Human Tuberculosis Epidemiology and Agricultural Transmission Risks

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February 23, 2017

Overview

- General tuberculosis overview
  - Zoonotic tuberculosis
- Human tuberculosis epidemiology
  - Global, national, state
  - Tuberculosis control policies related to agriculture
  - Agricultural transmission risks
  - Case studies

Tuberculosis

- Tuberculosis (TB) is caused by a bacterium called *Mycobacterium tuberculosis*.
- The bacteria usually attack the lungs, but TB bacteria can attack any part of the body such as the kidney, spine, and brain.
- Not everyone infected with TB bacteria becomes sick.
  - Latent TB infection (LTBI)
  - TB disease

M. Tuberculosis Complex

- *M. tuberculosis* complex consists of eight closely related mycobacterial species:
  - *M. tuberculosis*
  - *M. bovis*
  - BCG strain - attenuated version developed for vaccine
  - *M. africanum*
  - *M. microtus*
  - *M. caprae*
  - *M. pinnipedii*
  - *M. canetti*
  - *M. mungi*

Tuberculosis - Symptoms

- Pulmonary TB Disease
  - Cough
  - Hemoptysis
  - Loss of appetite
  - Unexplained weight loss
  - Night sweats
  - Fever
  - Fatigue
- Extrapulmonary TB Disease
  - Depends on the part of the body that is affected by the disease

Tuberculosis - Transmission

Airborne

- *M. tuberculosis* is carried in airborne particles, called droplet nuclei, of 1-5 microns in diameter.
- Infectious droplet nuclei are generated when a person who has pulmonary or laryngeal TB disease coughs, sneezes, shouts or sings.
- Depending on the environment, can remain suspended in the air for several hours.
- Transmission occurs when a person inhales droplet nuclei containing *M. tuberculosis*, and the droplet nuclei traverse the mouth or nasal passages, upper respiratory tract, and bronchi to reach the alveoli of the lungs.
Tuberculosis - Probability of Transmission

Many factors impact the probability of transmission of *M. tuberculosis*:
- Susceptibility
- Infectiousness
- Environment
  - Concentration of infectious droplet nuclei
  - Space
  - Ventilation
  - Air circulation
  - Specimen handling
  - Air pressure
- Exposure
  - Proximity
  - Length

Tuberculosis - Incubation Period

- Weeks
- Years
- Lifetime

Tuberculosis - Testing and Diagnosis

Testing and Diagnosis:
- Two methods for detection of TB infection:
  - Mantoux tuberculin skin test (TST)
  - Interferon-gamma release assays (IGRAs)
    - QantiFERON-TB Gold In-Tube test (GFT-GIT)
  - T-SPOT.TB test
- Medical history
- Physical examination
- Chest radiograph
- Bacteriologic examination of clinical specimens

Tuberculosis - Treatment

LTBI
- Isoniazid (INH) normally used alone for LTBI treatment
  - 6 or 9 month regimen
- Rifampin can be used as an alternative
  - 4 month regimen

TB Disease
- Directly Observed Therapy (DOT)
- INH, rifampin (RIF), pyrazinamide (PZA), and ethambutol (EMB) are considered first-line anti-TB drugs and form the core of standard treatment regimens
  - Rifabutin and rifapentine may also be used as first line drugs in some situations
- Second line drugs: streptomycin, cycloserin, capreomycin, p-Aminosalicylic acid, levofloxacin, moxifloxacin, gatifloxacin, amikacin/kanamycin, ethionamide

Tuberculosis - Financial and Personal Cost of TB, MDR TB and XDR TB
Zoonotic Tuberculosis

- Zoonotic TB is a form of TB in people predominantly caused by *M. bovis*, part of the *M. tuberculosis* complex.
- *M. bovis* is commonly found in cattle (bovine TB) and other animals such as bison, elk, and deer.
- In people, zoonotic TB causes TB disease that can affect the lungs, lymph nodes, and other parts of the body.

Zoonotic Tuberculosis - Transmission

- Eating or drinking contaminated, unpasteurized dairy products.
- Direct contact with a wound, such as might occur during slaughter or hunting, or by inhaling bacteria in air exhaled by infected animals.
- Direct transmission from animals to humans through the air is thought to be rare, but *M. bovis* can be spread directly from person to person when people with the disease in their lungs cough or sneeze.

Zoonotic Tuberculosis - Symptoms, Diagnosis and Treatment

- Symptoms and treatment are similar to *M. tuberculosis*, although up to one-third of cases may be extrapulmonary.
- Not possible to clinically differentiate between infections caused by *M. bovis* or *M. tuberculosis*.
- Sputum smear microscopy or the rapid molecular assay, Xpert MTB/RIF, cannot differentiate *M. tuberculosis* from *M. bovis*.
- *M. bovis* is typically resistant to one of the antibiotics, pyrazinamide (PZA), typically used to treat TB disease.

