PRRS: Science, Application and Risk Assessment

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Disclosure of funding and in-kind

- USDA NRI PRRS CAP 1 and 2
- National Pork Board
- MN Pork Board
- MN Rapid Agricultural Response Fund
- Preserve International
- Midwest Microtek
- Swine Disease Eradication Center partners
SDEC partners

- **Corporate members**
  - PIC
  - Genetiporc
  - Boehringer-Ingelheim
  - Pfizer
  - Novartis
  - Camfill Farr/Filtration Systems Inc.
  - Noveko
  - Clarcor

- **Practice members**
  - Pipestone Vet Clinic
  - Fairmont Vet Clinic
  - Swine Vet Center
  - Clinique Demeter
  - Carthage Veterinary Service
  - Cannon Valley Veterinary Clinic
  - Japanese Association of Swine Veterinarians
Disclosure: Air Filtration

- I do not
  - Receive royalties or commissions on the sales of filters or filtration equipment.
  - Have patents on filtration inventions.
  - Have research contracts or consulting agreements/retainers with filtration/equipment companies.
Topics

■ 1. Overview of PRRSV

■ 2. Aerobiology of PRRSV

■ 3. Air filtration: A means to reduce risk
1. Overview of PRRSV

- Porcine reproductive and respiratory syndrome virus
  - ss enveloped RNA virus
  - Persistent infections
  - Prolonged viremia
  - Transplacental infection
  - Target cell is macrophage
  - Undergoes constant genetic change
    - Collins et al., 1991, Murtaugh et al., 2005

- $560 million/year annual industry cost
  - Neumann et al., 2005
Transmission and biosecurity (Pitkin et al., 2009)

<table>
<thead>
<tr>
<th>Route</th>
<th>Example</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetics</td>
<td>pigs, semen fresh pork</td>
<td>quarantine &amp; test prohibit entry</td>
</tr>
<tr>
<td>Fomites</td>
<td>boots, coveralls, containers</td>
<td>disinfection</td>
</tr>
<tr>
<td>Personnel</td>
<td>hands</td>
<td>entry protocols</td>
</tr>
<tr>
<td>Transport</td>
<td>contaminated trailers</td>
<td>sanitation drying</td>
</tr>
<tr>
<td>Insects</td>
<td>mosquitoes, houseflies</td>
<td>screens, insecticides</td>
</tr>
<tr>
<td><strong>Airborne</strong></td>
<td><strong>bioaerosols</strong></td>
<td><strong>filtration</strong></td>
</tr>
</tbody>
</table>
2. Aerobiology of PRRSV

- Aerosol transmission of PRRSV is variant-dependent.
  - Cho et al., 2006 & 2007

- MN-184 (high path) vs. MN-30100 (low path)
  1. Viral loads in blood & tissues \((p=0.0005)\)
  2. Frequency of aerosol shedding \((p=0.0005, \text{OR}=3.22)\)
  3. Transmissibility via aerosols \((p=0.04)\)
Risk factors associated with airborne PRRSV (Dee et al., 2010)

- Neighboring source population actively shedding virus via bioaerosols ($p = 0.0002$)

- Directional winds moving from a shedding source to an at-risk population ($p = 0.0003$)

- Winds of low velocity (1.4 to 1.9 m/s) with intermittent gusts (2.8 to 3.7 m/s) ($p = 0.002$)
Meteorological conditions associated with airborne PRRSV (Dee et al., 2010)

- Cool temperatures: -2.6 to 4.8°C ($p = 0.01$)
- High relative humidity: 77 to 82% ($p = 0.003$)
- Rising pressure: 979 to 984 hPa ($p = 0.003$)
- Low sunlight levels: ($p = 0.04$)
Otake et al., 2010
3. Air filtration: A means to reduce risk

- A French innovation
  - Interesting clinically
  - Lacked controlled data
  - Costly
  - Positive pressure/HEPA filter systems

- Research questions
  - How to test?
  - How to apply?
The Production Region Model
(Pitkin et al., 2009, Dee et al., 2010)

- **Objective**
  - To develop a model of a swine production region that is endemically infected with PRRSV to evaluate routes of transmission and protocols of biosecurity.

