CLINICAL UTILITY AND INTERPRETATION OF DIAGNOSTIC TESTS FOR BOVINE RESPIRATORY DISEASE

BRENT CREDILLE, DVM, PHD, DACVIM
ASSISTANT PROFESSOR
SECTION HEAD – FARM PRACTICE, THERIOGENOLOGY, AND PRODUCTION MEDICINE
DIRECTOR, FOOD ANIMAL HEALTH AND MANAGEMENT PROGRAM
DEPARTMENT OF POPULATION HEALTH
COLLEGE OF VETERINARY MEDICINE
UNIVERSITY OF GEORGIA
OVERVIEW

Bovine Respiratory Disease
• Introduction

• Epidemiology

Diagnostic Tests
• Terminology and Characteristics

Availability of Tests for BRD Pathogens
• Advantages and Disadvantages

• Recommendations for Use
BOVINE RESPIRATORY DISEASE

Introduction and Epidemiology

• Most common and costly disease of beef cattle
  • Nursing calves (Pre-weaning)
    • Variable levels of morbidity
      • Farm to farm
  • Year to year

• Stocker and feedlot placements (Post-weaning)
  • 75% overall morbidity and mortality in feedlot placements
  • 90% overall morbidity and mortality in stocker populations
BOVINE RESPIRATORY DISEASE

Introduction and Epidemiology

- Nursing Beef Calves – USDA MARC

Snowder et al, 2005
BOVINE RESPIRATORY DISEASE

Introduction and Epidemiology

• Nursing Beef Calves

Snowder et al, 2005
BOVINE RESPIRATORY DISEASE

Introduction and Epidemiology

- Nursing Beef Calves

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Percent of respondents identifying this pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannheimia haemolytica</td>
<td>60</td>
</tr>
<tr>
<td>Pasteurella multocida</td>
<td>53</td>
</tr>
<tr>
<td>Mycoplasma bovis</td>
<td>37</td>
</tr>
<tr>
<td>Bovine respiratory syncytial virus (BRSV)</td>
<td>33</td>
</tr>
<tr>
<td>Bovine viral diarrhea virus (BVDV)</td>
<td>33</td>
</tr>
<tr>
<td>Infectious bovine rhinotracheitis virus (IBRV)</td>
<td>25</td>
</tr>
<tr>
<td>Histophilus somni</td>
<td>23</td>
</tr>
<tr>
<td>Coronavirus</td>
<td>12</td>
</tr>
<tr>
<td>Bibersteinia trehalosi</td>
<td>5</td>
</tr>
<tr>
<td>Parainfluenza type 3 virus (PI3V)</td>
<td>2</td>
</tr>
<tr>
<td>Other*</td>
<td>2</td>
</tr>
</tbody>
</table>

Woolums et al, 2014
BOVINE RESPIRATORY DISEASE

Introduction and Epidemiology

- Stocker/Feedlot

Cernicchiaro et al, 2012
BOVINE RESPIRATORY DISEASE

Introduction and Epidemiology

- Stocker/Feedlot - Pathogens
  - Fulton et al, 2009
    - 237 fatal cases of BRD observed from 2002 to 2003 in one Oklahoma feedyard
      - *M haemolytica* – 25%
      - *P multocida* – 25%
      - *Mycoplasma* spp – 71%
      - BRSV – 4.6%
      - Coronavirus – 11%
## BOVINE RESPIRATORY DISEASE

