Camps)
- Application Processing (AFC, HFA, Child Care, Camps)

State Licensed
- Freestanding Surgical Outpatient Facilities
- Hospice Agencies & Residences
- Hospitals
- Nursing Homes
- Substance Use Disorder Programs

Other Functions
- Complaint Intake (Health)
- Construction Permits
- Fire Safety (LTC)
- Nurse Aide Training Program
- Nurse Aide Registry
- FOIA
- Workforce Background Checks
- Enforcement/Compliance

Federal Certification
- Ambulatory Surgical Centers
- Clinical Laboratory Services
- Comprehensive Outpatient Rehabilitation Facilities
- Dialysis Centers
- Home Health Agencies
- Hospice Agencies & Residences
- Hospitals
- Nursing Homes
- Outpatient Physical Therapy (OPT)/Speech Pathology Providers
- Portable X-Ray Suppliers
- Rural Health Clinics
Michigan Covered Providers
(As of December 29, 2015)

* Some federal oversight for organ procurement organizations (1) and federally qualified health centers (215).

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<th>No. of Providers</th>
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### BCHS State/Federal Oversight by Covered Providers

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<td>NO</td>
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<td>Rural Health Clinics (RHC)</td>
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General Overview

State Licensure
- Initial licensure
- Routine surveys/inspections
- Complaints
- Renewal
- Enforcement

Federal Certification
- Initial certification
- Routine recertification surveys
- Complaints
- Recertification
- Enforcement
Presentation Objectives

• Discuss recent changes made by LARA in TB testing requirements for healthcare facilities.

• Describe how these changes may affect employee and patient TB screening in the workplace.
Proposed TB Requirements

• Administrative Rules
  – Use the CDC’s TB risk assessment* as a guide for requirements for routine TB screening
  – Eliminated the requirement for admission chest x-ray along with the History & Physical
  – Maintain record of baseline screening for communicable disease for employee
How often to screen employees and patients?
- Baseline, and then according to the facility’s risk assessment; Low, Medium and Ongoing transmission.

What to do if there is a positive TB test?
- Identify the source, isolate, N-95/mask patient notify Local Health Department, initiate contact tracing.

When to conduct TB risk assessments for your facility type?
- Annually, or when a cluster of conversions or an actual TB case
Resources

• Guideline for Preventing Transmission of Mycobacterium Tuberculosis in Healthcare Setting
  http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5417a1.htm?s_cid=rr5417a1_e

• **TB Risk Assessment form:

• Prevention and control in Long-term care facilities
  http://www.cdc.gov/mmwr/preview/mmwrhtml/00001711.htm

• State of Michigan Data and Statistics:
  http://www.michigan.gov/mdhhs/0,5885,7-339-71550_5104_5281_46528_59091---,00.html
Questions & Answers

Bureau of Community and Health Systems
Ottawa Building, 1st Floor
611 W Ottawa Street
Lansing, MI 48909
Main Line: (517) 335-1980
www.michigan.gov/bchs

Thank you for your efforts to provide quality health care to Michigan residents!
TB GENOTYPING AND CLUSTERS IN MICHIGAN

Shona Smith, MPH
TB Epidemiologist
Michigan Department of Health and Human Services
Disclosures

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Objectives

1. Provide a brief overview of genotyping and how it is used with M. tuberculosis specimens
2. Review the TB GIMS system and its application of genotyping for identifying outbreak clusters
3. Examine prominent TB clusters in Michigan
4. Discuss best practices for investigating clusters
Content

• Genotyping overview for Tuberculosis
  – Best practices for cluster investigations
  – Using genotype information to assist in contact investigations

• TB GIMS
  – Overview of cluster reports
  – Interpretation of cluster reports

• Genotype clusters in MI
  – Trends in primary Michigan clusters
  – Compare with clusters nationwide

• Intro to new cluster survey tool
OVERVIEW OF GENOTYPING FOR TUBERCULOSIS

What does it mean?

