Update on Avian Influenza in the US

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Avian Influenza

• Influenza A viruses with high pathogenicity (HPAI) and \textbf{H5 and H7} subtypes with low pathogenicity (H5/H7 LPAI) are reportable worldwide.

• \textbf{Waterfowl are natural reservoir hosts for all influenza A subtypes, but not usually HPAI.}

• Influenza A viruses tend to circulate within flyways seasonally and wax/wane and in multiyear cycles.

• The only \textbf{HPAI} recognized to circulate in natural reservoir hosts emerged in domestic poultry in \textbf{Asia (goose Guangdong [GsGD] lineage H5N1)}
**HPAI Reported Worldwide (US in BLUE)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Subtype(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890’s-1950’s</td>
<td>numerous fowl plague outbreaks, subtypes not known</td>
<td></td>
</tr>
<tr>
<td>1924-25</td>
<td>North east US?</td>
<td></td>
</tr>
<tr>
<td>1927</td>
<td>New Jersey?</td>
<td></td>
</tr>
<tr>
<td>1934</td>
<td>Germany, H7N1</td>
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</tr>
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<td>1959</td>
<td>Scotland, H5N1</td>
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<tr>
<td>1961</td>
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<td>1963</td>
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<td>1966</td>
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<td></td>
</tr>
<tr>
<td>1975</td>
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</tr>
<tr>
<td>1979</td>
<td>Germany, H7N7</td>
<td></td>
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<tr>
<td>1979</td>
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<tr>
<td>1983-84</td>
<td>USA, H5N2</td>
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<tr>
<td>1983</td>
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<td>1985</td>
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<td>1994-95</td>
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<td>1995</td>
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<td>Netherlands, H7N7</td>
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<tr>
<td><strong>2004 USA, H5N2</strong></td>
<td>– per cleavage site</td>
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<td><strong>2012 Mexico, H7N3</strong></td>
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<tr>
<td>2014</td>
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<td>2014-2015</td>
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<td>H5Nx, China, Chinese Taipei, South Korea</td>
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<td>2015-2016</td>
<td>France, H5N’s</td>
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<tr>
<td><strong>2016 H7N8 US</strong></td>
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</table>

Outbreaks in red are ongoing.

Goose-Guangdong H5 lineage

3

Courtesy E. Spackman, USDA ARS Southeast Poultry Research
AI Epidemiology

Over 200 avian species are susceptible hosts

Exposure Adaptation

Re-adaptation of goose/Guangdong (GD) H5N1 HPAI

H5N8/H5N2/H5N1

Also GD lineage

FluA | LPAI H5/H7

Potential for HA Mutation
H5/H7

HPAI (H5/H7)

Mammals

Courtesy M. Pantin-Jackwood, USDA ARS Southeast Poultry Research
Host range


Courtesy A. Vincent USDA, ARS
Influenza viruses can rapidly EVOLVE

- Antigenic Drift
- Antigenic Shift

- Pathotype: determined in CHICKENS
- Potential for H5/H7 to mutate from LPAI to HPAI
  - Addition of basic amino acids (AA) most common, H5 or H7
  - Accumulation of basic AA
  - Insertion of random sequence (H7)
  - Viruses with different cleavage sites will often circulate simultaneously

- Host Adaptation
  e.g. Gs/GD lineage H5N2

Mallards > Pheasants, Partridges, GF, Pekin, geese > Quail > Turkeys > Chickens

Adapted from E. Spackman and M. Pantin-Jackwood SEPRL
AI Surveillance in the United States

NPIP breeding flocks
- Egg and Meat-Type chickens
- Turkeys, Exhibition Poultry, Upland Game birds and Waterfowl

NPIP production flocks
- Meat-type chickens & turkeys
- Table Egg Layers
- Upland Game birds and Waterfowl

Live Bird Marketing System
- Producers, distributors, and retail markets
- Backyard flocks, auctions, swap meets, etc.

Other Diagnostics
- Passive surveillance, export testing, foreign animal disease investigations
- Wild bird surveillance

>2 million tests/year
Current Diagnostics

Molecular / Sequencing
- Both screening and confirmation
- fluA, H5, H7, and H5-icA 2.3.4.4 specific assay
- Subtyping direct from samples using Sanger methods

Virus isolation
- Molecular and antigenic characterization
- In vivo pathotyping

Serologic assays
- fluA, subtype specific

Pen-side tests
- Screening test for clinically ill/dead birds – requires confirmation
If fluA detected – forward samples for confirmation and continue with H5/H7 testing.

If fluA detected – forward samples and continue with H5/H7 if neg H5/H7 can proceed with SwH1/H3, N1/N2 (subject to user fees).

If fluA detected – Refer to IAV-S surveillance for guidance on Sw H1/H3 & N1/N2.

If fluA detected, forward samples for confirmation and continue H5/H7.