### Introduction and Epidemiology

- **Stocker/Feedlot - Pathogens**

<table>
<thead>
<tr>
<th>Respiratory agent</th>
<th>Overall percent (proportion) positive</th>
<th>Animal-level prevalence (95% Confidence Intervals)</th>
<th>Prevalence by production class (95% Confidence Intervals)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cow-calf</td>
<td>Dairy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(95% Confidence Intervals)</td>
<td>(95% Confidence Intervals)</td>
</tr>
<tr>
<td>BRSV</td>
<td>3.81% (122/3205)</td>
<td>0.69% (0.1-3.5)</td>
<td>1.92% (0.6-5.8)</td>
</tr>
<tr>
<td>BHV-1</td>
<td>1.59% (51/3205)</td>
<td>1.49% (0.4-7.6)</td>
<td>1.45% (0.6-3.3)</td>
</tr>
<tr>
<td>BVDV</td>
<td>3.56% (114/3205)</td>
<td>3.94% (2.4-6.3)</td>
<td>4.98% (2.4-10.2)</td>
</tr>
<tr>
<td>IVD</td>
<td>8.30% (266/3205)</td>
<td>2.20% (0.5-9.5)</td>
<td>4.90% (2.4-9.6)</td>
</tr>
<tr>
<td>BCoV</td>
<td>43.81% (1404/3205)</td>
<td>15.98% (5.0-40.6)</td>
<td>24.96% (10.1-49.8)</td>
</tr>
<tr>
<td>M. bovis</td>
<td>20.12% (645/3205)</td>
<td>11.09% (3.1-33.1)</td>
<td>23.69% (9.4-48.1)</td>
</tr>
<tr>
<td>Multiple positive</td>
<td>17.32% (555/3205)</td>
<td>9.65% (3.4-24.5)</td>
<td>15.64% (7.1-31.2)</td>
</tr>
</tbody>
</table>

Lubbers et al, 2017
DIAGNOSTIC TESTS
DIAGNOSTIC TESTS

Two Important Characteristics

• **Sensitivity**
  - Probability of an animal being test positive given that it is truly diseased
    • Freedom from false negatives

• **Specificity**
  - Probability of an animal testing negative given that it is truly healthy
    • Freedom from false positives
## DIAGNOSTIC TESTS

### Sensitivity and Specificity

- Determined by comparing test results to the results of a gold standard

<table>
<thead>
<tr>
<th></th>
<th>TEST (+)</th>
<th>TEST (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISEASE (+)</td>
<td>true positive</td>
<td>false negative</td>
</tr>
<tr>
<td>DISEASE (-)</td>
<td>false positive</td>
<td>true negative</td>
</tr>
</tbody>
</table>
DIAGNOSTIC TESTS

Sensitivity and Specificity

- Characteristics of a test *per se*
  - Most useful when comparing performance of one test to another

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abaxis CHAT™</td>
<td>78 (72–84)</td>
<td>97 (84–100)</td>
<td>81 (71–82)</td>
</tr>
<tr>
<td>IDEXX SNAP® Heartworm RT Test</td>
<td>84 (78–89)</td>
<td>97 (84–100)</td>
<td>86 (81–90)</td>
</tr>
<tr>
<td>Heska Solo Step®</td>
<td>79 (73–85)</td>
<td>97 (84–100)</td>
<td>82 (71–82)</td>
</tr>
</tbody>
</table>
DIAGNOSTIC TESTS

Positive and Negative Predictive Value

• PPV = Probability that an animal that tests positive truly has the disease

• NPV = Probability that an animal that tests negative is truly healthy

• PPV highly influence by prevalence
  • High prevalence = High PPV
  • Low prevalence = Low PPV
DIAGNOSTIC TESTS

Population = 1000 high risk, auction market derived beef calves

Ear notched to determine BVD PI status

• Sensitivity of ear notch = 99%

• Specificity of ear notch = 99%

• Prevalence of BVD PI = 0.4%
## DIAGNOSTIC TESTS

<table>
<thead>
<tr>
<th></th>
<th>TEST (+)</th>
<th>TEST (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISEASE (+)</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>DISEASE (-)</td>
<td>11</td>
<td>985</td>
</tr>
</tbody>
</table>

**PPV = 27%, NPV = 100%**
DIAGNOSTIC TESTS

Population = 1000 high risk, auction market derived beef calves

Ear notched to determine BVD PI status

• Sensitivity of ear notch = 99%

• Specificity of ear notch = 99%

• Prevalence of BVD PI = 2%
## Diagnostic Tests

<table>
<thead>
<tr>
<th></th>
<th>Test (+)</th>
<th>Test (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease (+)</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Disease (-)</td>
<td>11</td>
<td>969</td>
</tr>
</tbody>
</table>

