

MONTHLY SCIENTIFIC REVIEW ON AVIAN INFLUENZA A (H5N1, H1N1, H3N8)

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ANRS Emerging Infectious Diseases - Paris, France

Situation at a glance

- In 2025, 18 human cases of A(H5N1) infection were reported in Cambodia, including 9 deaths, and 30 cases globally. No evidence of human-to-human transmission has been identified.
- The 2025-2026 influenza season is characterized by an early onset and high intensity in Europe and in France, driven by the circulation of the A(H3N2) variant K strain, which has become predominant, as well as the continued circulation of A(H1N1)pdm09. All age groups are affected, with a particularly marked impact among children under 5 years of age and adults aged 65 years and older.

Scientific articles

This section presents relevant articles published on peer-reviewed scientific journals or pre-print platforms.

2026-01-15

The expanding H5N1 avian influenza panzootic causes high mortality of skuas in Antarctica.

Journal: Sci Rep

Authors: Matteo Iervolino, Anne Günther, Lineke Begeman, Begoña Aguado, Theo M Bestebroer, Beatriz Bellido-Martin, Adam Coerper, M Valentina Fornillo, Bruno Fusaro, Andrés E Ibañez, Lonneke Leijten, Simeon Lisovski, Mariané B Mañez, Alice Reade, Peter van Run, Florencia Soto, Ben Wallis, Meagan Dewar, Antonio Alcamí, Martin Beer, Ralph E T Vanstreels, Thijs Kuiken

[See details](#)

2026-01-16

Moderate protection from vaccination against influenza A(H3N2) subclade K in Beijing, China, September to December 2025.

Journal: Euro Surveill

Authors: Ying Shen, Daitao Zhang, Zhaomin Feng, Chunna Ma, Weixian Shi, Wei Duan, Jia Li, Lu Zhang, Dan Wu, Jiaojiao Zhang, Jiaxin Ma, Yingying Wang, Xiaodi Hu, Shuning Yan, Yuanzhi Di, Jiachen Zhao, Hui Xu, Quanyi Wang, Peng Yang

During the 2025/26 influenza season in Beijing, subclade K of influenza A(H3N2) rapidly predominated. Among 9,579 participants, 84.8% of A(H3N2)-positive samples were subclade K, with antigenic divergence noted. Despite this, the influenza vaccine demonstrated moderate effectiveness, with an adjusted VE of 41.3% against laboratory-confirmed influenza.

[See details](#)

2026-01-17

Polymerase mutations underlie early adaptation of H5N1 influenza virus to dairy cattle and other mammals.

Journal: Nat Commun

Authors: Vidhi Dholakia, Jessica L Quantrill, Samuel A S Richardson, Nunticha Pankaew, Maryn D Brown, Jiayun Yang, Fernando Capelastegui, Tereza Masonou, Katie-Marie Case, Jila Ajeian, Maximillian N J Woodall, Callum Magill, Graham Freimanis, Amy McCarron, Ecco Staller, Carol M Sheppard, Ian H Brown, Pablo R Murcia, Claire M Smith, Munir Iqbal, Paul Digard, Wendy S Barclay, Rute M Pinto, Thomas P Peacock, Daniel H Goldhill

H5N1 outbreak in US dairy cattle in 2024 led to spillovers into poultry, wild birds, other mammals, and humans. Cattle-adapted H5N1 viruses rapidly acquired polymerase mutations (PB2 M631L, PA K497R, PB2 E627K, D740N) enhancing replication in bovine and mammalian cells, i

[See details](#)

2026-01-24

An H5N1 clade 2.3.4.4b virus vaccine that elicits cross-protective antibodies against conserved domains of H5 and N1 glycoproteins.

