Assessment of H5N1 HPAI Risk and the Importance of Wild Birds

Dirk Pfeiffer
Royal Veterinary College
University of London

Outline
- background
  - risk assessment and modelling
- H5N1 HPAIV risk assessment
  - qualitative risk assessment - EFSA
  - quantitative risk assessment
  - simulation
- conclusion

Risk Assessment
- estimate risk of adverse events
- structured approach
- qualitative and/or quantitative
- component of risk analysis
  - science-based and transparent approach to risk management
  - express and communicate risk as well as uncertainty!!!

Risk Analysis Components (after OIE Animal Health Code)

Risk Communication

Hazard Identification → Risk Assessment → Risk Management

Release Assessment → Exposure Assessment → Consequence Assessment
Risk Assessment Models

- risk pathway diagrams
- release, exposure and consequence assessment
- model implementation
- qualitative or quantitative
- knowledge-driven
  - expert opinion
  - data-driven components
    - statistical models
  - simulation models \( \rightarrow \) risk management

EFSA Risk Assessment on H5N1 HPAIV in Migratory Wild Birds

- probability of introduction of HPAI virus (specifically: Asian lineage H5N1 HPAIV) to territory of European Union by migratory wild birds
- probability of transmission of Asian lineage H5N1 HPAIV virus
  - to wild birds (residential and seasonally present) within EU and subsequent establishment of endemic infection of wild bird populations and
  - to domestic poultry within EU as consequence of infection in migratory birds or residential birds

Risk Pathway – Release Assessment

- H5N1 in infected wild birds
- H5N1 exposure of wild birds
- H5N1 contaminated environment
- H5N1 infection in migratory birds
- H5N1 infection in non-migratory birds
- H5N1 HPAIV release to EU territory

Risk Pathway – Exposure and Consequence Assessment

- EU border
- Seasonally present wild bird populations
- Resident wild bird populations
- Intensively reared poultry populations
- Free range poultry populations
- Backyard and hobby flocks
- Game birds for release or live decoys
- Other transmission (e.g., hunters, mammalian species)
- Meat derived from hunting (legal or illegal)
- Domestic waste
- Environment (e.g., water, vegetation)
- Other bird populations (e.g., zoo, bird park)
High Risk Wild Bird Species – Release Assessment

- migratory
- high degree of mixing with other species
- occur in Europe
- gregarious
- not mainly in littoral, marine or other habitats
- pass through areas with outbreaks of H5N1 HPAIV outside EU

**Migratory water birds more likely to be exposed to Asian lineage H5N1 HPAIV outside EU and likely to come to EU territory**

from EFSA 2006

Resulting High Risk Species (for Release Assessment)

- swans
  - Bewick’s Swan, Mute Swan
- geese
  - Pink-footed Goose, Bean Goose, Greater White-fronted Goose (European race), Lesser White-fronted Goose, Greylag Goose, Barnacle Goose, Brent Goose, Red-breasted Goose, Canada Goose
- ducks
  - Eurasian Wigeon, Common Teal, Mallard, Northern Pintail, Garganey, Northern Shoveler, Marbled Teal, Red-crested Pochard, Common Pochard, Tufted Duck
- shorebirds
  - Northern Lapwing, Eurasian Golden Plover, Black-tailed Godwit, Ruff
- gulls
  - Black-headed Gull, Common Gull

from EFSA 2006

High Risk Wild Bird Species – Exposure and Consequence Assessment

- migratory birds at high risk of H5N1 HPAIV infection and likely to come into contact with poultry in EU
  - only excluded Lesser White-fronted Goose and Marbled Teal from previous group
- resident and other wild bird species in EU likely to come into contact with poultry (“bridge species”)
  - feral domestic species
  - wild birds that often have close association with domestic poultry or their habitats
  - wild waterbirds that may share wetland habitat with free-range poultry

from EFSA 2006

Bridge Species – Exposure and Consequence Assessment

- feral domestic species
  - Domestic Goose, Domestic Mallard, Domestic Muscovy Duck, Feral Pigeon, House Sparrow
- wild birds that often have close association with domestic poultry or their habitats
- wild waterbirds that may share wetland habitat with free-range poultry
  - Egrets, Herons, Cormorant, Storks, Mute Swan, Greylag Goose, Canada Goose, Ducks, Mallard, Common Coot, Moorhen

from EFSA 2006
**Probability Outcomes in Qualitative Risk Assessment**

<table>
<thead>
<tr>
<th>Category</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>So rare that it does not merit to be considered</td>
</tr>
<tr>
<td>Very low</td>
<td>Very rare but cannot be excluded</td>
</tr>
<tr>
<td>Low</td>
<td>Rare but does occur</td>
</tr>
<tr>
<td>Medium</td>
<td>Occurs regularly</td>
</tr>
<tr>
<td>High</td>
<td>Occurs very often</td>
</tr>
<tr>
<td>Very high</td>
<td>Occurs almost certainly</td>
</tr>
</tbody>
</table>

**Uncertainty Categories in Qualitative Risk Assessment**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Solid and complete data available; strong evidence provided in multiple references; authors report similar conclusions</td>
</tr>
<tr>
<td>Medium</td>
<td>Some but no complete data available; evidence provided in small number of references; authors report conclusions that vary from one another</td>
</tr>
<tr>
<td>High</td>
<td>Scarce or no data available; evidence not provided in references but rather in unpublished reports or based on observations, or personal communication; authors report conclusions that vary considerably between them.</td>
</tr>
</tbody>
</table>