Proportion of culture confirmed TB cases genotyped (%)

- 2004: 52.6%
- 2005: 68.5%
- 2006: 70.1%
- 2007: 80.9%
- 2008: 81.6%
- 2009: 86.8%
- 2010: 91.6%
- 2011: 94.2%
- 2012: 94.8%
- 2013: 95.6%
- 2014: 95.3%

National Indicator: 94%

* The proportion of positive cultures with at least one genotyped isolate.
** Includes 50 states and the District of Columbia.
Genotyping Coverage for Culture Positive TB Cases
Michigan, 2010-2015

<table>
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<th>Year</th>
<th>Percent genotyped</th>
<th>Percent within a cluster</th>
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<td>90.4</td>
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<tr>
<td>2010</td>
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<td>2013</td>
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<tr>
<td>2014</td>
<td>97.4</td>
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<tr>
<td>2015</td>
<td>100.0</td>
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</table>

2015 National Indicator: 94%
QUESTION: What is TB Genotyping?

a. Laboratory method to detect TB infection

b. A blood test to detect drug-resistant TB

c. Laboratory approach to analyze genetic material (DNA) of Mycobacterium tuberculosis (M. tuberculosis)

d. Tool to help understand transmission of M. tuberculosis

e. Both c and d

DNA = deoxyribonucleic acid
ANSWER:
TB Genotyping Is

a. Laboratory method to detect TB infection

b. A blood test to detect drug-resistant TB

c. Laboratory approach to analyze genetic material (DNA) of M. tuberculosis

d. Tool to help understand transmission of M. tuberculosis

e. Both c and d

DNA = deoxyribonucleic acid
TB Genotyping

- Only for culture-confirmed TB
  - The technique requires material from a culture
- Matching genotypes may indicate that TB cases are related
Genotypes and *M. tuberculosis* Transmission

- Genotyping helps us understand transmission relationships between TB cases.
- We expect genotypes from transmission-related TB cases.
Matching Game – Do the Pictures Match?
Genotype Clusters
How Can Genotyping be Useful in TB Control?

- Assist with contact investigations
  - Confirm or refute patient connections
- Find previously unidentified contacts
- Detect and prevent outbreaks
- Refute outbreaks
- Distinguish relapse from new infection
- Detect false-positive culture results
Case Scenario 1: A Household

Persons diagnosed with TB spent most of their time together at the same house

- Likely related by transmission
Case Scenario 1: A Household

Genotype results for TB cases linked to household

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<tbody>
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<td>G08464</td>
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<tr>
<td>Son</td>
<td>G08464</td>
</tr>
<tr>
<td>Neighbor</td>
<td>G08464</td>
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</table>
Case Scenario 1: A Household Interpretation of Genotyping Results

- All cases had matching genotypes
- All spent time together in the same house
- These cases were likely transmission-related
Case Scenario 1: A Household
Back to the Household

• Contact investigation did not find any other cases
• Two other family members were diagnosed and treated for TB infection
• Neighbor with TB did not identify any other contacts aside from family
Case scenario 1: A Household Review of Genotype Data for County A – 2013

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<table>
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<td>Patient A</td>
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<tr>
<td>Patient B</td>
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Case Scenario 1: A Household
What do the Genotype Results Indicate?

- Five cases with matching genotypes within 6 months
- Cases may all be related by transmission, but
  - When?
  - Where?
- More information is needed
Case Scenario 1: A Household

Next Steps

• Investigate to understand relationship of Patient A and Patient B to the other patients in the cluster
  – Identify likely locations of transmission
  – Determine if there are missed contacts

• Review
  – Public health records
  – Contact investigation logs
  – Estimated infectious periods
  – Re-interview TB patients and contacts
Case Scenario 2: A Workplace

- Within one month
  - Three women diagnosed with TB
  - All work at the same casino
  - All work on the same evening shift

- One woman’s boyfriend also diagnosed with TB
Case Scenario 2: A Workplace

QUESTION:
Are these TB cases related by transmission?

a. Yes
b. No
c. Maybe
Case Scenario 2: A Workplace

ANSWER:

Are these TB cases related by transmission?