Journal: Nat Commun

Authors: Eduard Puente-Massaguer, Thales Galdino Andrade, Michael J Scherm, Kirill Vasilev, Hassanein Abozeid, Alesandra J Rodriguez, Joshua Yueh, Disha Bhavsar, John D Campbell, Dong Yu, Richard J Webby, Yoshihiro Kawaoka, Gabriele Neumann, Julianna Han, Andrew B Ward, Florian Krammer

This study evaluates an inactivated H5N1 clade 2.3.4.4b vaccine with Alum/CpG adjuvant in mice, inducing strong humoral and cellular immunity, cross-reactive antibodies, and protection against homologous and heterologous H5N1 challenges, suggesting broad, durable immunity.

[See details](#)

2025-12-07

Immunogenicity and efficacy of commercial poultry avian influenza vaccines against HPAI A(H5N1) clade 2.3.4.4b viruses in Mexico.

Journal: Virology

Authors: David C Brice, Konstantin Andreev, Lance Miller, Christopher Patton, Patrick Seiler, Tehui Garcia, Morgan L LeBlanc, Taylor Hibler, Eda Ozdemir, Alexandra H Mandarano, Faten Okda, Alejandro García, Richard J Webby, Ahmed Kandeil

This study evaluated five H5 poultry vaccines against a recent H5N1 clade 2.3.4.4b virus in Mexico. All vaccines induced antibodies and provided 80-100% protection from mortality, despite some not eliciting detectable hemagglutination inhibition or microneutralization tit

[See details](#)

2026-01-28

Resistance Mutations to Broadly Neutralizing Antibodies Destabilize Hemagglutinin and Attenuate H1N1 Influenza Virus.

Journal: Viruses

Authors: Guohua Yang, Po-Ling Chen, Samuel W Rovito, Karine Minari, Haley N Witt, Jennifer DeBeauchamp, Jeri Carol Crumpton, Lisa Kercher, Rebecca M DuBois, Richard J Webby, Charles J Russell

Resistance mutations (A44V/T) in H1N1 HA2 reduce bNAbs binding, virus stability, and pathogenicity in mice and ferrets, with airborne transmission requiring reversion or compensatory mutations.

[See details](#)

2026-01-28

Genetic Characterization and Evolutionary Insights of Novel H1N1 Swine Influenza Viruses Identified from Pigs in Shandong Province, China.

Journal: Viruses

Authors: Zhen Yuan, Ran Wei, Rui Shang, Huixia Zhang, Kaihui Cheng, Sisi Ma, Lei Zhou, Zhijun Yu

Two novel H1N1 SIV strains (SD6591, SD6592) identified in Shandong, China. SD6591 is a unique triple-reassortant, while SD6592 shows genomic conservation with prior H1N1 swine strains. Neither exhibited significant recombination.

[See details](#)

2025-11-30

Genomic diversity and reassortment of highly pathogenic avian influenza A/H5N1 virus (clade 2.3.4.4b) in Brazil: Evidence of multiple introductions and intra-epidemic reassortment in 2025.

Journal: Virology

Authors: Anselmo Vasconcelos Rivetti, Dilmara Reischak, Lorcan Carnegie, Juliana Nabuco Pereira Otaka, Christian Steffe Domingues, Fernanda Gomes Cardoso, Ana Luiza Savioli da Silva, Soraya Cecília Albieri Camillo, Aristóteles Goés-Neto, Marcelo Fernandes Camargos

The study characterizes A/H5N1 (clade 2.3.4.4b) in Brazil using whole-genome NGS, revealing two distinct clades: one linked to Argentina and another to North America, with new reassortment events. This underscores the need for ongoing molecular surveillance to track viral evolution and impacts on animal and public health.

[See details](#)

2026-01-25

Can H5N1 avian influenza in dairy cattle be contained in the US?

Journal: Cell

Authors: Jonathan E Pekar, Alvin Crespo-Bellido, Philippe Lemey, Andrew S Bowman, Thomas P Peacock, Jennine N Ochoa, Andrew Rambaut, Oliver G Pybus, Michael Worobey, Martha I Nelson

H5N1 in US dairy cattle since 2024 shows long-term transmission, with genomic surveillance revealing diffusion, interspecies spread, and evolution, but data gaps hinder real-time tracking and control.

