AVIAN INFLUENZA VIRUS: VETERINARY AND PUBLIC HEALTH INSIGHTS

TALKING ONE HEALTH

Belén Colazo-Salbetti PhD; Marcos Rivas, DVM PhD

This piece provides an overview of the avian influenza virus, with a focus on HPAI H5N1, its zoonotic transmission potential, and implications for pandemic preparedness.

The United States (U.S.) is currently facing significant challenges related to the detection of highly pathogenic avian influenza (HPAI) H5N1 in dairy cows.

Of particular concern, human cases linked to animal exposure have been reported. However, no sustained human-to-human transmission has been detected to date, indicating that the virus has not yet acquired the capacity for efficient spread among people.

These zoonotic spillover events have intensified avian influenza surveillance efforts worldwide and renewed attention to avian influenza as a One Health priority, recognizing the interplay of animal, human, and environmental health.

The HPAI H5N1 strain identified in U.S. dairy herds is not currently circulating in the European Union (EU). Nevertheless, coordinated veterinary and public health policies between the U.S. and the EU are actively assessing emerging risks and implementing preventive measures.

For stakeholders in the veterinary pharmaceutical sector, animal health services, agriculture, and veterinary public health, understanding the current epidemiological and biological landscape of avian influenza virus is essential for informed decision-making.

Avian Influenza Virus: Host Range and Pandemic Potential

Avian influenza virus can infect a wide range of host species.

Wild birds represent the natural reservoir of avian influenza virus, where the virus can persist, evolve, and occasionally adapt to infect poultry and mammalian hosts, including pigs and humans.

The emergence of a novel avian influenza virus capable of infecting humans and sustaining transmission represents a recognized zoonotic spillover risk and a potential trigger for a pandemic. Whether such events occur depends on a combination of viral factors and host susceptibility, including viral genetic mutations that facilitate human-to-human spread.

Avian Influenza Structure: Genome and Key Proteins

The avian influenza virus particle consists of:

- A segmented RNA genome
- A surrounding protein matrix
- An outer lipid membrane acquired from host cells during viral release

Embedded in this membrane are two critical surface proteins:

Hemagglutinin (HA)

- Mediates viral attachment to host cell receptors
- Enables viral entry into host cells
- Plays a central role in host specificity and immune recognition

Neuraminidase (NA)

- Facilitates viral release from infected cells
- Promotes viral spread within the host and transmission to new hosts
- Serves as the target of antiviral drugs such as oseltamivir and zanamivir

These proteins are central to avian influenza pathogenesis and antiviral strategies.

Viral Subtypes and Pathogenicity

Avian influenza viruses are classified according to:

- **Hemagglutinin (HA) subtypes** (16 identified)
- **Neuraminidase (NA) subtypes** (9 identified)

The combination of these proteins defines the strain. While H1N1 and H3N2 are associated with seasonal human influenza, animal-associated subtypes such as H5N1, H7N9, and H9N2 pose significant zoonotic and pandemic risks.

Viruses are further classified based on pathogenicity in poultry:

- Low pathogenic avian influenza (LPAI)
- Highly pathogenic avian influenza (HPAI)

Among HPAI strains, HPAI H5N1 is considered the most pathogenic, causing high mortality in poultry and severe disease in humans.

Avian Influenza Genetic Variability and Evolutionary Risk

A key feature of avian influenza virus is its high genetic variability, driven by two key mechanisms:

Influenza Antigenic Drift

- Gradual accumulation of mutations in HA and NA
- Enables viral immune escape and ongoing viral evolution
- Contributes to seasonal influenza dynamics

Influenza Antigenic Shift

- Occurs when different influenza viruses co-infect the same host
- Results in the reassortment of gene segments
- Can generate novel viruses with pandemic potential, due to the lack of population immunity

Together, these mechanisms facilitate zoonotic spillover events and increase the risk of zoonotic emergence.

Transmission of Avian Influenza Virus

Wild birds remain the primary reservoir of avian influenza viruses. However, infection has been documented in a broad range of species, including swine, domestic birds, cats, horses, dogs, humans, and other mammals.

Transmission Pathways of Avian Influenza A Virus

Avian influenza virus can spread through multiple routes, particularly in environments with close human–animal interaction:

- Direct contact with infected animals
  Exposure to respiratory secretions, saliva, mucus, or feces from infected birds or livestock.
- Contact with contaminated environments or animal by-products
  Infection may occur via contaminated surfaces, equipment, or liquids, including raw milk from infected cattle, when the virus contacts the eyes, nose, or mouth.
- Airborne transmission (droplets or dust)
  Inhalation of virus-containing droplets or dust particles in contaminated environments, particularly at close range.
- Ingestion of contaminated products
  Consumption of food or beverages contaminated with live virus, though this route appears less common.
- Limited human-to-human transmission (rare)
  Very rare cases have occurred following prolonged close contact without appropriate personal protective equipment. Sustained transmission has not been documented.

Zoonotic Transmission and Occupational Exposure

Human infection with HPAI H5N1 is primarily associated with prolonged or unprotected exposure to infected animals or contaminated environments.

High-Risk Occupational Groups

- Dairy farm workers
- Poultry farm workers
- Slaughterhouse personnel

- Milk processing facility employee
- Veterinarians

Pathogenesis and Clinical Manifestations of Avian Influenza in Humans

Although animal influenza viruses primarily circulate in animal populations, some strains can infect humans. As mentioned, human cases are mainly linked to animal exposure, and sustained human-to-human transmission has not been observed.

Clinical outcomes range widely and may include:

- Asymptomatic or mild infection, particularly in occupationally exposed individuals
- Upper respiratory tract symptoms
- Respiratory and gastrointestinal manifestations
- Conjunctivitis
- Neurological complications, including encephalitis and encephalopathy

Implications for the Veterinary Pharmaceutical Sector and One Health Stakeholders

For veterinary pharmaceutical companies, animal health professionals, and regulators, avian influenza underscores the need for:

- Integrated avian influenza surveillance across animal and human health systems
- Evidence-based, ethical risk communication
- Scientifically accurate education and training

- Pandemic preparedness strategies aligned with One Health principles

Bottom Line

Avian influenza virus, particularly highly pathogenic avian influenza H5N1, remains a complex and evolving challenge at the intersection of the veterinary pharmaceutical sector and medicine, public health, and global biosecurity.

While sustained human-to-human transmission has not occurred, recent detections in cattle highlight the importance of vigilance, coordinated surveillance, and scientifically sound communication.

For stakeholders across the veterinary pharmaceutical sector, informed preparedness—not alarmism—remains essential.

At **Talking One Health**, we support veterinary, animal health, and pharmaceutical organizations with expert medical writing and strategic communication grounded in science and regulatory best practices.

Written by Belén Colazo-Salbetti, PhD and Marcos Rivas, PhD, DVM.

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