**fluA and subtyping assays may be run in parallel where case presentation warrants**
WI-AV-0020

Avian Sample Collection


**Chickens/turkeys**

* Up to 5 OP swabs in 3mls VTM or 11 swabs in 5mls VTM*

* Pooling of up to 6 swabs from the same species, location, and sampling route in 3 mls allows for testing of a single 11-swab pool per Secure Supply plans and NPIP surveillance using two tubes rather than three.

**Domestic waterfowl**

* Up to 5 CL swabs in 3mls VTM

If sampling free ranging waterfowl – 1 OP and 1 CL swab in SAME TUBE may be preferred (and is recommended for wild waterfowl)
Alternate Sampling

• OP swabs recommended for routine detection
• For egg production drops (potential for swine lineage viruses) consider additional sampling routes
  – Cloacal swabs (CL)
  – Oviduct swabs
  – Semen

For egg production drops, collect up to 5 CL swabs in 3mls VTM

Swine lineage H1/H3 detection in turkeys

<table>
<thead>
<tr>
<th>H1</th>
<th>H3</th>
<th>2015</th>
<th>2016</th>
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<tbody>
<tr>
<td>H1</td>
<td></td>
<td>MN, NC</td>
<td>AR, MI, MN, MO*</td>
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<tr>
<td>H1/H3</td>
<td></td>
<td>IA</td>
<td>IN, SD</td>
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<tr>
<td>H3</td>
<td></td>
<td>IL</td>
<td>IL</td>
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</table>

* pH1N1 in 2016
For Routine Poultry Surveillance:

FORWARD samples non-negative for fluA (including H5/H7) to NVSL

CONFIRMATION at NVSL (molecular testing)

SEQUENCING for full subtype and LPAI vs HPAI

If HPAI Suspected:

- **WITH:** H5 or H7 detection from a flock meeting HPAI case definition AND agreement between state and federal officials

Initiate depopulation and forward samples to NVSL for confirmation and sequencing

Determine the virus status of the flock for AGID, ELISA detection in unvaccinated flock or ACIA detection: collect additional swab samples for PCR testing
Fastest route for confirmation

Submit duplicate samples

- NVSL leverages the Ct from NAHLN Lab PCR to target samples for rapid subtype/pathotype by partial sequence where sufficient RNA is present.
Monitoring influenza A in natural reservoir hosts

Monthly Summary Data from the National Wild Bird Avian Influenza Surveillance Program:
July 2015 to February 2016

Graph 1. Percent of wild duck samples positive for low pathogenic Type A influenza viruses as determined by RT-PCR.

July 2016 – June 2017
Last Updated: 8/26/2016

Total birds sampled: 5,339
Total HPAI positive cases (HA gene sequence confirmed): 1
icA molecular detection only (HA gene sequence unsuccessful/no virus isolated) cases: 0

WILD BIRD HIGHLY PATHOGENIC AVIAN INFLUENZA CASES IN THE UNITED STATES

<table>
<thead>
<tr>
<th>LINE</th>
<th>COLLECTION DATE</th>
<th>SPECIES</th>
<th>COUNTY</th>
<th>STATE</th>
<th>SUBTYPE</th>
<th>CONFIRMATION DATE</th>
<th>COLLECTING AGENCY</th>
<th>COLLECTION STRATEGY</th>
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<tbody>
<tr>
<td>1</td>
<td>8-12-2016</td>
<td>Mallard</td>
<td>Fairbanks</td>
<td>AK</td>
<td>EA/AM H5N2</td>
<td>8-25-2016</td>
<td>Alaska DFG</td>
<td>L</td>
</tr>
</tbody>
</table>
Introduction of Novel Viruses

Lee DH, Torchetti MK, Winker K, Song CS, Swayne D. Intercontinental Spread of Asian-origin H5N8 to North America through Beringia by Migratory Birds

Summary of Key Events during the 2014–2015 HPAI Outbreak

- First Backyard Detection 12/18/2014 (Oregon)
- First Turkey Detection 1/23/2015 (California)
- First Backyard Control Area Released 1/28/2015 (Oregon)
- First Commercial Control Area Released 3/3/2015 (California)
- First IP Quarantine Released 3/26/2015 (Oregon)
- First Chicken Layer Detection 4/11/2015 (Wisconsin)
- First Restock Approved Premises 5/26/2015 (South Dakota)
- Last Backyard Detection 6/3/2015 (Nebraska)
- Last Turkey Detection 6/4/2015 (Minnesota)
- Last Chicken Layer Detection 6/16/2015 (Iowa)
- Last Commercial Control Area Released 8/19/2015 (Iowa)
- Last Restock Approved Premises 12/5/2015 (Minnesota)
- Last IP Quarantine Released 1/4/2016 (South Dakota)
Midwest EA/AM H5N2 Findings

- The Midwest viruses cluster into different subgroups; wild bird-type viruses present in most – potential to move virus ahead of birds
- Earliest viruses suggestive of point source introductions with limited evidence of lateral spread
- There is evidence for point source introductions and lateral spread concurrently
- Late viruses suggest predominantly lateral spread

Refer to H5 September 2015 Epi and Virus Report
Overview

• More rapid response now possible upon diagnosis with agreement of State and Federal officials.