[See details](#)

2025-12-31

AI-Powered Identification of Human Cell Surface Protein Interactors of the Hemagglutinin Glycoprotein of High-Pandemic-Risk H5N1 Influenza Virus.

Journal: Viruses

Authors: Christian Poitras, Benoit Coulombe

AI pipeline identifies human cell surface proteins likely interacting with H5N1 hemagglutinin, aiding viral entry and tropism, accelerating host factor discovery for pandemic influenza.

[See details](#)

2026-01-22

Immune history confers antibody- and T cell-dependent cross-protection against highly pathogenic avian influenza H5N1 viruses.

Journal: J Virol

Authors: Pamela H Brigleb, Bridgett Sharp, Lauren Lazure, Brandi Livingston, Shelby Patrick, Victoria Meliopoulos, Ericka Kirkpatrick Roubidoux, Lee-Ann Van de Velde, Shaoyuan Tan, Dorothea R Morris, Tyler Ripperger, Lauren Rowland, Alexis C Thompson, Katie Kleinhenz, Velmurugan Balaraman, Kiril Dimitrov, Paul G Thomas, Stacey Schultz-Cherry

Pre-existing immunity to H1N1 or live-attenuated influenza vaccine protects mice and ferrets against lethal H5N1 challenge, with T cells playing a crucial role. Conserved T cell epitopes and CD4 T cell help are vital for cross-reactive antibody responses and survival.

[See details](#)

2026-01-16

Molecular basis of 60 years of antigenic evolution of human influenza A(H3N2) virus neuraminidase.

Journal: Cell Host Microbe

Authors: Miruna E Rosu, Kim B Westgeest, Miranda de Graaf, Blake M Hauser, Sina Tureli, Sarah James, Felisita F Sinartio, Theo M Bestebroer, Pascal Lexmond, Mark R Pronk, Stefan van der Vliet, Eugene Skepner, Monique I J Spronken, Barbara Mühlemann, Mathilde Richard, Terry C Jones, Derek J Smith, Sander Herfst, Ron A M Fouchier

The study quantifies NA antigenic evolution in A(H3N2) and A(H2N2) viruses since 1957, finding more gradual NA evolution than HA, with discordant antigenic changes. Multiple substitutions around the NA active site and tetramer lateral side determine antigenic properties,

[See details](#)

2025-12-25

Genotype A3 influenza A(H5N1) isolated from fur seals shows high virulence in mammals, but not airborne transmission.

Journal: Sci Rep

Authors: Anastasia S Panova, Andrey S Gudymo, Natalia P Kolosova, Alexey V Danilenko, Kiunnei N Shadrinova, Natalia V Danilchenko, Olga N Perfilieva, Anastasia A Moiseeva, Elena I Danilenko, Galina S Onkhonova, Natalia I Goncharova, Svetlana V Svyatchenko, Natalia N Vasiltsova, Marina L Egorova, Vasiliy Yu Marchenko

Genotype A3 H5N1 from fur seals shows high mammalian virulence due to PB2-K482R and NP-N319K mutations, but no airborne transmission in ferrets, suggesting limited pandemic risk.

[See details](#)

2026-01-14

Intranasal replicon vaccine establishes mucosal immunity and protects against H5N1 and H7N9 influenza.

Journal: Nat Commun

Authors: Matthew R Ykema, Michael A Davis, Darshan N Kasal, Madeleine F Jennewein, Ethan Lo, Jasneet Singh, Samuel Beaver, Noah Cross, Eduard Melief, Sierra Reed, Christopher Press, Devin S Brandt, Wynton D McClary, Raodoh Mohamath, Pauline Fusco, Julie Bakken, Corey Casper, Airn Tolnay Hartwig, Alana Gerhardt, Richard A Bowen, Emily A Voigt

Replicon-NLC vaccines against H5N1 and H7N9 show robust systemic and mucosal immunity via IN dosing in mice, protecting ferrets from morbidity and mortality.

[See details](#)

2026-01-28

Pathobiology of Highly Pathogenic Avian Influenza A (H5N1 Clade 2.3.4.4b) Virus from Pinnipeds on Tyuleniy Island in the Sea of Okhotsk, Russia.

