Emerging Diseases in the Global Swine Herd

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Recent Emerging/Remerging Diseases

Global

- Porcine Enteric Corona Virus
  - Porcine Epidemic Diarrhea virus (PEDV)
  - Porcine Delta Corona virus (PDCoV)
- PRRS virus
- Influenza A
- PCV2
- ASF
- CSF
- Ebola
Transmission of Ebola virus from pigs to non-human primates

*Reston ebolavirus vs Zaire ebolavirus*

*Zaire ebolavirus* was transmitted from pigs to four macaques without direct contact


CFIA and others, Winnipeg, Canada
African Swine Fever
Porcine Corona Viruses in the US Swine Herd
Coronaviruses

- Enveloped, single stranded RNA viruses
  - Family *Coronaviridae*
  - Corona from the Latin for “crown” or “halo”

- Recently emerged human coronaviruses
  - Severe Acute Respiratory Syndrome Virus (SARS-CoV)
  - Middle East Respiratory Syndrome Virus (MERS-CoV)

- Porcine coronaviruses
  - Respiratory
  - Enteric
Porcine Corona Viruses

• Enteric Corona Viruses
  - Transmissible Gastroenteritis Virus (TGEV)
  - Porcine Epidemic Disease Virus (PEDV)
  - Porcine Delta Corona Virus (PDCoV)

• Respiratory Corona Virus
  - Porcine Respiratory Corona Virus (PRCV)
Porcine Coronaviruses

- Enteric Coronaviruses
  - Transmissible Gastroenteritis Virus (TGEV)
  - Porcine Epidemic Disease Virus (PEDV)
  - Porcine Delta Corona Virus (PDCoV)
    - Recently emerged in US

- Respiratory Coronavirus
  - Porcine Respiratory Corona Virus (PRCV)
PEDV and PDCoV Emergence in US

• PEDV in US
  • May 2013 first reported
    • Retrospective study – April 2013
  • June 2013 – PEDV variant
    • INDEL strain (Ohio Dept. of Ag - Feb 2014)
  • Feb 2014 – third strain
    • S2aa-del strain

• PDCoV
  • Feb 2014
  • First identified in China in 2012
PEDV Origin

- Traced to a specific province in China
PEDV Origin

- Traced to a specific province in China; Anhui
- China to NA?
- Feed ingredients implicated initially
PEDV Radial Dendrogram

Source: Jianfa Bai, Elizabeth Poulsen; KSVLD
Enteric Coronavirus Lessons Learned

• Rapid research funding to fill knowledge gaps
  • June 2013 - $1M committed to research
• Increased industry/state/federal collaboration
  • Diagnostic lab commitment
• FADs – Regulatory effort and plans well laid out
  • Trans-boundary diseases, not regulatory effort
• Swine Health Monitoring Project
  • Inter-producer communication
  • Communication of health status
Enteric Coronavirus Lessons Learned

- Pathogen Matrix Exercise - AASV
- Secure Pork Supply – Industry/State/Fed
  - FAD preparedness
  - Allow animal movements
    - Estimated ~750K pigs in transit each day
- Rapid Response teams – USDA/Industry
- Swine Health Information Center – NPB
- Emerging Disease Response Plan - NPPC
- Swine Health Board - NPPC
Swine Health Monitoring Project

- Collaborative effort USDA/NPB/AASV/NPPC
  - Producers willing to share health status data
- Reporting data set
  - 2.1M sows; 752 breeding herds
- Data collected and reported by UMN
  - Dr. Dane Goede
  - Reported weekly
PED Cumulative Incidence (SHMP)

Chart 1 - PED Cumulative Incidence / weekly and cumulative
Beginning July 1 for years 2012-2015

% of herds reporting new infections

Source: SHMP
PED Exponentially-weighted Moving Average (EWMA)

Source: SHMP
PED Aggregate Prevalence BH Status

Chart 2 - PED Aggregate Prevalence of Sow Herd Status
Beginning May 1, 2013

Source: SHMP
PED Aggregate Prevalence BH Status

Chart 2 - PED Aggregate Prevalence of Sow Herd Status
Beginning May 1, 2013

Classification Scheme
1 Positive Unstable
2v Positive Stable, Ongoing exposure
2 Positive Stable
3 Provisionally Negative
4 Negative

<table>
<thead>
<tr>
<th>Number of sows</th>
<th>2,106,648</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farms</td>
<td>747</td>
</tr>
</tbody>
</table>

Source: SHMP
The Virus Matrix exercise...