Bovine Tuberculosis - Transmission

- Bovine TB can be introduced into a heard by infected animals or people.
  - Purchase of or exposure to infected cattle
  - Exposure to infected free-ranging wildlife
  - TB bacteria can be found in the saliva, urine, manure, other bodily fluids and milk of infected animals.
  - Airborne particles from the respiratory tract
  - Feed and watering sites
  - Consuming unpasteurized dairy products
  - Greatest risk in enclosed areas with poor ventilation.
  - Barns and dairies
Bovine Tuberculosis - Testing and Diagnosis

- Animals are typically tested for bovine TB if they are:
  - Suspected of having bovine TB;
  - Part of an epi investigation;
  - Required to for participation in a show or exhibition;
  - Required to for change of ownership;
  - Preparing for interstate movement;
  - Part of surveillance activities at slaughter
- Tuberculin skin test
  - Animal receives an injection of tuberculin in the skin and is checked for a reaction 72 hours later
  - Caudal fold

Human Tuberculosis Epidemiology - Global

- One third of the world’s population is infected with TB.
- TB is the ninth leading cause of death worldwide and the leading cause from a single infectious agent.
- In 2016, an estimated 10.4 million people fell ill with TB, and 1.7 million died from the disease.
- TB is a leading killer of people who are HIV infected.

WHO estimated that there were 147,000 incident cases of zoonotic TB in people and 12,500 deaths due to the disease in 2016.
Human Tuberculosis Epidemiology - Virginia

Tuberculosis Cases by Country of Birth, Virginia, 2015

Tuberculosis Control Policies Related to Agriculture – United States

- Bovine TB Eradication Program initiated in the United States in 1917
  - Administered by the U.S. Department of Agriculture’s (USDA) Animal and Plant Health Inspection Service (APHIS), State animal health agencies, and U.S. livestock producers
  - Bovine TB has been nearly eradicated from the Nation's livestock population.
  - The presence of bovine TB in humans has also been reduced as a result of several factors, including the eradication program and pasteurization of milk.
- National TB Surveillance Plan

Human Tuberculosis Epidemiology - Virginia

Figure 4. TB Cases by Health Region, VA: 2012-2016

Figure 5. Total Drug Resistance and MDR-TB, VA: 2012-2016

Tuberculosis Control Policies Related to Agriculture – United States

- Regulations for Cattle and Bison
  - Bovine TB Eradication Uniform Methods and Rules (UMR)
  - United States Code of Federal Regulations, Title 9, Animals and Animal Products, Subchapter C: Interstate Transportation of Animals (Including Poultry) and Animal Products, Part 77: Tuberculosis (9 CFR 77)
  - United States Code of Federal Regulations, Title 9, Animals and Animal Products, Subchapter B: Cooperative Control and Eradication of Livestock or Poultry Diseases, Part 50: Animals Destroyed Because of Tuberculosis (9 CFR 50)
Tuberculosis Control Policies Related to Agriculture - United States

United States Bovine Tuberculosis Affected Herds and Zone Status

Tuberculosis Control Policies Related to Agriculture - Virginia

2VAC5-141-70. Cattle Entry Requirements
- All cattle entering VA must bear official ID number
- All cattle that originated in or have transited through a foreign country, or are intended to be used for rodeo or other entertainment purposes, require a negative caudal fold or CCT test within 60 days prior to entry into VA
- All cattle originating from a region not considered free of TB for cattle by the USDA require a permit and negative caudal or CCT test within 60 days prior to entry into VA
- Cattle from a region considered free of TB for cattle by the USDA may enter VA for the purpose of sale at a livestock marketing facility w/o a certificate of veterinary inspection

Reduce Agricultural Transmission Risks
- Have livestock tested for TB
- Keep a closed herd and raise your own replacement stock
- Buy animals from an accredited TB-free herd
  - Test new animals and isolate them for 60 days and retest prior to comingling
  - Restrict contact with other herds
  - Clean and disinfect facilities or trailers that have house newly purchased animals
  - Keep on-farm visitors away from your herd whenever possible
- Ensure your herd is separated from wildlife

Reduce Agricultural Transmission Risks
- Encourage and support health screenings of farm workers
  - Improve health education and access for farm workers
  - Ensure timely assessment and reporting of ill animals
  - Ensure cross-communication between state and local agencies

Tuberculosis Control Policies Related to Agriculture - Virginia

2VAC5-38-30. Reportable Disease List.
A. The Board of Agriculture and Consumer Services declares suspected or confirmed cases of the following multiple-species diseases to be reportable by the persons enumerated in 27AOCS 50-20: Conditions identified by an asterisk (*) are foreign animal diseases.
  - Tuberculosis (M. bovis, M. tuberculosis)