- **Hypothesis**
  - The frequency of PRRSV infections via the aerosol route will be significantly lower in treatment facilities versus controls.
Building 1
PRRSV and M hyo-positive
source population

Predominant wind
direction

120m

Building 4
(treatment)

4m

Building 3
(treatment)

4m

Building 2
(control)
Size and Scope

- Summary:
  - 1438 days of study (June 2006-Nov 2010)
  - 4744 pigs utilized
  - Multiple pathogens tested
    - PRRSV 184, 1-26-2, 1-18-2
    - M hyo
  - 3 types of filters evaluated
    - Mechanical
    - Antimicrobial
    - Electrostatic
  - 38,519 samples collected
    - Air, personnel, fomites, transport, insects, pigs (sera, nasal)
### Airborne transmission data by filter type

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Control</th>
<th>MERV 16</th>
<th>MERV 14</th>
<th>Anti-microbial</th>
<th>Electrostatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRRSV</td>
<td>28/65</td>
<td>0/39 (p &lt;0.0001)</td>
<td>0/13 (p &lt;0.0001)</td>
<td>0/26 (p &lt;0.0005)</td>
<td>0/13 (p &lt; 0.0001)</td>
</tr>
<tr>
<td>M hyo</td>
<td>17/39</td>
<td>0/13 (p &lt;0.0001)</td>
<td>0/13 (p &lt;0.0001)</td>
<td>0/26 (p &lt;0.0001)</td>
<td>0/13 (p &lt; 0.0001)</td>
</tr>
</tbody>
</table>
Application (Spronk et al., 2010, Dee et al., 2010)

- **Objective:**
  - To evaluate the efficacy of air filtration for reduction of external PRRSV introduction to large sow herds located in swine dense regions

- **Project Participants:**
  - UMN, SDSU PVC, FVC, SVC

- **Selection criteria:**
  - > 2400 sows
  - > 4 external virus introductions over the past 4 years
  - > 4 pig sites within 4.7 km radius of candidate herd
  - Industry standard biosecurity

- **Duration of study:**
  - 4 years

- **Outcomes measured:**
  - External virus introduction
  - Cost-benefit
Attic installation of filter boxes

Photos courtesy of Dr. Spronk
Filter bank

Photos courtesy of Dr. Reicks
Frequency of infection pre- and post- filtration across the 2 infected filtered herds

<table>
<thead>
<tr>
<th>BHI</th>
<th># sites 4.7km</th>
<th># infections pre-filter (48 months)</th>
<th>infection frequency pre-filter</th>
<th># infections post-filter (30 months)</th>
<th>infection frequency post-filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3128</td>
<td>17</td>
<td>7</td>
<td>1 infection every 6.8 months</td>
<td>1</td>
<td>1 infection every 30 months</td>
</tr>
<tr>
<td>3240</td>
<td>9</td>
<td>4</td>
<td>1 infection every 12 months</td>
<td>1</td>
<td>1 infection every 30 months</td>
</tr>
</tbody>
</table>
Control herd data (30 months)

- Re-infection has occurred in 28/30 (93%) of non-filtered herds.

- Of the 28 herds infected:
  - 17/28 (62%) have experienced 1 new virus introduction
  - 7/28 (25%) have experienced 2 new virus introductions
  - 4/28 (13%) have experienced 3 new virus introductions

- Re-infection less likely in filtered herds versus non-filtered herds
  - \( p = 0.0001 \)
In Closing

- 1. The routes of PRRSV transmission within and between herds are well understood.

- 2. Science-based biosecurity protocols are available to reduce these risks.

- 3. Air filtration is an essential component of an effective biosecurity plan for herds in swine-dense regions.