**PPV = 65%, NPV = 100%**
DIAGNOSTIC TESTS

Agreement

• How well the results of one test “agree” to results of another that tests the same quantity or parameter
  • Cheaper test
  • Less invasive
  • Technically less challenging

• Can we trust the results of our new test?
## DIAGNOSTIC TESTS

**Agreement**

- **Kappa coefficient**

<table>
<thead>
<tr>
<th>Kappa Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.20</td>
<td>Poor Agreement</td>
</tr>
<tr>
<td>0.20 – 0.40</td>
<td>Fair Agreement</td>
</tr>
<tr>
<td>0.40 – 0.60</td>
<td>Moderate Agreement</td>
</tr>
<tr>
<td>0.60 – 0.80</td>
<td>Good/Substantial Agreement</td>
</tr>
<tr>
<td>0.80 – 1.00</td>
<td>Very Good/Almost Perfect Agreement</td>
</tr>
</tbody>
</table>
Agreement of NS, NPS, and BAL relative to TTW in dairy calves with BRD

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Method</th>
<th>+/+</th>
<th>+/-</th>
<th>-/+</th>
<th>% Positive</th>
<th>Agreement</th>
<th>Kappa (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mannheimia haemolytica</em></td>
<td>NS</td>
<td>16</td>
<td>0</td>
<td>4</td>
<td>80</td>
<td>88.9 (78.1, 99.7)</td>
<td>0.86 (0.74, 0.99)</td>
<td>.125</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>82</td>
<td>90.9 (60.7, 100)</td>
<td>0.89 (0.77, 1.00)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>82</td>
<td>90.9 (60.7, 100)</td>
<td>0.89 (0.77, 1.00)</td>
<td>1.00</td>
</tr>
<tr>
<td><em>Pasteurella multocida</em></td>
<td>NS</td>
<td>57</td>
<td>2</td>
<td>3</td>
<td>38</td>
<td>95.8 (92.1, 99.5)</td>
<td>0.90 (0.81, 0.99)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>58</td>
<td>1</td>
<td>3</td>
<td>38</td>
<td>96.7 (93.4, 99.9)</td>
<td>0.92 (0.84, 1.00)</td>
<td>.625</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>57</td>
<td>2</td>
<td>3</td>
<td>38</td>
<td>95.8 (92.1, 99.5)</td>
<td>0.90 (0.81, 0.99)</td>
<td>1.00</td>
</tr>
<tr>
<td><em>Mycoplasma spp.</em></td>
<td>NS</td>
<td>81</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>95.3 (92.0, 98.6)</td>
<td>0.90 (-0.10, 0.01)</td>
<td>.727</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>78</td>
<td>8</td>
<td>5</td>
<td>0</td>
<td>92.3 (81.1, 96.5)</td>
<td>0.90 (-0.14, -0.01)</td>
<td>.581</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>81</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>96.4 (93.6, 99.3)</td>
<td>0.90 (-0.06, 0.02)</td>
<td>.219</td>
</tr>
<tr>
<td><em>Mycoplasma haemofelis</em></td>
<td>NS</td>
<td>41</td>
<td>7</td>
<td>1</td>
<td>39</td>
<td>91.1 (85.0, 97.3)</td>
<td>0.82 (0.70, 0.94)</td>
<td>.070</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>41</td>
<td>4</td>
<td>3</td>
<td>35</td>
<td>92.1 (86.3, 97.9)</td>
<td>0.83 (0.71, 0.95)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>45</td>
<td>1</td>
<td>2</td>
<td>40</td>
<td>96.8 (93.1, 100)</td>
<td>0.93 (0.86, 1.00)</td>
<td>1.00</td>
</tr>
<tr>
<td><em>Bovine respiratory syncytial virus</em></td>
<td>NS</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td>78</td>
<td>60.9 (37.3, 84.4)</td>
<td>0.56 (0.30, 0.81)</td>
<td>.180</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>76</td>
<td>78.6 (61.8, 95.3)</td>
<td>0.75 (0.56, 0.94)</td>
<td>.688</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>13</td>
<td>0</td>
<td>3</td>
<td>78</td>
<td>92.9 (83.0, 100)</td>
<td>0.92 (0.80, 1.00)</td>
<td>.500</td>
</tr>
<tr>
<td><em>Bovine coronavirus</em></td>
<td>NS</td>
<td>6</td>
<td>0</td>
<td>7</td>
<td>6</td>
<td>63.2 (37.8, 88.5)</td>
<td>0.59 (0.33, 0.86)</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>6</td>
<td>0</td>
<td>9</td>
<td>10</td>
<td>57.1 (31.9, 82.4)</td>
<td>0.52 (0.27, 0.78)</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>80.0 (57.8, 100)</td>
<td>0.78 (0.55, 1.00)</td>
<td>.250</td>
</tr>
</tbody>
</table>