Journal: Viruses

Authors: Alexander Alekseev, Ivan Sobolev, Kirill Sharshov, Marina Gulyaeva, Olga Kurskaya, Nikita Kasianov, Maria Chistyeva, Alexander Ivanov, Olesia Ohlopkova, Aleksey Moshkin, Marina Stepanyuk, Anastasiya Derko, Mariya Solomatina, Batyrgishi Mutashev, Mariya Dolgopolova, Alimurad Gadzhiev, Alexander Shestopalov

First documented HPAI H5N1 clade 2.3.4.4b in pinnipeds caused mass mortality in fur seals and a sea lion in Russia. Isolated viruses showed high pathogenicity in chickens and mice, with distinct disease progression and organ tropism. Genomic analysis revealed mammalian ad

[See details](#)

2026-01-07

Intrahost HA polymorphisms and culture adaptation shape antigenic profiles of H3N2 influenza viruses.

Journal: J Virol

Authors: Kritika Prasai, Zunlin Yang, Minhui Guan, Tao Li, Daphne Ware, Jun Hang, Xiu-Feng Wan

This study reveals that intrahost HA polymorphisms and culture adaptation in MDCK cells significantly alter the antigenic profiles of H3N2 influenza viruses, emphasizing the need for direct profiling of clinical specimens for accurate vaccine strain selection.

[See details](#)

2025-12-22

Vaccine-induced antigenic drift of a human-origin H3N2 Influenza A virus in swine alters glycan binding and sialic acid avidity.

Journal: bioRxiv

Authors: Matias Cardenas, Pradeep Chopra, Brianna Cowan, C Joaquin Caceres, Tavis K Anderson, Amy L Baker, Daniel R Perez, Geert-Jan Boons, Daniela S Rajao

Vaccine-induced immunity in swine drives H3N2 HA mutations, enhancing α 2,6-sialic acid avidity and abolishing Neu5Gc binding, suggesting a trade-off between receptor breadth and avidity.

[See details](#)

2025-12-05

Autoantibodies neutralizing type I IFNs in a fatal case of H5N1 avian influenza.

Journal: J Exp Med

Authors: Qian Zhang, Taylor S Conrad, Marcela Moncada-Velez, Kaijun Jiang, Anastasija Cupic, Jonathan Eaton, Kimberley Hutchinson, Adrian Gervais, Ruyue Chen, Anne Puel, Paul Bastard, Aurelie Cobat, Theresa Sokol, Ryan A Langlois, Lisa Miorin, Adolfo García-Sastre, John A Vanchiere, Jean-Laurent Casanova

A 71-year-old man with fatal H5N1 pneumonia had autoantibodies neutralizing type I IFNs (AAN-I-IFNs), rare in the elderly and linked to severe viral diseases. AAN-I-IFNs may facilitate zoonotic IAV adaptation and transmission.

[See details](#)

2025-12-17

Quantitative risk assessment of human H5N1 infection from consumption of fluid cow's milk.

Journal: medRxiv

Authors: Katherine J Koebel, Ece Bulut, Samuel D Alcaine, Aljoša Trmčić, Mohammed Nooruzzaman, Lina M Covalada, Diego Diel, Renata Ivanek

This QMRA assesses H5N1 infection risk from consuming raw and pasteurized milk, finding pasteurization highly effective. Raw milk risk is significantly higher, with qRT-PCR testing of bulk tank milk reducing risk. Knowledge gaps include human H5N1 dose-response and raw milk consumption patterns.

[See details](#)

Relevant news

This section presents official reports from health agencies, manufacturers and press releases with reliable sources.

2025-11-27

Zoonotic avian influenza. Epidemiological situation and public health risk at national and international level. Risk analysis of November 10, 2025.