• Biosecurity remains crucial – tailor program to production type.

• Investigation of whole house pathogen detection continues.

• To date, the 2016 detections originate from ‘native’ North American LPAI and are not related to the 2014-15 Eurasian H5 viruses.

• There have been no confirmed Eurasian H5 wild bird or poultry detections since June 2015.
# Commercial Poultry

<table>
<thead>
<tr>
<th>H5/H7</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR, IA, MN, ND, NE, SD, WI</td>
<td>H5N2 HPAI</td>
<td>--</td>
</tr>
<tr>
<td>CA</td>
<td>H5N8 HPAI</td>
<td>--</td>
</tr>
<tr>
<td>MO</td>
<td>H5N2 HPAI</td>
<td>H5N1 LPAI</td>
</tr>
<tr>
<td>CA</td>
<td>H7N3 LPAI</td>
<td>--</td>
</tr>
<tr>
<td>IN</td>
<td>--</td>
<td>H7N8 HPAI/LPAI</td>
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# LBM/BYD

<table>
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<tr>
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<tbody>
<tr>
<td>CT, NJ, NY, PA, RI</td>
<td>H2N2</td>
</tr>
<tr>
<td>NC</td>
<td>H2N2</td>
</tr>
<tr>
<td>AL</td>
<td>H3N1</td>
</tr>
<tr>
<td>CA</td>
<td>H3N2 quail</td>
</tr>
<tr>
<td>PA</td>
<td>H3N9; H1N9</td>
</tr>
<tr>
<td>ID, KS, MT, OR, WA</td>
<td>H5N2 HPAI</td>
</tr>
<tr>
<td>IN</td>
<td>H5N8 HPAI</td>
</tr>
<tr>
<td>NJ</td>
<td>H5N1 LPAI</td>
</tr>
<tr>
<td>NY</td>
<td>--</td>
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<tr>
<td>PA</td>
<td>--</td>
</tr>
<tr>
<td>PA</td>
<td>H7N7 LPAI</td>
</tr>
<tr>
<td>CA</td>
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# IAV Events
2016 H5/H7 Events

– H7N8 HPAI/LPAI of North American wild bird lineage, January 2016 in turkeys; epi and genetic data suggest a single introduction; mutation to HPAI occurred in a single flock.

– H5N1 LPAI of North American wild bird lineage, April 2016 in turkeys; epi and genetic data suggest a single introduction.

– H5N2 LPAI of North American wild bird lineage, June 2016 in LBMs; epi and genetic data suggest a single introduction.
Avian Influenza Summary

• US poultry are free of HPAI
• Wild waterfowl are natural reservoir hosts fluA
  – Low pathogenicity fluA (non-H5/H7 subtypes) and H5/H7 LPAI
  – Asian lineage H5 (GsGD) known to circulate in natural reservoir host as HPAI
• Recent outbreaks in the U.S. have stimulated change to policies and procedures
  – Be aware, know where to find information
  – Updates to sample collection and testing
  – Real time use of sequence data and contribution to epidemiologic information
• Efforts to identify opportunities for early detection continue
• AI is of animal and public health significance
Special thanks to the avian team and our partners!
Biosecurity

- USDA Guidance for Hunters
- USDA Guidance - Backyard Biosecurity
- Refer to HPAI FAD-Prep Materials for commercial poultry

**Routine Precautions**

- Do not handle or consume game animals that are obviously sick or found dead.
- Do not eat, drink or smoke while cleaning game.
- Wear rubber gloves when cleaning game.
- Wash hands with soap and water, or alcohol wipes, immediately after handling game.
- Wash tools and working surfaces with soap and water and then disinfect.
- Keep uncooked game in a separate container, away from cooked or ready-to-eat foods.
- Cook game meat thoroughly; poultry should reach 165°F internally to kill disease organisms and parasites.

**Please report sick or dead birds to local wildlife agencies or to 1-866-4USDA-WS.**
USDA APHIS VS Guidance Documents

• May supersede NVSL protocols when essential to address outbreak needs. Such changes shall be communicated in a timely manner and documented. Some examples include but are not limited to:
  • HPAI Response Plan: The Red Book
  • HPAI Response Goals
  • Stamping-Out & Depopulation Policy
  • Avian Sample Collection WI-AV-0020
  • Post C&D Environmental Sampling Guide
  • H5/H7 Avian Influenza Case Definition
  • Use of the Antigen Capture Immunoassay