Doyle et al, 2017
DIAGNOSTICS FOR BRD
Rationale for The Use of Diagnostic Tests

• **BRD = Multifactorial**
  - Colonization and infection of the LRT with viral and bacterial pathogens

• **Monitoring for specific pathogens might be useful**
  - Design of preventive health programs

• **Prevalence of AMR in bacterial pathogens**
  - Therapeutic regimens
DIAGNOSTICS FOR BRD

When Should Diagnostics Be Considered?

• Not necessary for every animal on every operation
  • Design of treatment/control regimens on individual operations
    • Prevalence of specific pathogens
    • Antimicrobial susceptibilities
  • Recurrent outbreaks within a population
    • Unusual patterns of disease within an outbreak
    • High morbidity/mortality
  • Lack of response to symptomatic therapy
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

- **Gold standard = analysis of tissue from lung**
  - Post-mortem

- **Biased representation of disease process**
  - End-stage of disease
    - Cause of death rather than cause of disease

- **Treatment failures**
  - Multiple treatments given

- **Over-representation of antimicrobial resistant bacteria**
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

• Lung biopsy
  • Antemortem collection of lung tissue
    • Fewer issues with airway contaminants

• Acute BRD prior to therapy
  • Better representation of cause of disease?
    • Pathogens
  • Antimicrobial susceptibility
What Diagnostics Should I Choose?

- Lung biopsy
  - Burgess et al, 2011
    - Samples collected from right cranioventral lung (ICS 2)
      - Few side effects
  - Technically challenging
  - 43% success in field settings
  - Poor agreement with lung culture
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

• Other available tests
  • Transtracheal wash (TTW)
  • Bronchoalveolar lavage (BAL)
  • Deep Nasopharyngeal Swab (DNP)
  • Nasal Swab (NS)
What Diagnostics Should I Choose?

- TTW
  - Percutaneous passage of sterile tubing through trachea for collection of pooled pulmonary secretions at tracheal bifurcation
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

• BAL
  • Passage of sterile tubing through nares and into the lower airway (guided or unguided) and wedged in a bronchus
  • Sterile fluid infused (120-240 ml), aspirated
What Diagnostics Should I Choose?

- DNP
  - Passage of a guarded catheter through nares and into the nasopharynx
What Diagnostics Should I Choose?

- Nasal Swab
  - Passage of sterile culture swab into external nares
What Diagnostics Should I Choose?

- Each test = advantages and disadvantages
  - Cost
  - Technical difficulty
  - Area of respiratory tract that is sampled

- How do the available tests AGREE with one another relative to an established reference method?
  - How can I incorporate this into my practice?
What Diagnostics Should I Choose?