a. Yes
b. No

[Images of people with stars indicating possible transmission]

c. Maybe!
Case Scenario 2: A Workplace Genotype Results for TB Cases Linked to Casino

<table>
<thead>
<tr>
<th>Employee</th>
<th>Genotype ID</th>
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<tr>
<td>Employee 1</td>
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<td>Employee 2</td>
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<td>Employee 3</td>
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<td>Boyfriend</td>
<td>G16470</td>
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Case Scenario 2: A Workplace

QUESTION:
How to interpret the genotype results?

a. The genotype data are wrong

b. The genotype data could be wrong, since cases are linked epidemiologically

c. These cases are not related by transmission

d. I don’t know
Case Scenario 2: A Workplace

ANSWER:

How to interpret the genotype results?

a. The genotype data are wrong

b. The genotype data could be wrong, since cases are linked epidemiologically

c. **These cases are not related by transmission**

d. I don’t know
Case Scenario 2: A Workplace Interpretation of Genotype Results

- Genotype results from all cases were different
  - These cases are not related by transmission
  - This was a coincidence

- Four contact investigations are needed
  - Three in same work site

- Not an outbreak
How is it created?

THE COMPOSITION OF A GENOTYPE
How are Genotyping Results Obtained?

Person with suspected TB → Specimen

TB isolated from culture → TB genotype test result
Definition for Tuberculosis Genotyping in the United States

Spoligotype: 000000000003771

Initial 12-locus MIRU-VNTR\(^1\): 223325173533

Additional 12-locus MIRU-VNTR (MIRU2): 444534423428\(^2\)

PCRType: PCR00002

GENType: G00010

Sequentially assigned for each unique spoligotype and initial 12-locus MIRU-VNTR combination

Sequentially assigned for each unique spoligotype and 24-locus MIRU-VNTR combination

---

\(^1\) Mycobacterial interspersed repetitive unit–variable number tandem repeat.

\(^2\) The complete set of 24 loci is referred to as 24-locus MIRU-VNTR and is used for GENType designation for genotype in the United States.
# A Few Examples

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TB GENOTYPING INFORMATION SYSTEM (TB GIMS) REPORTS

How is it used?
# Cluster Snapshot for G15185

## Cluster Definition

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<td>Date Type:</td>
<td>Count Date</td>
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<tr>
<td># cases in cluster:</td>
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</tr>
<tr>
<td>State/County/Region:</td>
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## Data Completeness

- Genotype Coverage: 96.8%
- # Patients with PCRType but no MIRU2 result: 0
- # Isolates with no linked surveillance record: 0
- Genotype report date of most recent isolate without surveillance record:

## Cluster Detection

- Alert Level: N/A
- Recent change in alert level:

  Alert level and LLR are only available for single county areas.
The Epidemic Curve has been expanded to display the historical occurrence of cases for 3 years prior to dates selected. The first blue column will include all cases in the quarter regardless of whether they are in selected timeframe or are part of baseline period. 0 out of 1 cases are from the baseline period.

Geography

- # cases in rest of state: N/A
- % of all cases in this state with this genotype: 4.10
- Five other counties with most cases: N/A
- # cases in adjacent states: 0
- Adjacent states with cases:
- # cases in entire rest of U.S.: 2
- % of all cases in U.S. with this genotype: 0.06
### Cluster Snapshot for G15185

#### Person

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<th>Comparative demographics (selected jurisdiction vs. rest of U.S.) n(%)</th>
<th>High risk characteristics of transmission or poor outcome n(%)</th>
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<td>Black</td>
<td>9 (90.0%)</td>
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<tr>
<td>White</td>
<td>1 (10.0%)</td>
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<tr>
<td>Gender</td>
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</tr>
<tr>
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<tr>
<td>Male</td>
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<tr>
<td>Birth</td>
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<td>Child (5-14 years)</td>
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<tr>
<td>Dead at diagnosis or died while on therapy</td>
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There are no foreign born cases for the selected criteria.
## Cluster Snapshot for G15185

