The use of models in contingency planning

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Models – in relation to contingency

• Risk related to
  – Import of disease to
    • Herd
    • Country
    • Europe

  – Spread
    • Within a herd
    • Between herds
    • Between countries
Models – in relation to contingency

• Risk related to
  – Import of disease to
    • Herd
    • Country
    • Europe

– Spread
  • Within herd
  • Between herds
  • Between countries
Risk of introduction
Risk of spread – within a herd
Risk of spread – within a herd
Risk of spread – within a herd
Risk of spread – within a herd
Risk of spread – within a herd
Risk of spread of spread between herds

- Infected herd
- Neighbouring herd
- Person contacts
- Transport vehicle
- Semen
- Abattoir
- Movements of pigs
Risk of spread of spread between herds

Movement data
- movements of live animals
- movements to slaughter
- milk tankers
- distances

Herd-data
ID-numbers
Numbers of animals
Coordinates
Herd-types

Data related to FMD
- incubation period
- time to clinical signs
- spread time within herd

Danish contingency
- probability to detect disease
- probability of compliance
- probability of reporting contacts
Methods – DTU-DADS

All epidemics start on 1 herd

Several epidemics simulated
Methods – DTU-DADS

Local spread
• 3km
• incl. limited airborne spread
• unregistered person contacts
• rats, birds, cats, etc.
Control measures

- Surveillance
- Depopulation
- Movement restrictions
- Vaccination
Control measures

- Surveillance
- Depopulation
- Movement restrictions
- Vaccination

**BASIC** scenario

**DEPOPULATION** scenarios

**VACCINATION** scenarios

To live
To die
Results

FMD: In DK pre-emptive depopulation of neighbor herds
- more efficient than vaccination
- both from an epidemiological and an economic point.
Results

FMD: In DK pre-emptive depopulation of neighbor herds
- more efficient than vaccination
- both from an epidemiological and an economic point.

FMD: In DK control can be improved by enlarging surveillance zones to 15 km.
Export is driving the economics in DK
Ressource estimations
Used for contingency planning

Number of persons needed daily. After day 14, the average per day is calculated for each week.
DTU-DADS - ASF

- The DTU-DADS model has been further developed to also model spread of
  - ASF
The DTU-DADS model has been further developed to also model spread of
- ASF
- Including within-herd spread
- And residues from dead animals
DTU-DADS - ASF

• The DTU-DADS model has been further developed to also model spread of
  – ASF
    • Including within-herd spread
Infection process

Susceptible pig

Subclinical pig (μ)

Clinical pig

Residues of dead pigs (ε)

Exponential Decrease
Infection process

\[ PI_t = 1 - e^{-\beta[(S_{t-1}*\mu)+(C_{t-1})+(\varepsilon*\sum_{i=1}^{d_{\text{max}}}(e^{-i*\gamma}*\text{dead}_{t-i}))]/N} \]

Susceptible pig

Clinical pig

Residues of dead pigs (\( \varepsilon \))
DTU-DADS - ASF

• Within-herd spread, including residues from dead animals, are then used in a between-herd spread model similar to the FMD-model.
DTU-DADS - ASF

• Within-herd spread, including residues from dead animals, is used in a between-herd spread model similar to the FMD model. Limited size and duration of outbreaks are predicted, however still with a considerable economic impact, based on export losses.

Simulating the epidemiological and economic effects of an African swine fever epidemic in industrialized swine populations

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Journal homepage: www.elsevier.com/locate/vetmic
DTU-DADS - ASF

- Within-herd spread, including residues from dead animals, are then used in a between-herd spread model similar to the FMD-model

Sampling and testing dead animals in surveillance zones will significantly reduce the duration and economic losses of the outbreak – (submitted for publication)
Risk of introduction - CSF

- Bronvoort et al. (2008)

Quantitative assessment of the likelihood of the introduction of classical swine fever virus into the Danish swine population

B.M. de C. Bronsvoort\textsuperscript{a,c,*}, L. Alban\textsuperscript{b}, M. Greiner\textsuperscript{c,d}

\textsuperscript{a} University of Edinburgh, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, Easter Bush Veterinary Centre, Roslin
Risk of introduction - CSF

- Bronvoort et al. (2008)
  - Returning livestock trucks
  - Legal meat imports

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Risk of introduction - CSF

- Bronvoort et al. (2008)
  - Returning livestock trucks
  - Legal meat imports

- de Vos et al. (2004)
  - Returning livestock trucks

- Highest risk for importing CSF in DK
- Highest risk for importing CSF in NL
Risk of introduction - CSF

• Bronvoort et al. (2008)
  - Returning livestock trucks ➔ highest risk for importing CSF in DK
  - Legal meat imports

• de Vos et al. (2004)
  - Returning livestock trucks ➔ highest risk for importing CSF

This model can be run for all EU member states, however results are only available for NL.

Scenario Tree Modeling to Analyze the Probability of Classical Swine Fever Virus Introduction into Member States of the European Union

Chaziel J. de Vos, Helmut W. Saatkamp, Mirjam Nielen, and Rudi B. M. Hoornaert
Risk of introduction - ASF

• Mur et al. (2012)
  - Returning trucks
    - Waste from international planes
    - Waste from international ships

• Costard et al. (2013)
  - Illegal import of pork and products
Figure 3. Results of the release assessment. Overall risk scores for the release of ASFV via illegal importation of pork and pork products into the European Union member states. 
doi:10.1371/journal.pone.0061104.g003
Figure 4. Results of the exposure assessment. Overall risk scores for the exposure of the European Union member states if ASFV was released through illegal importation of pork and pork products. doi:10.1371/journal.pone.0061104.g004
Risk of spread in HRP - ASF

- Nigsch et al. (2013)
  - Spread from 1st infected herd → 1st detection (HRP)
  - HRP – 10, 20, 30, 40, 50, 60 days
  - Limited numbers of infected herds (1-4)
  - Super-spreader: DK, NL, LT, LV
  - Super-recievers: DE, PL

Stochastic spatio-temporal modelling of African swine fever spread in the European Union during the high risk period

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Ongoing and future work

- Dorea et al. (2016)
  - DTU-DADS model
  - simulating FMD
  - Sweden

- Limited size and duration of Swedish outbreaks

- No additional effect of adding pre-emptive culling or vaccination
Ongoing and future work

• Simons et al. (2016)
  
  – Modeling the spread of ASF in the Belgian pig livestock industry
  – Using the DTU-DADS-ASF model

• The model is also being used in
  
  – France - ASF
  
  – Germany – FMD & ASF
Thank you for your attention
References


Halasa, T., Bøtner, A., Mortensen, S., Christensen, H., Toft, N., Boklund, A., 2016b. Simulating the epidemiological and economic effects of an African swine fever epidemic in industrialized swine populations. Veterinary Microbiology 193, 7-16.

