

Avian Influenza in North America, 2009–2011

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SUMMARY. All reports of avian influenza virus infections in poultry and isolations from wild bird species in Canada, the United States, and Mexico between 2009 and 2011 involved low pathogenic avian influenza. All three countries reported outbreaks of low pathogenic notifiable avian influenza in poultry during this period. The reports involved outbreaks of H5N2 among commercial turkeys in Canada in 2009 and 2010; outbreaks of H5N3 in turkeys in 2009, H5N2 in chickens in 2010, H7N3 in turkeys in 2011, and H7N9 in chickens, turkeys, geese, and guinea fowl in 2011 in the United States; and multiple outbreaks of H5N2 in chickens in Mexico in 2009, 2010, and 2011. Outbreaks of pandemic H1N1 infections in turkey breeder flocks were reported in Canada in 2009 and in the United States in 2010. Active surveillance of live bird markets in the United States led to the detection of H2, H3, H4, H5, H6, and H10 subtypes. Despite the fact that wild bird surveillance programs underwent contraction during this period in both Canada and the United States, H5 and H7 subtypes were still detected.

RESUMEN. Influenza Aviar en América del Norte en los años 2009–2011.

Todos los reportes de infecciones por el virus de la influenza aviar en avicultura y los aislamientos de aves silvestres de Canadá, Estados Unidos y México entre los años 2009 y 2011 involucraron virus de influenza aviar de baja patogenicidad. Los tres países informaron brotes de influenza aviar de baja patogenicidad en aves comerciales durante este período. Los reportes involucraron brotes con el subtipo H5N2 en pavos comerciales en Canadá en los años 2009 y 2010, brotes por H5N3 en pavos en 2009, brotes por H5N2 en pollos en 2010, brotes por H7N3 en pavos en el 2011, y brotes por H7N9 en pollos, pavos, gansos y gallinas de Guinea en el año 2011 en los Estados Unidos, y finalmente múltiples brotes de H5N2 en pollos en México en los años 2009, 2010 y 2011. Los brotes por la infección con el subtipo pH1N1 en pavos reproductores se registraron en Canadá en el año 2009 y en los Estados Unidos en el año 2010. La vigilancia activa de los mercados de aves vivas en los Estados Unidos llevó a la detección de los subtipos H2, H3, H4, H5, H6, y H10. A pesar de que los programas de vigilancia de aves silvestres se han reducido durante este período, en Canadá y los Estados Unidos se siguen detectando los subtipos H5 y H7.

Key words: avian influenza, low pathogenic notifiable avian influenza, surveillance, live bird markets

Abbreviations: AI = avian influenza; APHIS = Animal and Plant Health Inspection Services; APMV-1 = avian paramyxovirus serotype 1; cELISA = competitive enzyme-linked immunosorbent assay; HPAI = highly pathogenic avian influenza; LBM = live bird market; LPNAI = low pathogenicity notifiable avian influenza; NAI = notifiable avian influenza; NVSL = National Veterinary Services Laboratories; pH1N1 = pandemic H1N1; RT-PCR = reverse-transcription PCR; TR = triple reassortant; USDA = United States Department of Agriculture

This report gives a brief account of avian influenza (AI) virus or antibody detection in domestic poultry and other captive birds in North America during the period 2009 to 2011. AI virus detection in wild birds from government surveillance programs over the same period is also briefly summarized. The results of influenza surveillance in wild birds that has been conducted by nongovernment research groups like the St. Jude Children's Research Hospital in Memphis, Tennessee, and the University of Maryland College Park, Maryland, is not included. Although the occurrence of notifiable avian influenza (NAI) is reportable to the World Organisation for Animal Health and published on their website, information regarding the occurrences of low pathogenic AI cannot be found in a centralized source. The data presented for low pathogenic nonnotifiable AI were obtained from surveillance programs of the participating countries. There was no occurrence of highly pathogenic avian influenza (HPAI) in North America during 2009–2011.

LOW PATHOGENICITY NOTIFIABLE AVIAN INFLUENZA

Canada. An H5N2 outbreak associated with respiratory disease in meat turkeys in the Fraser Valley of British Columbia was detected by passive surveillance in January 2009. The index site was an open-sided, multi-stage barn containing approximately 30,000 birds. The infection subsequently spread to an adjacent barn of the same type and size. Although analysis of all eight gene segments of the viruses isolated from both barns indicated a likely wild bird origin, viruses from the second barn possessed a 72 nucleotide/24 amino acid deletion in the stalk of the N2 as well as an additional glycosylation site in the HA1 subunit of the hemagglutinin. Both of these changes are considered adaptations to gallinaceous poultry. The outbreak was quickly brought under control with birds in both flocks depopulated. In November 2010, a second H5N2 outbreak, also detected by passive surveillance, occurred in a 43-wk-old turkey breeder flock in Manitoba with an associated drop in egg production. All eight gene segments showed ~99% identity with influenza viruses that had been isolated from wild aquatic birds in Canada and the United States over the past 10 yr, indicating a likely wild bird origin. In contrast to the viruses characterized from the 2009 British Columbia outbreak, no adaptive changes were found in

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any of the viruses isolated from this outbreak. Birds on the farm were depopulated and surveillance of surrounding farms indicated no spread of infection.