Source: PRS

Since August 2025, intense circulation of highly pathogenic avian influenza A(H5N1) clade 2.3.4.4b among wild birds in Europe, including France, with mass crane mortality. High epizootic risk across France, with 16 outbreaks in poultry farms and 7 in backyard flocks. Mand

[See details](#)

2025-12-22

USDA says H5 detection in Wisconsin dairy herd is new spillover event

Source: CIDRAP

USDA confirmed a new H5N1 spillover in a Wisconsin dairy herd, distinct from previous events. The detected strain, H5N1 clade 2.3.4.4b genotype D1.1, is the same as in earlier dairy herd outbreaks. No consumer health risks or milk supply safety concerns were noted. Additi

[See details](#)

Clinical Studies

This section presents relevant clinical trials.

2024-09-23

Dose, Safety, and Pathogenicity of a New Influenza A H3N2 Challenge Strain

Status: Completed

Sponsor(s): hVIVO (United Kingdom)

This study aims to determine the optimal dose, safety, and pathogenicity of a new Influenza A H3N2 challenge strain in healthy adults aged 18-55. Part A will randomly allocate 40 participants to receive one of two virus doses. Part B will use the findings from Part A to administer one of the initial doses or a new dose to further assess safety and pathogenicity.

[See details](#)

2025-11-16

Immunogenicity and Safety of 2 Doses of Avian Influenza A (H5N1) Vaccine Administered 3 vs. 8 Weeks Apart

Status: Active not recruiting

Sponsor(s): Canadian Immunization Research Network, Dalhousie University, IWK Health Centre, Public Health Agency of Canada (PHAC), Canadian Center for Vaccinology, CHU de Quebec-Universite Laval, Vaccine Evaluation Center, Canada, McGill University Health Centre/ Research Institute of the McGill University Health Centre

This study evaluates the immunogenicity and safety of the H5N1 vaccine (Arepanrix™) administered in two doses, comparing 3-week and 8-week intervals between doses, to inform optimal dosing strategies for high-risk individuals.

[See details](#)

2024-06-21

Single Dose Texas 2017 (H3N2) Challenge Study

Status: Completed

Sponsor(s): Duke University, United States Department of Defense, Owlstone Ltd, Darwin Biosciences

This study uses a controlled H3N2 (A/Texas/71/2017) infection model in 40 healthy adults to identify early infection markers in breath and saliva, with 3-week follow-up.

[See details](#)

2025-02-23

H5N1 Milk Detection Study

Status: Recruiting

Sponsor(s): Emory University, National Institute of Allergy and Infectious Diseases (NIAID)

This study investigates if consuming pasteurized milk containing inactive H5N1 virus particles can lead to viral detection in the nose or throat, and if it elicits an antibody response. Findings aim to enhance CDC's understanding of milk consumption's impact on flu surveillance.

[See details](#)

2025-04-27

Human Infection Study of H3N2 Influenza in Healthy Adults

Status: Active not recruiting

Sponsor(s): University of Melbourne, National Institute of Allergy and Infectious Diseases (NIAID), WHO Collaborating Centre for Reference and Research on Influenza

This study investigates immune responses to H3N2 influenza in healthy adults (18-50) during and post-infection in a controlled inpatient setting, using a clinically-researched H3N2 challenge virus, anticipating mild to moderate symptoms. It marks the first flu challenge study in Australia.

[See details](#)

2025-10-10

BPL-1357 Against H1N1 Influenza Virus Challenge

Status: Not yet recruiting

Sponsor(s): National Institute of Allergy and Infectious Diseases

This study evaluates the efficacy and safety of an experimental flu vaccine, BPL-1357, against H1N1 in healthy adults, using outpatient vaccinations and controlled exposure.

[See details](#)

2025-11-27

Establishing a Controlled Human Infection Model for Influenza H3N2 as a Foundation for Pandemic Preparedness

Status: Not yet recruiting

Sponsor(s): Dalhousie University, Canadian Center for Vaccinology, McGill University Health Centre/Research Institute of the McGill University Health Centre

The overall objective is to establish an influenza Controlled Human Infection Model (CHIM) in Canada that can be used to assess the safety and efficacy of candidate vaccines, biologics, and therapeutics targeting influenza viruses.