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<th>Cavity</th>
<th>DrugRes</th>
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<th>SubAbus</th>
<th>Corr</th>
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<th>ReasEval</th>
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National Distribution of G15185

**Spoligotype:** 777777777760700

**24-locus MIRU-VNTR:** 223325133224 242524224225

**Number of cases with this genotype in U.S. (Z):** 12

**Percent of all genotyped cases in the U.S. with this genotype:** 0.06

**PCRType:** PCR00291

**Family Name:** EuroAmerican (L4)

**Number of States reporting this genotype:** 3

**Date Range:** 08/19/2012 - 08/19/2015

**Date Type:** Count Date

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<th>All cases with any genotype in state (Y)</th>
<th>% of all cases in state with this genotype (X/Y)</th>
<th>% of U.S. cases with this genotype in the state (X/Z)</th>
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## Surveillance Summary of G15185

**State:** MICHIGAN  
**County:** ALL  
**Region:** NA  
**Spoligotype:** 77777777750700  
**Date Range:** 03/03/2005 - 03/03/2015

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<tr>
<td>65+</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>34</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

### Birth

<table>
<thead>
<tr>
<th>Birth Type</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>US-Born</td>
<td>41</td>
<td>2</td>
</tr>
<tr>
<td>Foreign-Born</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Race/Ethnicity

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asian</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Black</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Native Hawaiian/Pacific Islander</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>White</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multiple Race</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Homeless in past year

<table>
<thead>
<tr>
<th>Homeless Status</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

### Excessive Alcohol Use

<table>
<thead>
<tr>
<th>Excessive Alcohol Use</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14</td>
<td>1</td>
</tr>
</tbody>
</table>

### Drug Use (injecting/non-injecting)

<table>
<thead>
<tr>
<th>Drug Use Status</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>13</td>
<td>0</td>
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</tbody>
</table>

### Incarcerated at Diagnosis

<table>
<thead>
<tr>
<th>Incarceration Status</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4</td>
<td>0</td>
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</tbody>
</table>

### HIV Status

<table>
<thead>
<tr>
<th>HIV Status</th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Negative</td>
<td>31</td>
<td>2</td>
</tr>
<tr>
<td>Other/Unknown</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

### TOTAL

<table>
<thead>
<tr>
<th></th>
<th>MICHIGAN</th>
<th>Other US</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: 'County: ALL' refers to all the counties in the state.*
## Surveillance Summary of G01835

**State:** MICHIGAN  
**County:** ALL  
**Region:** NA  
**Spoligotype:** 0000000000003771  
**Date Range:** 08/06/2012 - 08/06/2015  

**Family Name:** East Asian (L2)  
**City:** NA  
**PCRType:** PCR00012  
**24-locus MIRU-VNTR:** 322325173543 445544423329  
**Date Type:** Count Date

### Drug Susceptibility Results

<table>
<thead>
<tr>
<th>Drug Resistance</th>
<th>MICHIGAN</th>
<th>Other</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>n%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Susceptible to initial testing of first line drugs</td>
<td>2</td>
<td>100.0</td>
<td>5</td>
</tr>
<tr>
<td>INH resistant only</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>RIF resistant only</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>PZA resistant only</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>MDR</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>XDR</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Other resistance pattern</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Missing/unknown for first line of drugs</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2</strong></td>
<td><strong>7</strong></td>
<td></td>
</tr>
</tbody>
</table>

1. Includes INH, RIF, and EMB. PZA is included when results are available.
2. MDR indicates resistance to at least RIF and INH. May be resistant to other drugs, but not meet criteria for XDR.
3. XDR indicates resistance to RIF, INH, any fluoroquinolone and at least one injectable TB drug.
4. Any other combination of resistance patterns to the four first line drugs that do not fit into other categories.
5. Any patient with unknown/missing for RIF, INH or EMB, with or without PZA results.