United States. Investigations associated with a 10%–20% decrease in egg production in a broiler breeder operation in Kentucky led to the detection of an H7N9 infection in April 2009. Positive results for agar gel immunodiffusion and real-time reverse-transcription PCR (RT-PCR) (matrix and H7) tests obtained at the regional veterinary diagnostic laboratory were confirmed at the national reference laboratory. Although no virus was isolated, serological subtyping by hemagglutination-inhibition and neuraminidase-inhibition assays indicated that the birds had been exposed to an H7N9 virus and the site was subsequently depopulated. Additional sites that were positive for antibodies to H7N9 were detected during April and May of 2009 as a result of preslaughter National Poultry Improvement Plan testing. This included a flock of meat turkeys in Illinois and two broiler breeder flocks in Tennessee. Although subsequent testing was negative for real-time RT-PCR and virus isolation, both sites were nevertheless depopulated. Surveillance testing carried out on surrounding flocks was negative. In 2010 antibodies to H5N2 were detected in two submissions from a single backyard chicken from Washington State. In 2011 multiple detections of H7N9 virus or antibodies to H7N9 were reported in Minnesota and Nebraska. Three isolates were obtained from geese and guinea fowl from Nebraska in April 2011 as a result of trace-back surveillance. Five isolates were obtained from turkeys from multiple sites in Minnesota in July 2011. The Nebraska and Minnesota H7N9 viruses were 99% similar. Serum antibodies specific for H7N9 were also detected in three submissions from turkeys from Minnesota and 12 submissions from turkeys and chickens from Nebraska. Finally, serologic evidence for H7N3 infection in commercial tom turkeys was reported for one submission from Missouri in 2011. In all cases a combination of controlled marketing and euthanasia by foam were the control measures that were instituted.

Mexico. The descendants of the LPAI precursor, which gave rise to the HPAI H5N2 outbreak of 1994–1995 (3), continue to circulate in Mexico in 2009–2011. There were a total of 32 isolates from eight states in 2009, 66 isolates from eight states in 2010, and 26 isolates from eight states in 2011. The majority of these were detected by an active surveillance program that is done each year.

LOW PATHOGENICITY NONNOTIFIABLE AI

Canada. Pandemic H1N1 2009 virus (pH1N1) isolated from breeder turkeys in Ontario and Quebec in October 2009 was detected by passive surveillance (2). Both cases involved laboratory investigations that were triggered by a progressive drop in egg production in the affected flocks. Other viruses isolated from breeder turkeys that were associated with decreased egg production included an H10N8 in which all eight gene segments were most similar to those found recently in wild birds and three swine origin H3N2 viruses. The H3N2 isolates were noteworthy in that one of the isolates was similar to prototypical triple reassortant (TR) H3N2 viruses that have been circulating in North American swine since 1998, while the other two isolates were reassortants between TR H3N2 and pH1N1 (1). An H1N1 of wild bird origin was isolated from chickens that presented clinically with a slight increase in mortality, yolk peritonitis, and nephritis. An H6N1 virus was detected in ducklings imported from Germany during routine testing while in quarantine. All gene segments of this H6N1 virus were of North American lineage, and thus the ducklings likely acquired the infection after arriving in quarantine.

Active serosurveillance with on-farm sampling to test for NAI was begun in 2009. This Canadian national AI surveillance program was established to fulfill requirements for trade purposes. It has two components: 1) a preslaughter surveillance component that targets healthy poultry flocks and 2) a hatchery supply flock component. The program targets a combined 10,000 samples per year from these two compartments. Sera are screened with a competitive enzyme-linked immunosorbent assay (cELISA) that detects antibodies to influenza A virus nucleoprotein. Sera that test positive by cELISA undergo further testing by HI. In 2011, 77 sera that were cELISA positive were shown to have HI antibodies to the H3 subtype. All of these sera originated from turkey breeder operations in which the birds had been vaccinated with inactivated whole virus vaccines to protect them against swine TR H3N2 infection.

