Epidemiology -
Animal Tracing Exercise

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Thanks to....

• Tanya Beaucaire  AHT -- USDA
• Bill Grigsby  AHT – USDA
• Dennis Wilson  DVM, MPVM, PhD -- CDFA
• Larry Lanzon  DVM  -- Lander Veterinary Clinic
Animal Disease Programs

• Traditional
  • Brucellosis, Tuberculosis, Scrapie

• Nontraditional
  • Piroplasmosis, CEM, Trichomonosis

• FADs
  • FMD, CSF, AI, END
Legal Authority and Guidelines

• Code of Federal Regulations
  – 9 CFR Animals and Animal Products
    • Tuberculosis -- Part 77
    • Brucellosis – Part 78

• Uniform Methods and Rules (UM&R)
  – “Field Guide” describes how to manage cases and implement the disease program
    • Bovine Tuberculosis Eradication : Uniform Methods and Rules, Effective January 1, 2005
    • Brucellosis Eradication: Uniform Methods and Rules (UM&R), Effective October 1, 2003
What is Epidemiology

- $P(T^+ = x) = \sum_{y=0}^{d} \frac{\binom{y}{n-y}}{\binom{N-d}{N}} \sum_{j=0}^{y} \sum_{x=0}^{n-y} (1-Se)^j \binom{n-y}{x} (1-sp)^{x-j} Sp^{n-x-y+j}$
- $P = (t + S_p -1) \times (S_e + S_p -1)$
- P – value
- Confidence intervals
- 2x2 tables
- Incidence
- Prevalence
Epidemiology

- **analytical epidemiology** statistical analysis of epidemiological data in an attempt to establish relationships between causative factors and incidence of disease
- **descriptive epidemiology** information about the occurrence of a disease
- **theoretical epidemiology** the use of mathematical models to explain and examine aspects of epidemiology
- **shoe-leather epidemiology** - epidemiology conducted in the field
Principles of diagnostic test interpretation

• Sensitivity (Se) -- Sensitivity is the ability of a test to correctly classify an animal as 'diseased’
  – How often it calls a positive, positive
    • 95% Se will call a positive sample positive 95% of the time
    • ↓ Se will ↑ false negatives

• Specificity (Sp) -- The ability of a test to correctly classify an animal as disease-free is called the test’s specificity
  – How often it call a negative sample negative
    • 95% Sp will call a negative sample negative 95% of the time
    • ↓ Sp will ↑ false positives
Sensitivity -- Specificity

<table>
<thead>
<tr>
<th></th>
<th>Dz +</th>
<th>Dz -</th>
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</thead>
<tbody>
<tr>
<td>Test +</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test -</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td>a+c</td>
<td>b+d</td>
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- **Sensitivity** = \(\frac{a}{a+c}\)
  - \(a\) (true positive) / \(a+c\) (true positive + false negative)
  - \(Se\) = Probability of being test positive when disease present.

- **Specificity** = \(\frac{d}{b+d}\)
  - \(d\) (true negative) / \(b+d\) (true negative + false positive)
  - \(Sp\) = Probability of being test negative when disease absent.
Testing Strategies

• Testing in series
  • ▲ Specificity

• Testing in parallel
  • ▲ Sensitivity
Predictive Values

– Positive
  • It is the percentage of animals with a positive test that actually have the disease.

– Negative
  • It is the percentage of animals with a negative test that do not have the disease.
Predictive Values

- **PPV**: \( \frac{a}{a+b} \)
  - PPV = \( \frac{a}{a+b} \) (true positive \( a \) / true positive + false positive \( a+b \))
  - PPV = Probability (animal having disease when test is positive)

- **NPV**: \( \frac{d}{c+d} \)
  - NPV = \( \frac{d}{c+d} \) (true negative \( d \) / false negative + true negative \( c+d \))
  - NPV = Probability (animal not having disease when test is negative)

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Tracing

• Connecting the dots
  – Finding the location of the animal previous to the currently known
    • Repeat
    • Repeat
    • Repeat
    • Repeat
      – Until locate herd of origin or can’t go any farther
Tracing tools

- Lab reports
- Slaughter plant kill sheets
- Slaughter consignment sheets
- Dealer records
- Saleyard consignment sheets
- Owner records
- Brands
Information for Tracing

- Lab report
  - Info
    - Diagnostic results and tests performed
      - Negative
      - Suspect
      - Reactor or Positive
  - Slaughter plant
  - Date killed
  - Date tested
  - Animal ID
    - Back tag
    - Ear tags
      » Owner herd tags
      » Official ID
        • Brucellosis vaccination tag
        • Silver bright
Information for Tracing, cont.