- Allen et al, 1991
  - Comparison of DNP and BAL in feedlot calves with naturally occurring BRD
    - Agreement between DNP and BAL moderate for most pathogens at individual calf level
      - *M. haemolytica* = 0.47
      - *P. multocida* = 0.61
      - *M. bovis* = 0.53
      - *H. somni* = 0.55
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

- Allen et al, 1991

Group Level Agreement Between DNP and BAL
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

• DeRosa et al, 2000
  • Comparison of DNP to guarded TTW
    • 45 beef calves with acute BRD sampled once at diagnosis
      • DNP isolates genetically identical to TTW samples 70% of time
    • If both methods positive: same organism present 96% of the time
    • Antimicrobial susceptibilities for sampling methods identical
  • Conclusion: DNP comparable to guarded TTW
What Diagnostics Should I Choose?

- Godinho et al, 2007
  - Comparison of DNP to post-mortem lung lavage
    - 4-6 month old beef calves with naturally occurring BRD
      - PPV = 100% (*M. haemolytica* and *M. bovis*)
      - NPV = 67% (*M. haemolytica*) and 33% (*M. bovis*)
    - Susceptibility to tulathromycin equivalent for all samples for both methods
  - Conclusion: NPS comparable to lung lavage
What Diagnostics Should I Choose?

- Doyle et al, 2017
  - Agreement between 4 sampling methods in dairy calves with acute BRD
    - Dairy calves > 30 days of age with acute BRD
    - Agreement of NS, DNP, and BAL relative to TTW good for identification of:
      - M. haemolytica
      - P. multocida
      - M. bovis
### DIAGNOSTICS FOR BRD

#### What Diagnostics Should I Choose?

- Doyle et al, 2017

### Table: Agreement of NS, NPS, and BAL relative to TTW in dairy calves with BRD

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Method</th>
<th>1/+</th>
<th>1/-</th>
<th>2/+</th>
<th>2/-</th>
<th>Percent Positive Agreement</th>
<th>Kappa (95% CI)</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. haemolytica</em></td>
<td>NS</td>
<td>16</td>
<td>0</td>
<td>4</td>
<td>80</td>
<td>88.9 (78.1, 99.7)</td>
<td>0.86 (0.74, 0.99)</td>
<td>.125</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>82</td>
<td>90.9 (80.7, 100)</td>
<td>0.89 (0.77, 1.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>82</td>
<td>90.9 (80.7, 100)</td>
<td>0.89 (0.77, 1.00)</td>
<td></td>
</tr>
<tr>
<td><em>P. multocida</em></td>
<td>NS</td>
<td>57</td>
<td>2</td>
<td>3</td>
<td>38</td>
<td>95.8 (92.1, 99.5)</td>
<td>0.90 (0.81, 0.99)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>58</td>
<td>1</td>
<td>3</td>
<td>38</td>
<td>96.7 (93.4, 99.9)</td>
<td>0.92 (0.84, 1.00)</td>
<td>.625</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>57</td>
<td>2</td>
<td>3</td>
<td>38</td>
<td>95.8 (92.1, 99.5)</td>
<td>0.90 (0.81, 0.99)</td>
<td></td>
</tr>
<tr>
<td><em>Mycoplasma spp.</em></td>
<td>NS</td>
<td>81</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>95.3 (92.0, 98.6)</td>
<td>-0.04 (-0.10, 0.01)</td>
<td>.727</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>78</td>
<td>8</td>
<td>5</td>
<td>0</td>
<td>92.3 (88.1, 96.5)</td>
<td>-0.07 (-0.14, -0.01)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>81</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>96.4 (93.6, 99.3)</td>
<td>-0.02 (-0.06, 0.02)</td>
<td></td>
</tr>
<tr>
<td><em>M. bovis</em></td>
<td>NS</td>
<td>41</td>
<td>7</td>
<td>1</td>
<td>39</td>
<td>91.1 (85.0, 97.3)</td>
<td>0.82 (0.70, 0.94)</td>
<td>.070</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>41</td>
<td>4</td>
<td>3</td>
<td>35</td>
<td>92.1 (86.3, 97.9)</td>
<td>0.83 (0.71, 0.95)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>45</td>
<td>1</td>
<td>2</td>
<td>40</td>
<td>96.8 (93.1, 100)</td>
<td>0.93 (0.86, 1.00)</td>
<td></td>
</tr>
<tr>
<td>Bovine respiratory syncytial virus</td>
<td>NS</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td>78</td>
<td>60.9 (37.3, 84.4)</td>
<td>0.56 (0.30, 0.81)</td>
<td>.180</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>76</td>
<td>78.6 (61.8, 95.3)</td>
<td>0.75 (0.56, 0.94)</td>
<td>.688</td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>13</td>
<td>0</td>
<td>2</td>
<td>78</td>
<td>97.9 (83.0, 100)</td>
<td>0.92 (0.87, 1.00)</td>
<td></td>
</tr>
<tr>
<td>Bovine coronavirus</td>
<td>NS</td>
<td>6</td>
<td>0</td>
<td>7</td>
<td>76</td>
<td>63.2 (37.8, 88.5)</td>
<td>0.59 (0.33, 0.86)</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>NPS</td>
<td>6</td>
<td>0</td>
<td>9</td>
<td>70</td>
<td>57.1 (31.9, 82.4)</td>
<td>0.52 (0.27, 0.78)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BAL</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>77</td>
<td>80.0 (57.8, 100)</td>
<td>0.78 (0.55, 1.00)</td>
<td>.250</td>
</tr>
</tbody>
</table>