**Release Assessment**

- presence of susceptible wild birds in countries where Asian lineage H5N1 HPAIV occurs
  - very high (low uncertainty)
- transmission of Asian lineage H5N1 HPAIV from domestic poultry to migratory or non-migratory wild birds under management conditions similar to East and South-east Asia via direct or indirect pathways
  - high – very high (medium uncertainty)

**Release Assessment cont.**

- infection of wild birds after exposure to Asian lineage H5N1 HPAIV
  - high - very high (high uncertainty)
- infected wild birds reach mixing or concentration areas
  - low - high (high uncertainty)
- transmission of Asian lineage H5N1 HPAIV between wild birds at mixing and concentration areas
  - very high (medium uncertainty)

(from EFSA 2006)
**Release Assessment cont.**

- detection of infection
  - very low – low (high uncertainty)
- infected wild birds reach staging, wintering or breeding areas inside EU after infection outside EU
  - medium (high uncertainty)

**Summary Conclusions for Release Assessment**

- conditional probability of Asian lineage H5N1 HPAIV being released into EU by migratory birds (in selected species)
  - high (high uncertainty)

**Overall Conclusions from EFSA Risk Assessment**

- release assessment
  - conditional probability of migratory birds infected with Asian lineage H5N1 HPAIV reaching EU
    - low to high (high uncertainty)
- exposure assessment
  - conditional probability of Asian lineage H5N1 HPAIV becoming endemic in migratory and non-migratory European wild birds
    - low to high (high uncertainty)

**Overall Conclusions from EFSA Risk Assessment cont.**

- consequence assessment
  - exposure of free-range or backyard flocks
    - high (medium uncertainty)
  - exposure of intensively-reared or indoor flocks
    - negligible to very low (low uncertainty)
  - transmission of Asian lineage H5N1 HPAIV to poultry
    - high (low uncertainty)
  - detection of Asian lineage H5N1 HPAIV in poultry
    - very high (low uncertainty)
Summary Conclusions of EFSA Risk Assessment

- conditional probability of Asian lineage H5N1 HPAIV being transmitted from wild birds
  - to poultry in free-range and backyard flocks in Europe or indoor flocks without high biosecurity standard
    - low – medium (high uncertainty)
  - to indoor poultry flocks kept under conditions of high biosecurity standard
    - in high poultry density population area
      - very low (low uncertainty)
    - in a low to moderately high poultry density population area
      - negligible (low uncertainty)

Quantitative Risk Assessment

- less transparent for stakeholders with limited experience in working with quantitative data
- requires quantitative estimates of probabilities (and distributions) on risk pathway
  - incubation period, period of infectiousness, survival, probability of becoming infected
- can be based on studies or expert opinion
  - statistical data analysis can generate parameter estimates

Statistical Modelling of H5N1 HPAIV Risk in Vietnam

- cause-effect relationship
  - Evan’s postulates
    - assess statistical association using field data
    - take account of causal web
    - need multiple studies of different design
- data analysis
  - outcome
    - commune HPAI outbreak status data
  - wild bird exposure
    - need to use proxy variables (surface water, wetlands)

Comparison of Epidemics in Northern Vietnam

2003-4
2004-5
2005-6
Comparison of Epidemics in Southern Vietnam

Risk Factors associated with HPAIV Outbreaks in Vietnam
- three major regions of country (south, central, north)
- mean distance to next major road
- mean distance to next population aggregation of > 50 people per sqkm
- % land area used for aquaculture
- % land area used as paddy fields
- domestic water bird density

Simulation Modelling
- useful for testing hypotheses
- effect of control strategies
- requires understanding of infection dynamics in wild bird populations
- currently focussed on modelling spread of potential pandemic in humans (Ferguson 2006; Longini 2004 etc)

H5N1 HPAIV Farm Transmission Model for Vietnam

Magalhaes et al 2006
Example – Simulation Output – Impact of Vaccination in Sector 4

Conclusion

- currently need to rely on qualitative risk assessment to describe infection risk from wild birds
- field studies required to help providing parameters for future quantitative models
  - statistical modelling in Vietnam suggests limited importance of wild birds for spread of infection (compared with other mechanisms)
- simulation models can be used to test hypotheses in relation to role of wild birds in context of other transmission pathways

Acknowledgements

EFSA Scientific Panel for Animal Health & Welfare
Bo Algers
Harry J. Blokhuis
Donald M. Brown
Berta Capua
Stefano Cinotti
Michael Gunn
Jörg Hartung
Per Hava
Xavier Manceau Vilanoa
David B. Morton
Michel Pépin
Ronald John Roberts
José Manuel Sánchez Vizcaino
Alexandra Schubel
James Michael Sharp
Georgios Theodorepoulos
Philippe Faivre
Marina Verga
Martin Voss
Marlon Wackenbrügge

EFSA Working Group on H5N1 HPAI Risk from Migratory Birds for EU
Ian Brown
Ron A.M. Fouchier
Nicolas Gaidet
Vittorio Guberti
Timm Harder
Rosema Langston
Ricardo Jorge Soares Magalhaes
Vincent Martin
James Michael Sharp
Katharine Stark
David Stroud
Bogdan Szewczyk
Jan Yeen
Jonas Waldenström