Zoonotic Potential of M. bovis: A brief review

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Animal and Plant Health Inspection Service
Veterinary Services
The epidemiology of *Mycobacterium bovis* infections in animals and man: a review

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**SUMMARY.** Tuberculosis is principally a zoonotic disease with zoonotic potential, with the main host being cattle. The epidemiology of bovine tuberculosis, and the control measures required, is reviewed.

Humans and Cattle: A Review of Bovine Zoonoses

Clinton J. McDaniel, Diane M. Cardwell, Robert B. Mullner, Jr.‡ and Gregory C. Gray§

**Abstract.** Zoonotic infections are a significant public health concern. The transmission of infections from animals to humans is a complex process involving the interaction of various factors such as the pathogen, the host, and the environment. The epidemiology of *M. bovis* infections in cattle and humans is reviewed, with a focus on the transmission routes, disease incidence, and control measures. The importance of understanding the epidemiology of bovine zoonoses for public health is highlighted.
Human M. bovis disease

Cattle M. bovis disease

Ingestion of raw milk and milk products

Ingestion of undercooked meat

Inhalation of coughed particles or sputum

Contact with infected carcasses

Wildlife transmission

Aerosolized particles from cough spray, ingestion of raw milk and milk products, ingestion of undercooked meat

Aerosolized particles from cough spray and sputum, fecal and urine contamination of barn or pasture

Fecal contamination of shared housing by infected cow

Ingestion of contaminated milk or colostrum from infected cow

Exposure to infected wildlife

Aerosolized particles from infected cows

Bovine Tuberculosis Transmission Model
Human M. bovis disease

Transmission Routes

Primarily spread through the consumption of raw dairy products and inhalation of infectious droplets from cattle with minimal human to human transmission.
Human TB due to M. bovis in the U.S.  
(Hlavsa et al., 2008)

Overall, 1.4% of 11,860 cases of TB were identified as M. bovis based on spoligotyping and MIRU linked to national surveillance data for TB cases reported for the period 2004-2005 and select cases for 1995-2003.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Adjusted OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country of birth (not in the U.S.)</td>
<td>2.59</td>
<td>1.11 – 6.04</td>
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<tr>
<td>Hispanic</td>
<td>10.19</td>
<td>2.30 – 45.08</td>
</tr>
<tr>
<td>Age 5-14 years</td>
<td>14.19</td>
<td>3.91 – 51.49</td>
</tr>
<tr>
<td>HIV Infection</td>
<td>2.63</td>
<td>1.23 – 5.63</td>
</tr>
<tr>
<td>Extrapulmonary</td>
<td>10.91</td>
<td>6.16 – 19.31</td>
</tr>
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Human TB due to M. bovis in binational communities in the U.S.  
(Rodwell et al., 2008)

Overall, 45% of cases in children and 6% of adult cases of TB were identified as M. bovis based on TB case surveillance data from the San Diego, California region from 1994 to 2005.

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<tr>
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<th>Adjusted OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>7.97</td>
<td>2.36 – 26.93</td>
</tr>
<tr>
<td>Age 5-14 years</td>
<td>4.38</td>
<td>1.38 – 13.9</td>
</tr>
<tr>
<td>HIV Infection</td>
<td>1.75</td>
<td>0.93 – 3.29</td>
</tr>
<tr>
<td>Extrapulmonary</td>
<td>4.51</td>
<td>2.36 – 8.62</td>
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Case Studies of Human to Cow Transmission

- **New York state, 1966 (Baldwin, 1968)**
  - Farmer receiving treatment for pulmonary TB at time herd detected. A previous herd owned by farmer had been depopulated.

- **New York state, 1944 (Tice, 1944)**
  - 3 herds from one owner depopulated over 13 years. Owner had been in tuberculosis sanitarium for treatment.

- **Netherlands, (Huitema, 1969)**
  - Multiple TB positive herds identified with either workers or owners confirmed with genitourinary TB.
Investigation of human cases of M. bovis in California

- Data were acquired from CDPH Tuberculosis Control Branch
- Data included cases occurring from 2007-2011
All verified tuberculosis cases
12,540

- 47 (0.4%) Positive NAAT
- 55 (0.4%) Positive smear/tissue
- 10,020 (79.9%) Positive culture
- 1,594 (12.7%) Clinical case
- 824 (6.6%) Provider diagnosis

9,729 (97.1%)
Mono-pyrazinamide resistance tested

- 408 (4.2%) M. bovis
- 9,321 (95.8%) M. tuberculosis

8,143 (81.3%)
Spoligotyped

- 286 (3.5%) M. bovis
- 7,832 (96.2%) M. tuberculosis
- 25 (0.3%) Other lineages

Pyrazinamide-based case definition
Genotype-based case definition
All of the counties in which human M. bovis occurred were in the top 11 counties for employment of dairy workers in California according to 2004 labor data*

Fresno county employs a large number of dairy workers, and during the study was the home of three herds that experienced TB outbreaks

San Bernardino has the fourth most dairy workers of any California county

*Mines, 2006
Country of Origin of California M. bovis cases

- According to California labor statistics, the typical profile of an agricultural worker, including those that work with animals, is a younger Mexican male*

*Eastman et al., 2010
The majority of M. bovis cases being Hispanic or Latino could be expected.

- According to one study looking at respiratory health in California dairy workers, approximately 94% of workers were Latino.

*Mines, 2006*
- Majority of M. bovis cases were between the ages of 15-64, which could be considered a typical age range for dairy workers.
Reasons for evaluation of California M. bovis cases

- 2/3 of cases were exhibiting symptoms making them more likely to be shedding
Proportion of disease sites in California M. bovis cases

- Large percentage of extrapulmonary disease may support transmission model on farm
<table>
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<tr>
<th>Causation – Hill’s Criteria</th>
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<tbody>
<tr>
<td>• Temporal relationship</td>
</tr>
<tr>
<td>• Strength</td>
</tr>
<tr>
<td>• Dose-response relationship</td>
</tr>
<tr>
<td>• Consistency</td>
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<tr>
<td>• Plausibility</td>
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<tr>
<td>• Consideration of alternatives</td>
</tr>
<tr>
<td>• Experiment</td>
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<tr>
<td>• Specificity</td>
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<tr>
<td>• Coherence</td>
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