*Note: 'County: ALL' refers to all the counties in the state.*
Surveillance Summary of G01835

State: MICHIGAN
County: ALL
Region: NA
Spoligotype: 00000000000003771
Date Range: 08/06/2012 - 08/06/2015

Family Name: East Asian (L2)
City: NA
PCRType: PCR00012
24-locus MIRU-VNTR: 322325173543 445544423329
Date Type: Count Date

There are no US born cases born outside the 50 states and DC.

*Note: 'County: ALL' refers to all the counties in the state.
# Surveillance Summary of G01835

**State:** MICHIGAN  
**County:** ALL  
**Region:** NA  
**Spoligotype:** 0000000000003771  
**Date Range:** 08/06/2012 - 08/06/2015  
**Family Name:** East Asian (L2)  
**City:** NA  
**PCR Type:** PCR00012  
**24-locus MIRU-VNTR:** 322325173543 44554423329  
**Date Type:** Count Date

## Country of Birth for Foreign-Born TB Cases

<table>
<thead>
<tr>
<th>Country</th>
<th>MICHIGAN</th>
<th></th>
<th>Other US</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VIETNAM</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
</tbody>
</table>

*Note: 'County: ALL' refers to all the counties in the state.*
What’s been observed?

PRIMARY GENOTYPE CLUSTERS IN MICHIGAN
Genotyped and Clustered Cases, 2012-2014

United States
- 21,075 Genotyped Cases
- 4,544 (22%) Clustered Cases

Michigan
- 273 Genotyped Cases
- 241 GENTypes
- 33 Clusters
- 66 (24%) Clustered Cases

<table>
<thead>
<tr>
<th>GENType</th>
<th>MI Cluster Name</th>
<th>No. in MI</th>
<th>No. in Rest of US</th>
</tr>
</thead>
<tbody>
<tr>
<td>G15185</td>
<td>MI_0008_001</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>G15165</td>
<td>MI_0004_001</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>G01835</td>
<td>MI_0002_001</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>G08464</td>
<td>MI_0047_001</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>G16470</td>
<td>MI_0065_001</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>G00010</td>
<td>MI_0016_001</td>
<td>4</td>
<td>173</td>
</tr>
<tr>
<td>G00012</td>
<td>MI_0016_003</td>
<td>1</td>
<td>139</td>
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<tr>
<td>G05056</td>
<td>MI_0016_003</td>
<td>1</td>
<td>114</td>
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<tr>
<td>G00734</td>
<td>MI_0046_001</td>
<td>1</td>
<td>86</td>
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<tr>
<td>G12500</td>
<td>MI_0008_001</td>
<td>1</td>
<td>58</td>
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<tr>
<td>G10508</td>
<td>MI_0008_001</td>
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<td>52</td>
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<tr>
<td>G00734</td>
<td>MI_0008_001</td>
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<td>45</td>
</tr>
</tbody>
</table>
Cases of TB in Genotype Cluster G 15185
Michigan, 2009-2015

Number of Reported Cases

Year Reported

Cases of TB in Genotype Cluster G01835

Number of Reported Cases

Year Reported

Michigan	Other States
Cases of TB in Genotype Cluster G00010

Number of Reported Cases

Year Reported


Michigan Other States
What else can be done?

CLUSTER INVESTIGATION TOOL
Take Home Points

• TB genotyping can be useful in TB control
  – Find additional contacts
  – Detect and prevent outbreaks
  – Refute outbreaks

• Interpreting genotyping results can be as simple as, “Do the pictures match?”

• The number and proportion of clustered genotype cases in Michigan decreases each year”
CDC Resources on Genotyping

• CDC TB genotyping website
  www.cdc.gov/tb/programs/genotyping/default.htm

• TB genotyping best practices

• TB Genotyping Information Management System (TB GIMS)
  https://ajtv-nifm-web2.cdc.gov/TBGIMS/

• Email CDC
  tbgenotyping@cdc.gov
Thank You!

Acknowledgements

• CDC’s Division of Tuberculosis Elimination
• MDHHS TB Units

References

• Introduction to Tuberculosis Genotyping Facilitator Guide
  http://www.cdc.gov/tb/programs/genotyping/default.htm
• TB GIMS Reports

Contact

smiths79@michigan.gov