Global Assessment of Avian Influenza Control Strategies: Interrelationships between Surveillance, Outbreak Reporting and Vaccination

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• What are the goals of surveillance?
• General Ecology and Epidemiology of AIV
• Transmission and Spread of AIV
• Wild Bird Surveillance for AIV in Americas
• Wild bird Infectivity and Pathogenesis Studies
• Global Assessment of AI Control Programs, Especially Vaccines and Vaccination
• Summary
What Are the Goals of Surveillance?

• Broad goals
  – LPAIV ecology in reservoir host: subtypes, geographic location, species specificity, movement potential, etc.
  – Information on transmission risk of AIV from Wild Birds → Poultry
  – Emerging information of H5N1 HPAIV epidemiology

• Basic question – what role do wild birds serve in spread of H5N1 HPAI?
  – Introduction/initial cases in poultry
  – Secondary spread
  – WB as reservoir or spill-over from infected domestic ducks
  – Carrier distance – short, intermediate and long
Ecology and Epidemiology

Domestic Ducks

Exposure
Re-adaptation

Recent H5N1
HPAIV

Most HPAIV

LPAIV (H1-16)

Exposure
Adaptation

LPAIV (H1-16)

H5/H7 HA Mutation

HPAIV (H5/H7)

• Outdoor rearing
• Outdoor access
• Wild bird access to buildings
• Environmental exposure

Mutation
Initial Introduction from Free-Living Aquatic Birds to Poultry

- Contaminated Equipment → Feces & Respiratory Secretions → Infected Wild Waterfowl
- Water → Non-infected Commercial Poultry
- Air → Infected Wild Waterfowl
- Contaminated Clothing & Shoes (mechanical)

How Can AIV Spread?

- Initial introduction into country - possibilities
  - Infected poultry (esp. ducks); asymptomatic or symptomatic
  - Illegal movement of infected poultry & products
  - Contaminated equipment, shoes and clothes
  - Infected wild birds ("migratory")

- Secondary spread - possibilities
  - People activities (poor biosecurity/movement controls) – shoes, clothes, equipment, infected poultry (asymptomatic or symptomatic), other contaminated fomites
  - Periurban wild birds (mechanical or biological vectors) – house & tree sparrows, starlings, etc.
How Can AIV Spread?

- Complicating issues:
  - Underreporting of outbreaks in poultry, especially village poultry
  - Regional movement of poultry and poultry products both legal and illegal
  - Infections in domestic ducks without high mortality
  - Outdoor access and rearing of waterfowl
  - Unrestricted movement of sector 3 and 4 poultry
Wild birds can be infected with H5N1 HPAIV

But, a virus isolation does not make a reservoir!

HPAIV H5N1 has been isolated from many species that are most likely dead ends.

Can such isolations be explained?
The details ARE important!

Experimental studies can determine susceptibility to the viruses & assess threat

Known:

• Some dead wild birds with H5N1 HPAIV recovery
• Most surveys of asymptomatic live WB Asia and Africa either failed to find H5N1 HPAIV or very rare find
• High infection rate in domestic ducks in Asia

Stallknecht, FAO/OIE, 2006
Wild Bird Surveillance for AIV


- Beringian Crucible – summer breeding for N. Am and Eurasian migratory aquatic birds
- 8,254 samples, 100+ species represented
- Few AIV isolates found (0.06%) – H3, H4, H6, but no H5 (Winker et al. EID 13:547-552, 2007; Spackman et al. Virus Res. 114:89-100, 2005)


- 20888 samples during 2006 from Pacific Flyway – no H5N1 HPAIV (Dusek et al, Avian Dis. 2009 Jun 53:392-93)
Monitoring of wild birds in South America

• 1,000 + samples (Oct. 2001)
• Bolivia
  • 93 total specimens from 11 spp.
  • Ducks, sheldgeese and doves
  • 24 cinnamon teal
• One sample was positive for AIV
  – Cinnamon Teal (*Anas cyanoptera*)
  – All eight gene segments were directly sequenced
  – H7N3, NS subtype A
  – Isolated; LPAIV