To acknowledge and understand those viruses that are known to infect swine globally.
# Viruses Known to Infect Swine

<table>
<thead>
<tr>
<th>Baltimore classification group</th>
<th>Families affecting homeotherm vertebrates</th>
<th>Genera known to affect swine</th>
<th>Representative virus affecting swine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I (dsDNA)¹</strong></td>
<td><em>Herpesviridae</em></td>
<td>Varicellovirus</td>
<td>pseudorabies virus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>unassigned</td>
<td>porcine cytomegalovirus</td>
</tr>
<tr>
<td></td>
<td><em>Adenoviridae</em></td>
<td>Mastadenovirus</td>
<td>swine adenovirus</td>
</tr>
<tr>
<td></td>
<td><em>Asfarviridae</em></td>
<td>Asfivirus</td>
<td>African swine fever virus</td>
</tr>
<tr>
<td></td>
<td><em>Papillomaviridae</em></td>
<td>Alphapapillomavirus</td>
<td>swine papillomavirus</td>
</tr>
<tr>
<td></td>
<td><em>Polyomaviridae</em></td>
<td></td>
<td>none known to be pathogenic</td>
</tr>
<tr>
<td></td>
<td><em>Poxviridae</em></td>
<td>Suipoxvirus</td>
<td>swine pox</td>
</tr>
<tr>
<td><strong>Group II (ssDNA)³</strong></td>
<td><em>Anelloviridae</em></td>
<td>Alphatorquevirus</td>
<td>none known to be pathogenic</td>
</tr>
<tr>
<td></td>
<td><em>Circoviridae</em></td>
<td>Circovirus</td>
<td>porcine circovirus</td>
</tr>
<tr>
<td></td>
<td><em>Parvoviridae</em></td>
<td>Parvovirus</td>
<td>porcine parvovirus</td>
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<tr>
<td>Group III (dsRNA)(^4)</td>
<td>Birnaviridae</td>
<td>none known to be pathogenic</td>
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</tr>
<tr>
<td></td>
<td>Picobirnaviridae</td>
<td>none known to be pathogenic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reoviridae</td>
<td>Rotavirus</td>
<td>porcine rotavirus</td>
</tr>
<tr>
<td>Group IV (+ssRNA)(^5)</td>
<td>Arteriviridae</td>
<td>Arterivirus</td>
<td>porcine reproductive and respiratory syndrome virus</td>
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<tr>
<td></td>
<td>Astroviridae</td>
<td>Mamastrovirus</td>
<td>swine astrovirus</td>
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<tr>
<td></td>
<td>Caliciviridae</td>
<td>Sapovirus</td>
<td>porcine sapovirus</td>
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<tr>
<td></td>
<td></td>
<td>Vesivirus</td>
<td>vesicular exanthema of swine virus</td>
</tr>
<tr>
<td></td>
<td>Coronaviridae</td>
<td>Alphacoronavirus</td>
<td>porcine epidemic diarrhea virus</td>
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<tr>
<td></td>
<td></td>
<td>Torovirus</td>
<td>porcine torovirus</td>
</tr>
<tr>
<td></td>
<td>Picornaviridae</td>
<td>Aphthovirus</td>
<td>foot and mouth disease virus</td>
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<tr>
<td></td>
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<td>Cardiovirus</td>
<td>encephalomyocarditis virus</td>
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<tr>
<td></td>
<td></td>
<td>Enterovirus</td>
<td>swine vesicular disease virus</td>
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<td></td>
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<td>Kobuvirus</td>
<td>porcine kobuvirus</td>
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<td></td>
<td>Sapelovirus</td>
<td>porcine sapelovirus</td>
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<td>Senecavirus</td>
<td>Seneca valley virus</td>
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<td>Teschovirus</td>
<td>porcine teschovirus</td>
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<td></td>
<td>Flaviviridae</td>
<td>Pestivirus</td>
<td>classical swine fever</td>
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<tr>
<td></td>
<td></td>
<td>Flavivirus</td>
<td>Japanese encephalitis</td>
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<tr>
<td></td>
<td>Togaviridae</td>
<td>Alphavirus</td>
<td>Getah virus</td>
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<tr>
<td>Group V (-ssRNA)(^6)</td>
<td><em>Bornaviridae</em></td>
<td>none known to be pathogenic</td>
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<tr>
<td></td>
<td><em>Filoviridae</em></td>
<td>none known to be pathogenic</td>
<td></td>
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<tr>
<td></td>
<td><em>Paramyxoviridae</em></td>
<td>Henipavirus</td>
<td>Nipah virus</td>
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<td></td>
<td></td>
<td>Respirovirus</td>
<td>Sendai virus</td>
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<tr>
<td></td>
<td></td>
<td>Rubulavirus</td>
<td>porcine rubulavirus (blue eye disease), Menangle virus</td>
</tr>
<tr>
<td></td>
<td><em>Rhabdoviridae</em></td>
<td>Vesiculovirus</td>
<td>vesicular stomatitis virus</td>
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<tr>
<td></td>
<td></td>
<td>Lyssavirus</td>
<td>rabies</td>
</tr>
<tr>
<td></td>
<td><em>Arenaviridae</em></td>
<td>none known to be pathogenic</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Bunyaviridae</em></td>
<td>none known to be pathogenic</td>
<td></td>
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<td></td>
<td><em>Orthomyxoviridae</em></td>
<td>Influenzavirus A</td>
<td>Influenza A virus</td>
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<td>Influenzavirus C</td>
<td>Influenza C virus</td>
</tr>
<tr>
<td>Group VI (ssRNA-RT)(^7)</td>
<td><em>Retroviridae</em></td>
<td>none known to be pathogenic</td>
<td></td>
</tr>
<tr>
<td>Group VII (DNA-RT)(^8)</td>
<td><em>Hepadnaviridae</em></td>
<td>none known to be pathogenic</td>
<td></td>
</tr>
</tbody>
</table>
Virus Ranking Based On...

