



This document provides a brief overview of the HPAI Standard Operating Procedure (SOP) on Etiology and Ecology. It is intended to be an easy to use reference for responders at all levels and provide a common basis for understanding HPAI.

For further information please see the *HPAI SOP: Overview of Etiology and Ecology* and the *HPAI Response Plan: The Red Book*, available at <http://www.aphis.usda.gov/fadprep>.

**Avian Influenza Overview**

Avian Influenza (AI) is primarily an infection of birds. It is a highly infectious viral disease, classified according to its severity, with two recognized forms: HPAI, also known as fowl plague, and low pathogenicity avian influenza (LPAI). AI viruses that cause HPAI are highly virulent, and infected domestic flocks can experience high morbidity and mortality rates up to 100 percent. HPAI remains a high-priority concern for USDA APHIS as outbreaks have occurred in 2014–2015 (largest animal disease outbreak), 2016, and in 2017. Most AI viruses are LPAI viruses and do not result in high mortality in wild birds or domestic poultry; however, strain mutation or reassortment to an HPAI virus can occur (though antigenic shift or antigenic drift).

AI viruses are a significant concern to public health, such as H5N1, H5N6, and the Asian lineage H7N9. Human infection is generally uncommon, but fatalities have occurred after infection by certain strains.

**Etiology**

The HPAI virus (*Influenzavirus A*) belongs in the family *Orthomyxoviridae*. Influenza A virus is further classified on the basis of surface glycoproteins, hemagglutinin (HA or A) and neuraminidase (NA or N). Sixteen H (H1 to H16) subtypes and nine N (N1 to N9) subtypes of influenza A virus have been identified. Some influenza A subtypes can cause LPAI; H5 and H7 subtypes include both HPAI and LPAI strains.

**Current Circulation**

Up-to-date distribution of HPAI is available from the World Organization for Animal Health (OIE) and the U.N. Food and Agriculture Organization. HPAI is endemic in some countries, including (but not limited to) Egypt, China, India, Indonesia, Nigeria, and Vietnam. As of May 2017, ongoing global outbreaks of HPAI in poultry include H5N1, H5N2, H5N5, H5N6, H5N8, H7N3, and H7N9 (both lineages).

**Recent Incidents of HPAI in the United States**

| Year of Outbreak | Location                                | Disease   | Subtype                                 | Bird Loss    |
|------------------|---|-----------|---|--------------|
| 2014–2015        | Nationally—21 States                    | HPAI      | H5N2, H5N8, (H5N1—wild bird only)       | 50.5 Million |
| 2016             | Indiana                                 | HPAI/LPAI | H7N8                                    | 414,000      |
| 2017             | Tennessee, Alabama, Kentucky, & Georgia | HPAI/LPAI | H7N9 (North American wild bird lineage) | 253,000      |

**Ecology**

Many avian species are susceptible to infection with HPAI viruses, including chickens, turkeys, ducks, geese, guinea fowl, and a wide variety of other birds, such as migratory waterfowl and shorebirds. Psittacine birds, such as parrots and cockatiels, are rarely affected. Mammalian hosts, including humans, may be vulnerable to infection by some AI strains, including HPAI H5 and HPAI H7 subtypes.

**Reservoirs**

AI viruses usually infect migratory waterfowl, particularly Anseriformes (ducks and geese) and Charadriiformes (shorebirds) that can carry LPAI viruses without showing illness. The wild bird reservoir of LPAI viruses is considered a major potential source of infection for domestic birds, particularly free- and open-range poultry. Following transmission from wild to commercial birds, the virus can mutate or reassort in gallinaceous poultry flocks, resulting in an HPAI virus.





**The following are examples of how HPAI can be transmitted:**

- ◆ **Animal to animal contact:** HPAI is usually transmitted via direct exposure to HPAI-infected birds, feces, or secretions from infected birds. When a hen is infected, the HPAI virus is also likely to be present on the eggshell and internal egg contents; however, to date there is no evidence demonstrating vertical transmission of the virus.
- ◆ **Fomites:** HPAI is easily transmitted by objects and may persist on an item for an extended period of time. For example people, contaminated clothing, equipment, and vehicles can easily carry the virus.
- ◆ **Wildlife:** Contact with infected wild birds or their secretions, particularly wild waterfowl, is the most likely mode of introduction of AI into a poultry population.
- ◆ **Airborne:** Airborne transmission of HPAI is not likely a primary mode of transmission, although it may occur over short distances as an aerosol via contaminated dust.

Incubation periods are variable; HPAI may be longer and differ per subtype. Typically, the incubation period in naturally infected chickens ranges from 3 to 14 days. The OIE recognizes the incubation period as 21 days.

**Morbidity and Mortality in Domestic Poultry**

Birds affected with HPAI show a variety of clinical signs involving the respiratory, digestive, reproductive, or nervous systems. Signs of LPAI are typically much milder. Appearance of clinical signs vary; domestic ducks and wild birds may not show clinical signs. HPAI often causes morbidity and mortality rates in domestic poultry between 90–100 percent.

**Clinical signs in poultry commonly include:**

- ◆ Marked depression with ruffled feathers, droopiness, soft-shelled eggs, sudden drop in egg production, loss of appetite, excessive thirst, swollen wattles and combs, diarrhea, incoordination, respiratory distress, and increased daily mortality.

**Environmental Persistence**

**Persistence**

AI viruses can survive in cool and moist conditions, particularly when organic material is present.

| Action        | Resistance  |
|---------------|---|
| Temperature   | Pasteurization and cooking inactivate the AI virus. At 60 °C, cooking whole eggs for 188 seconds and poultry meat for 507 seconds will inactivate the virus. Cooking meat to a core temperature of 70 °C for 3.5 seconds will also inactivate the virus. The AI virus can survive indefinitely if frozen.   |
| pH            | Inactivated by pH extremes, pH 1-3 or pH 10-14.   |
| Chemicals     | Inactivated by organic solvents and detergents, such as sodium desoxycholate and sodium dodecylsulphate. If organic matter is present, aldehydes, β-propiolactone and binary ethyleneimine should be used for inactivation. After organic matter has been removed, phenolics, quaternary ammonium compounds, oxidizing agents (e.g., sodium hypochlorite), dilute acids (if pH ≤2.0), hydroxylamine, and lipid solvents should be used. |
| Disinfectants | For clean surfaces with no organic matter, use sodium hypochlorite (5.25 percent), sodium hydroxide (2 percent), phenols, acidified ionophors, chlorine dioxide, or strong oxidizing agents to inactivate.  |
| Survival      | Can survive in surface waters. Viable in liquid feces for 30–35 days at 4 °C and for 7 days at 20 °C. Survived 4 days in chicken feces held between 25–32 °C in the shade. In water, can survive 26–30 days at 28 °C, and 94–158 days at 17 °C. Composting kills virus within poultry carcasses in less than 10 days.   |

Source: OIE Technical Disease Card for HPAI, 2014; and OIE Terrestrial Animal Health Code, Chapter 10.4, 2016.

Burying, incineration, or composting is recommended for bird carcasses, as AI viruses can survive for several days at ambient temperatures and a few weeks at refrigeration temperatures.