Spackman et al., JVI 80:7760-7764, 2006
Hemagglutinin: H7

- Similar to 2002 poultry isolates from Chile
- 96.6% identity – close common ancestor
- Reassortant with other influenza A viruses – equine and AI viruses

Spackman et al., JVI 80:7760-7764, 2006
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Birds that exhibit morbidity shed higher titers of virus for longer durations

OFFLU Sabbatical Research Project

Conduct an evaluation of the avian influenza vaccine and vaccination component used in global avian influenza control strategies for poultry

- 16 month detail from U.S. Department of Agriculture to OFFLU at OIE Headquarters, Paris, France
- Part 1: Questionnaire to 80 countries on AI control strategies, especially on use of vaccines and vaccination: short & long forms
• 69 out of 80 countries completed and returned the questionnaire (86%)
• Responses all six inhabited continents: Asia (24), Africa (10), North America (5), South America (1), Europe (28) & Australia/Oceania (1)
  • 27 (39%) HPAI outbreaks in poultry
  • 11 (16%) HPAI outbreaks in wild birds
  • 26 (38%) HPAI outbreaks in both
  • 5 (7%) LPNAI outbreaks poultry only
  • 14 (20%) both HPAI and LPNAI
Responses: General Avian Influenza Vaccine Use

All countries had national HPAI/LPNAI control program with common components including:

- Quarantine and additional movement restrictions or controls
- Tracing of poultry in outbreak area
- Enhanced biosecurity measures
- Farmer and public education and awareness about the disease

- Surveillance in poultry & wild birds
- Monitoring
- Rapid diagnostics
- Stamping-out of positive cases
- Disinfection of facilities and equipment
- Decontamination and disposal of infectious materials
- Compensation
Responses: Avian Influenza Vaccine and Vaccination for 2002-2010

- 58% had vaccination option for HPAI and 39% for H5/H7 LPNAI control strategies
  - Emergency – vaccine bank, field trials, exercised...
  - Preventive – high risk for introduction
  - Routine – endemic infection
- 58% written plans w/specific vacc. use criteria
- 14% had completed AI vaccine and vaccination simulation exercises or worked-out the logistics of implementing a vaccination program
- Field trials: H5 vaccines in 25% & H7 vaccines in 7% of countries
- 30% used vaccines for HPAI control: poultry (16%), zoo/other collections of birds (10%) or both (4%)
Responses: Avian Influenza Vaccine and Vaccination for 2002-2010

- H5/H7 Vaccination usage:
  - Zoo birds and captive held non-poultry (ex. 14 EU countries)
  - Single poultry farm (ex. USA Connecticut layers H7N2 LPNAI)
  - Ring vaccination zone after outbreak (ex. Pakistan)
  - Targeted for high risk poultry – ex. outdoor ducks (France) or turkeys (USA), free-range layers (the Netherlands)
  - Focused sector-specific vaccination – ex. Italy in turkeys and capons 2003-2005 in Northern Italy
  - Massive vaccination of poultry – ex. China, Egypt, Vietnam, Indonesia
Responses: Avian Influenza Vaccine and Vaccination for 2002-2010

• Vaccine banks – 13 countries (19%):
  • Product held: government (8 of 13), private companies (2 of 13) or both (3 of 13).
  • H5 (n=10) and both H5 & H7 (n=3) vaccine
  • Quantity of vaccines ranged from 0.5-55m doses/subtype, but most countries ≤3.5m doses/subtype
  • Expiration dates 1-4 yrs
  • Two future options as vaccines expire:
    • Rotating stocks from commercial vaccine manufacturers
    • Most countries did not indicate desire to purchase more vaccines for a bank
Responses: Avian Influenza Vaccine and Vaccination for 2002-2010