• Slaughter consignment
  – Date of sale
  – Consigner (Seller)
  – Backtag number if applied

• Kill sheet
  – Backtag number
  – House number
    • Side A
    • Side B
  – Railout info
  – Kill group
  – Owner/Vendor Name
Information for Tracing, cont.

• Dealer records
  – Seller
    • Date of purchase
    • Name
    • Address

• Saleyard consignment
  – Date of sale
  – Consigner (Seller) information
  – Consignee (buyer) information
Information for Tracing, cont.

• Owner records
  – Purchased
    • Date
    • Seller
  – Home raised
    • Date of birth
    • Vaccination date
    • Health record
# 2008 California TB Investigation

## Table

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<tr>
<th></th>
<th># of Herds</th>
<th># of Cattle Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affected Herds</td>
<td>4</td>
<td>~25,000</td>
</tr>
<tr>
<td>Herds Tested</td>
<td>&gt;270*</td>
<td>~377,000*</td>
</tr>
</tbody>
</table>
# 2002-2003 TB Outbreak

<table>
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<tr>
<th></th>
<th># of Herds</th>
<th># of Cattle Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Affected Herds</strong></td>
<td>3</td>
<td>~13,000</td>
</tr>
<tr>
<td><strong>Herds Tested</strong></td>
<td>&gt;640*</td>
<td>~886,000*</td>
</tr>
</tbody>
</table>

* Totals include the retesting of high risk herds
2003 TB Outbreak Index Herd Trace outs
Trace details
Brucellosis

• Bacteriology
  – *Brucella abortus*
    • Bacteria
      – gram-negative rod

• Signs/symptoms
  • abortion
  • birth of weak calves
  • vaginal discharge
  • lowering of fertility
    – poor conception rates
Brucellosis

• In cattle and bison, the disease localizes in the reproductive organs and/or the udder.

• Bacteria are shed in
  – milk
  – via the aborted fetus, afterbirth, or other reproductive tract discharges.

• Primary route of infection is ingestion
Market Cattle Identification (MCI) Program

- Blood test on all cattle more than two-years-old at slaughter.
- Numbered backtags are placed on all cattle being marketed.
- Blood samples are collected at slaughtering plants.
- If a sample reacts to the test, it is traced by the backtag number to find the owner of the herd from which the animal originated.
- The owner is contacted by a State or Federal animal health official to arrange for testing of the herd.
MCI Bags
Diagnostics

• Test in series

  – 1\textsuperscript{st} - RAP Test - Rapid Automated Presumptive Test
    • Serum agglutination test
  – If Positive – Rivanol
    • Serum agglutination test
  – If Reactor -- CF – Compliment Fixation
Test Interpretation

- **RAP**
  - + or -

- **Rivanol**
  - 1:25 or lower  Negative
  - 1:25 or greater  Reactor

- **CF**
  - 1+ 1:10 or lower  Negative
  - 2+ 1:10 through 1+ 1:20  Suspect
  - 2+ 1:20 or higher  Reactor
Sensitivity and Specificity of diagnostic Tests for Brucellosis

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>60-97%</td>
<td>70-99%</td>
</tr>
<tr>
<td>Rivanol</td>
<td>89%</td>
<td>63%</td>
</tr>
<tr>
<td>CF</td>
<td>71-98</td>
<td>92-99%</td>
</tr>
</tbody>
</table>
Brucellosis Ring Test -- BRT

- Agglutination test using a stained antigen
- BRT is performed on pooled milk from dairy herds and represents all of the lactating cows that contributed milk to that sample.
Herd History

• CDFA AH Branch Data System
  – MCI History
  – BRT History
  – Calfhood Vaccination History
  – Herd test History
Now what ??

• Outcomes
  – Traced Test Recommended
  – Traced Test Not Recommended
  – Unable to Trace
Decisions, decisions.....

• To Test or Not to Test ???
  – Risk analysis Exercise

  – Probability of true infection
    • PVP ??
Exercise

• 3 – Cases
  – Trace back to herd of origin
  – Interview owner
  – Decision
    • Test Recommended
    • Test Not Recommended
  – After
    • Present your case
      – Lab info
      – Investigation summary
      – Action taken
      – Reasons for decision