SECD Root Cause Investigation in US

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• NAHLN laboratories
• APHIS-Wildlife Services
• DHS-National Bioforensic Analysis Center
• Swine producers of the USA
• Units and staff of APHIS-VS
PEDV identified in US; spring 2013

- US Stakeholders respond
- Multiple investigations: private veterinarians, industry organizations, laboratories, Universities, State and Federal officials
- Research studies funded and initiated
- Web sites and information distribution
- Voluntarily submitted testing results
2014: much information ...

• But no conclusive answer to source
• USDA issues Federal Order for reporting as well as funding for response activity
• Also initiates “Root Cause” investigation to revisit information accumulated
• Continued highest priority to find pathway
Root Cause investigation plan

1. Integrate information across all sources
2. Interview consultants, experts
3. Evaluate basic epidemiology: host, agent, environment, timelines, epi curves
4. Formulate criteria and scenarios
5. Collaborate FDA, DHS, industry, universities
6. Revisit farms and attending veterinarians
7. Further investigate scenarios
Basic Epidemiology information

• Three (four?) viruses novel to US swine
• Nearly homologous to viruses that plagued China in 2010-2013 outbreak
• Likely more than one outbreak; April to Dec 2013
• Earliest cases ID’ed in commercial farms
• First cases in growing pigs; their sow farms not infected
Basic Epidemiology information

- Infectious 100,000,000x dilution (UMN 2013)
- Survival study: <2 week in dry feed, room temp
- Multiple modes of lateral spread in US
- Farms almost same time in different states, different companies, different feed products
- No direct link between farms
Criteria for source

- Must fit basic epidemiology information
- Must survive for 3-6 weeks if on ship or few days for plane travel from an international source
- pH~6.5, low temperature, moisture or matrix to protect from desiccation
- Why US outbreak, but not Canada or EU?
- Why during April-Dec 2013?
Number PEDV pos herds or accessions
Data as of 7/16/14

Red arrows are outbreaks where a variant PEDV was identified; not known if it was an introduction.

Summer heat probably slowed propagation of the outbreak.

Samples shown prior to early May are from retrospectively testing banked samples.
Number of PDCoV herds or submissions
Data as of 7.16.14

Retrospective testing prior to mid-February through all of 2013

These may have been introductions that did not spread probably due to summer heat and dry August and October
“...when you have eliminated the impossible, whatever remains, however improbable, must be the truth...”

Sir Arthur Conan Doyle
Scenarios

• Intentional introduction
  – No evidence to indicate introduction directly to farms
  – No visitors or unusual events were noted

• Circulating in Feral swine
  – Farms large commercial-no evidence of feral exposure
  – Farms same time in different states, companies
  – No knowledge of infection in outdoor domestic
  – Scenario: feces ➔ truck or person ➔ feed mill or farm
  – Scenario: Blood?
Scenarios

- Clothing/shoes while traveling
  - No history of visitors to infected farms or international travel in time frame
  - Not before April 2013

- Human nasal passages (study underway)
  - Should have shown up in previous years
  - No travelers to infected farms in time frame
Scenarios

• Escape from laboratory or diagnostic sample
  – No evidence to suggest association
  – Farms near same time but in different states/companies

• Contaminated biological
  – No evidence to suggest a biological
  – No consistently used product

• Antibiotic filler; e.g., rice hulls
  – Possible contamination in processing
  – Same products used in Canada?
  – Product is very dry (~3-5%)
Scenarios

• Semen or live animals
  – No legal import from possible sources
  – Majority of early cases in growing pigs not sows

• Birds or bats
  – Genetic epi links US viruses to pigs more recently

• Illegal product entry
  – No evidence to suggest
  – Feed products from different feed mills/manufacturers
Scenarios

- Imported organic soybeans or corn
  - Imported product → X-contam in truck/grinder → next product to pigs
  - US imports some of these products
  - No links at this time

- Trucks: feed transport, salvage products
  - Contam product → Product cooked or dries out → truck’s next load is complete feed/pellets/grain/whey → pigs
Scenarios

• Vitamin/mineral premixes
  – Same products used in Canada and EU?
  – Products are dry (~5-7%)
  – Gelatin coating??

• Amino acid supplements
  – Common to all rations
  – Lysine price competition in early 2013
  – Most manufactured in microbial culture
  – Same product used in Canada/EU?
Scenarios

• Pet food/treats
  – Used in rations, but not directly fed to outbreak
  – Contaminate other rations?
  – Ingredient in base mixes?
  – Contaminate grinders/mixers?

• Complete feed swine base mixes/premixes
  – Associated with outbreaks (& normal herds)
  – No common brand unless produced under different labels or contaminated in truck or mill
Ongoing collaborations, studies and testing...

• Testing of archived samples:
  – Feral swine samples,
  – Human nasal swabs,
  – Pet treats
• Genetic epidemiology, virus relationships
• Sifting customs data
• Additional field epi data from index farms
• Trace index farm’s feed and ingredients
• Monitor US sequences for novel viruses
Questions?