• OIE vaccine bank – 62m doses to 8 countries

- Vietnam, 26.696
- Egypt, 28.021
- Ghana, 2
- Mauritania, 2
- Mauritius, 0.3
- Mali, 1
- Senegal, 1
- Togo, 1
Responses: Vaccine Usage

- Why some countries have not used H5/H7 vaccines?
  - Absence of AI in the country
  - No immediate risk for outbreaks
  - Stamping-out proved successful
  - Lack of adequate resources for vaccination
  - High cost of vaccines
  - Time because of large number of poultry in some countries
  - Labor cost to inject individual birds
  - Public acceptance
  - International trade embargoes when using vaccine
  - Vaccination in rural sector is difficult due to tracing movements of live poultry
Responses: Vaccine Usage

• Why some countries have not used H5/H7 vaccines?
  • Vaccines has to be injected individually to each bird and some require two doses
  • Questionable efficacy
  • Vaccines prevent clinical disease, but not infection
  • 7-14 days for protective immunity in population
  • Difficulty to identify infection in vaccinated birds
  • Antigenic drift in field viruses - vaccine failure
  • Vaccine may induce virus carrier animals
  • Risk of introducing exotic strains into the country through vaccination
Responses: Vaccine Usage

• Why are some countries using, have used or may used H5/H7 vaccines?
  • Stamping-out measures were not enough in large outbreaks
  • Control of localized infection “persistent” in some population of poultry species (i.e. domestic ducks)
  • To protect expensive breeds
  • Endemic disease
  • Resources for vaccination were adequate
  • Strong surveillance and laboratory resources available to carry out post-vaccination surveillance
  • Vaccine available for local isolate
  • Vaccination in zoos for rare or genetically valuable bird species which are preferred not to be killed in outbreak situation
Responses: Vaccine Usage

- Some countries conducted surveillance to determine the antibody protection level - minimum protective titers:
  - HI 1:16 (5)
  - HI 1:32 (1)
  - HI 1:64 (1)
  - HI 1:128 (2)
  - 2 countries using ELISA test

- DIVA strategies:
  - 16 countries use or potential use of non-vaccinated sentinel birds with serological and virological tests
  - 8 countries use heterologous NA vaccines with potentially use a neuraminidase differentiation test in vaccinated birds
Summary

• WB surveillance assists in understanding LPAIV ecology and transmission risks to poultry, and new information on H5N1 HPAIV epidemiology
• WB could play a role in introduction and secondary spread of H5N1, but data is lacking to support as reservoir or spill-over infection from domestic poultry
• Experimental evidence that WB can be infected with H5N1 and be limited asymptomatic carriers
• H5N1 HPAIV is unique in ability to infect and kill a variety of WB species
Summary

• Introduction and spread of H5N1 are country and production system specific with greatest risks from people and agricultural sector (poor biosecurity and movement controls)
• Surveys in N. Amer. at Asian-N. Amer cross over have not detected H5N1 HPAIV and most surveys in Africa and Asia have found very low incidence of H5N1 HPAIV in “healthy” WB
• Most H5N1 HPAIV recoveries from WB have been in birds found dead.
Summary

• For all countries, a national AI control program was in place.

• These national control programs had similar components but listed only qualitatively traits, and no assessment was included of the quantitative implementation and practice of each component.

• 58% countries had vaccination option for HPAI and 39% for H5/H7 LPNAI.

• 14% had completed AI vaccine and vaccination simulation exercises or worked-out the logistics of implementing a vaccination program.
Summary

• Field trials: H5 vaccines in 25% & H7 vaccines in 7% of countries

• Vaccine banks – 13 countries (19%) – but future of such banks unknown to questionable

• Various reasons for not using H5/H7 vaccines
  • Absence of AI in the country
  • No immediate risk for outbreaks
  • Stamping-out proved successful

• Various reasons for using, have used or may used H5/H7 vaccines
  • Stamping-out measures were not enough in large outbreaks
Thank You For Your Attention!