[See details](#)

2024-09-25

GEneRating Mucosal Immunity After INfluenzA Infection and Vaccination in Lung and Lymphoid Tissue

Status: Recruiting

Sponsor(s): Imperial College London, Imperial College Healthcare NHS Trust

This experimental medicine study aims to compare immune responses in healthy adult volunteers aged 18-40 years against influenza vaccination and infection in the upper and lower respiratory tract, following administration of a live-attenuated influenza vaccine delivered by nasal spray versus influenza A (H3N2) viral challenge.

[See details](#)

2024-04-16

A Study to Find and Confirm the Dose and Assess Safety, Reactogenicity and Immune Response of a Vaccine Against Pandemic H5N1 Influenza Virus in Healthy Younger and Older Adults

Status: Completed

Sponsor(s): GlaxoSmithKline

The aim of this study is to evaluate the safety, reactogenicity and immunogenicity of the Flu Pandemic messenger RNA (mRNA) vaccine (including dose-finding and dose-confirmation) administered in healthy adults 18 to 85 years of age.

[See details](#)

Guidelines and practical information

This section lists official manuals of recommendations for clinical practice or public health policy published by leading health organizations.

January 2024	Interim Guidance for Employers to Reduce Exposure to Avian Influenza A Viruses for People Working with Animals
August 2024	Practical interim guidance to reduce the risk of infection in people exposed to avian influenza viruses
June 2024	Highly Pathogenic Avian Influenza A(H5N1) Virus in Animals: Interim Recommendations for Prevention, Monitoring, and Public Health Investigations (CDC)
June 2024	Prevention and Antiviral Treatment of Avian Influenza A Viruses in People (CDC)
May 2024	Avis du COVARS du 24 mai 2024 - Point sur la situation liée au virus influenza H5N1 (MESRI)
December 2023	Considerations for emergency vaccination of wild birds against high pathogenicity avian influenza in specific situations (WOAH)
June 2023	Enhanced surveillance of severe avian influenza virus infections in hospital settings in the EU/EEA (ECDC)
January 2022	Guidelines for the clinical management of severe illness from influenza virus infections (WHO)
December 2021	Avis relatif à la prévention de la transmission à l'homme des virus influenza porcins et aviaires (HCSP)

Fact sheets

Transmission

Influenza A viruses are segmented, negative-sense single-stranded RNA viruses, members of the Orthomyxoviridae family. The antigenic diversity of these viruses arises from two surface glycoproteins: hemagglutinin (HA) and neuraminidase (NA). Combinations of these proteins create numerous influenza subtypes, with currently 18 HA and 11 NA subtypes recognized in the environment. Although avian influenza viruses spread mainly among waterfowl, particularly Anseriformes and Charadriiformes, as well as in other susceptible bird species such as Galliformes. Unlike most other avian influenza viruses, A(H5N1) 2.3.4.4b has infected more than 200 mammal species and they can occasionally infect humans but no sustained human-to-human transmission has been identified.

Diagnosis

Appropriate samples for influenza tests should be rapidly taken and processed from patients with a relevant exposure history within ten days preceding symptom onset. A(H5N1) viruses have been detected in raw milk from infected dairy cows in some locations.

Symptoms

The incubation period for A(H5N1) infection is typically two to five days after the last known exposure. A(H5N1) influenza virus infection can cause a range of diseases in humans, from mild to severe, and in some cases, it can even be fatal. Symptoms are primarily respiratory, including fever, malaise, cough, sore throat, and muscle aches. Other early symptoms may include conjunctivitis and other non-respiratory symptoms. The infection can quickly progress to severe respiratory illness and neurological changes. A(H5N1) virus has also been detected in asymptomatic individuals.

Treatment

Influenza patients should be managed properly to prevent severe illness and death. Patients with laboratory-confirmed should be treated with antiviral medicines like oseltamivir as soon as possible.

Vaccination

Vaccine development leading to the licensure of three H5N1 vaccines - clade 1 and 2.1 - by the FDA and EMA under the trade name Audenz® / Aflunox®, Preprandix® / Pumarix®, and Foclivia® / Adjupanrix®.