- Economic impact to domestic market
- Economic impact to exports
- Risk of introduction or reemergence in the US
- Zoonotic capabilities
Key Viruses of Concern
Ranked by AASV SHC

- FMD
- ASF
- Influenza A
- CSF
- PRV
- Swine Vesicular Disease
- Vesicular Stomatitis Virus
- PRRSv
- SECDV (PEDV & PDCoV)
Necessary Resource Categories

• Diagnostics
  – Detection and response

• Animal Movement Traceability
  – Premises IDs (PINs)
  – Electronic health certificates

• Epidemiology
  – Diagnostic submissions w/PINs
  – Temporospatial epidemiology

• Environmental Viability
  – Disinfectants
Necessary Resource Categories

- Immunity
  - Post-infection duration
  - Vaccine gaps
- Pathogenesis
- Biosecurity
  - Herd/region
  - Transportation
  - Market transport
    - 17% infected upon arrival; one additional infected after unloading (Lowe)
- Global distribution
Swine Health Information Center

• Mission: to protect and enhance the health of the US swine herd through…
  • Targeted research
  • Analysis of swine health data management
    • Monitoring for trends and data analysis
  • Global disease monitoring
Swine Health Information Center

- Virtual “Center”
- Direction and oversight of programs
- Focused Task Forces for technical issues
- NPB funded with $15,000,000 for five years unless
  - May be extended by recommendation of the Center’s Board of Directors and NPB
  - BOD has veterinarian representation
- Utilize AgConnect system to access health data.
  - Not FOIA accessible as the data will not be recreated, only viewed
- Transparency – sharing of health information
Swine Health Information Center

• This is a tool to…
  • Improve swine health management
  • Improve non-regulatory disease response
  • Enhance AASV, NPPC, and NPB acting for the industry

• This is not…
  • A disease response plan
  • FAD surveillance or response
  • A duplication of USDA, AASV, NPPC, or NPB
  • A “grand database” project

• Swine Health Board – the decision making body
The SFP Final report was published in 1999.

Provided a “blue print” for a comprehensive surveillance system which included emerging disease detection and response.

USDA/APHIS/VS – The National Animal Health Surveillance System (NAHSS)
Questions?

"Those who cannot remember the past are condemned to repeat it."

Santayana (Life of Reason 1905)