United States. The first confirmed case of pH1N1 infection in a commercial turkey breeder flock in the United States was in Virginia in November 2010. Infection was initially associated with a 10%–20% drop in egg production post-insemination that progressed to a 68% decline. Two additional pH1N1-infected turkey flocks were subsequently detected in California in February 2011. Additional viruses or antibodies detected in poultry or other birds by active and passive surveillance programs included H1N1, H2N3, H2N8, H3N1, H3N2, H3N3, H3N8, H4N2, H4N6, H4N8, H6N1, H6N2, H6N4, H6N8, H6N9, H9N2, H10N2, H10N7, and H11N9 (Tables 1, 2). Sera for serologic subtyping were received from a number of states. Nearly all of these were from turkey breeders that commonly vaccinate for H1 and H3 swine influenza viruses. In 2010, 352 out of 506 submissions were positive for H1 and/or H3 antibodies along with N1 and/or N2 antibodies. In 2011, 397 out of 578 submissions were positive for H1 and/or H3 antibodies along with N1 and/or N2 antibodies.

LPAI viruses detected in North American by isolation or serology are summarized in Tables 1 and 2.

AI IN LIVE BIRD MARKETS

United States. Since 1986 when LPAI H5N2 viruses belonging to the same lineage as those responsible for LPAI H5N2 virus infections in commercial poultry in Pennsylvania were detected in live bird markets (LBMs) in the northeastern United States, these markets have been the focus of targeted surveillance. In the period 2009–2011 the National Veterinary Services Laboratories (NVSL) received positive specimens for confirmatory testing. All of these originated from the 10 to 12 states that have the highest concentrations of LBMs. Surveillance for AI is conducted routinely in LBMs within the United States as outlined in the United States Department of Agriculture (USDA) LBM surveillance program. Specimens testing positive at the state laboratory are sent to the NVSL for confirmation and identification. In 2009 the NVSL received a total of 672 submissions consisting of 4377 swab specimens for AI testing. Influenza A virus and avian paramyxovirus type 1 (APMV-1) were isolated from 7% and 2%, respectively. In 2010 a total of 624 submissions consisting of 4283 swab specimens were tested of which 12% and 3.2%, respectively, were positive. In 2011 a total of 761 submissions consisting of 4397 swab specimens were tested, of which 8.8% and 2.6% were positive for influenza A virus and APMV-1, respectively. Noteworthy are the 14 LPAI H5N2 viruses isolated from LBMs in New York in 2009 and the H5N2 isolate from Pennsylvania in 2011. Other virus subtypes detected were H2N2 in New York and Pennsylvania, H2N3 in Pennsylvania, H3N1 in New York and Pennsylvania, H3N8 in New Jersey, H4N6 in Pennsylvania, H6N2 in Ohio and Texas, H6N4 in

Table 1. Subtypes of AI virus isolated from poultry and other captive birds in North America, 2009–2011.

Subtype	Host(s)	Country (state or province)	Month	Year
pH1N1	Turkey	Canada (ON, QC)	Oct.	2009
	Turkey	United States (VA, CA)	Feb., Nov.	2010
H1N1	Chicken	Canada (ON)	Feb.	2010
H2N8	Turkey	United States (CA)	ND ^A	2009
H3N2	Turkey	Canada (ON)	Feb., Jun.	2011
	Turkey	United States (IN)	Dec.	2011
H3N8	Game birds	United States (OR)	Aug.	2010
H4N2	Turkey	United States (MN)	ND	2009
	Duck	United States (OH)	ND	2009
H4N6	Chicken	United States (PA)	Sep.	2009
	Duck	United States (TX, VA)	Oct., Jan.	2010, 2011
	Quail	United States (PA)	Jun.	2010
H4N8	Environment	United States (PA)	Sep.	2009
H5N2	Turkey	Canada (BC, MB)	Jan., Nov.	2009, 2010
	Chicken	Mexico	Multiple	2009, 2010, 2011
H6N1	Duck	Canada (QC)	Nov.	2010
	Duck	United States (CA)	Feb.	2011
H6N2	Duck	United States (OH, CA)	Oct., Feb.	2009, 2011
	Chicken	United States (TX)	Jan.	2010
H7N9	Chicken	United States (NE)	Apr.	2011
	Turkey	United States (MN, NE)	Jul.	2011
H10N8	Geese/guinea fowl	United States (NE)	Apr.	2011
	Turkey	Canada (ON)	Oct.	2011

^ANot determined.

New Jersey, H6N8 in Florida and Pennsylvania, H10N2 in Florida, and H10N7 in Oregon.