Agreement of NS, NPS, and BAL relative to TTW in dairy calves with BRD.
What Diagnostics Should I Choose?

- **Capik et al, 2017**
  - Comparison of DNP to BAL obtained from beef calves with BRD
    - 28 mixed-breed beef calves 5 days after diagnosis of naturally occurring BRD
      - *M. haemolytica*
        - PPV and NPV of DNP = 67% and 100%
          - Kappa = 0.73
      - *P. multocida*
        - PPV and NPV of DNP = 75% and 100%
          - Kappa = 0.81
      - *H. somni*
        - PPV and NPV of DNP = 100% and 96%
          - Kappa = 0.78
What Diagnostics Should I Choose?

**Methods of Pathogen Detection with Testing Methods**

- **For bacteria**
  - Culture
    - Preferred for *M. haemolytica*, *P. multocida*, *H. somni*
    - Antimicrobial susceptibility
  - PCR
    - Preferred for *M. bovis* (from characteristic lesion)

- **For viruses**
  - PCR
    - Enhanced sensitivity/specificity with faster turnaround
  - Multiplex options available
DIAGNOSTICS FOR BRD

Resistance to Antimicrobials in BRD Pathogens

Courtesy of Brian Lubbers, K-State
DIAGNOSTICS FOR BRD
What Diagnostics Should I Choose?

- **Methods of Pathogen Detection with Testing Methods**
  - Viral PCR
    - Potential to detect vaccine virus in animals recently vaccinated with MLV vaccines
      - Parenteral and intranasal
        - BHV-1
      - BVDV
    - Shed for up to 3 weeks
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

• Take Home Points
  • No perfect antemortem test exists and each sampling method has advantages and disadvantages

  • Choice of tests depends on multiple factors
    • Individual vs Population

    • Specific pathogens of concern
      • Coronavirus

    • BRSV
What Diagnostics Should I Choose?

- **Take Home Points**
  - *In an individual calf*
    - BAL or TTW preferred over DNP or NS
  
  - *In a population of cattle*
    - DNP (or NS) will provide results that can be interpreted with some level of confidence that findings are real
  
  - *For Coronavirus*
    - DNP (or NS) preferred to BAL or TTW
  
  - *For BRSV*
    - BAL or TTW preferred to DNP or NS
DIAGNOSTICS FOR BRD

What Diagnostics Should I Choose?

• **Take Home Points**
  - Culture preferred for most bacterial pathogens
    - Antimicrobial susceptibility
  - PCR probably preferred for *M. bovis* and viral pathogens
    - Faster turnaround with multiplex options
  - Need to understand benchmarks for shedding within a specific population
    - Coronavirus
  - Consideration of vaccination history essential
    - BHV-1 and BVDV
QUESTIONS