AI IN WILD BIRDS

Canada. In 2005, Canada initiated a national interagency survey for influenza A viruses in live healthy wild ducks. One of the initial objectives of the survey was to obtain baseline information about the different virus subtypes that are circulating in the wild bird reservoir. Following the spread of Eurasian H5N1 from Asia into Europe and

Africa a dead bird surveillance component was added in 2006. Dead bird surveillance involved wild birds that were found dead and submitted to the Canadian Cooperative Wildlife Health Centre laboratories for diagnostic investigation. The dead bird surveillance component was added to better detect the incursion of HPAI H5N1. In survey years 2005, 2006, and 2007, a total of 4268, 3842, and 5498 swab specimens respectively were tested. Since 2008 the live bird testing component has been declining steadily. Despite the limited testing carried out on live birds during 2009–2011, low pathogenicity notifiable avian influenza (LPNAI) viruses were still detected. These included H5N2, H5N3, H7N3, and H7N7 viruses

Table 2. AI virus subtype specific antibodies detected in serum from various sources in the United States and Canada, 2009–2011.

Subtype	Host(s)	Country (state or province)	Month	Year
H1	Chicken	United States (PA)	Jul.	2010
	Turkey	United States (MA)	Sep.	2009, 2011
H3	Turkey	Canada		2010, 2011
H3N2	Turkey	United States (TX)	Jan.	2010, 2011
H3N3	Turkey	United States (MA)	Sep.	2009
H5N2	Chicken	United States (WA)	Jun.	2010
H5N3	Turkey	United States (MA)	Jan.	2009
H6N1	Chicken	United States (MD)	ND ^A	2009
	Pheasant	United States (MN)	Dec.	2010
H6N2	Duck	United States (CA)	ND	2011
	Chicken	United States (FL, TX)	Jan.	2009, 2010
H6N8	Turkey	United States (TX)		2010
	Turkey	United States (MN)	Nov.	2010
H7N3	Turkey	United States (MO)	Mar.	2011
H7N9	Chicken	United States (KY, TN, NE)	Apr.–May	2009, 2011
	Turkey	United States (IL, MN, NE)	Apr., May, Jun., Jul.	2009, 2011
H9N2	Chicken	United States (TN)	Jun.	2009
	Turkey	United States (PA)	Nov.	2010
H10N7,9	Chicken	United States (OK)	Jul.	2011
H11	Ostrich	United States (FL)	Apr.	2011
H11N9	Turkey	United States (MN, MI, IA)	Oct.–May	2010–2011

^ANot determined.

detected in a number of different species including mallards (*Anas platyrhynchos*), northern pintails (*Anas acuta*), and blue-winged teals (*Anas discors*).

United States. An extensive AI surveillance program involving all 50 states was initiated in 2006. This involved the participation of the Department of the Interior, U.S. Geological Survey, the USDA, Wildlife Services, and the USDA-Animal and Plant Health Inspection Services (APHIS)-NVSL. One of the primary objectives was the detection of HPAI H5N1. In 2006 a total of 164,000 specimens were tested, followed by 97,000 specimens in 2007, 83,634 specimens in 2008, 44,621 specimens in 2009, and 9803 in 2010. In 2011 the USDA wild bird surveillance program for the detection of HPAI H5N1 was curtailed due to lack of funding. Although Eurasian HPAI H5N1 was never detected, North American lineage LPAI H5N1 was detected from a number of states in multiple years. Other LPAI H5 and H7 subtype viruses were also detected. For 2010 and 2011 H5N2 and H7N3 were the predominant subtypes detected.

Mexico. In 2008–2009 surveillance was carried out on 2227 waterfowl samples taken from different wetlands within Mexico. This was a collaborative effort involving Animal Health, Wildlife and USDA-APHIS. Fifty-eight samples from three states were influenza type A virus positive; seven were LPAI H5 positive, while one was LPAI H7 positive. All test results were based on real-time RT-PCR; no virus was isolated. In 2011 a H4N2 virus was isolated from a wild bird using embryonating chicken eggs.

DISCUSSION

Although there were no HPAI outbreaks in North America during 2009–2011, LPNAI was reported in all three countries. For the United States and Canada, the viruses responsible for the LPNAI

outbreaks in poultry most likely were introductions from the wild bird compartment that resulted in no or very limited spread prior to being eradicated. This is in contrast to the endemic LPAI H5N2 situation in Mexico. Other LPAI subtypes continue to be sporadically detected by active and passive surveillance programs in the United States and Canada. Lastly, in addition to the swine origin H1 and H3 viruses, which continue to cause reproductive losses in turkey breeder operations, pH1N1 was also shown to be capable of inducing a similar clinical syndrome.

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