

Avian influenza in wild birds in Australia

Fact sheet

Introductory statement

Avian influenza (AI) is an infectious disease of birds caused by influenza virus type A strains. Avian influenza viruses (AIVs) are found worldwide in numerous bird species. Species in the avian orders *Anseriformes* (waterfowl) and *Charadriiformes* (shorebirds and gulls) are the main natural reservoirs for these viruses.

Outbreaks of highly pathogenic AI (HPAI) H5 have occurred in Asia since 2003, in both poultry and wild birds, spreading to Europe, Africa and North America. These pathogenic strains have not been detected in Australia.

Low pathogenic AIVs have been detected in wild birds in Australia, however mortality due to AIVs have not been reported in feral or native free-ranging birds (Arzey 2004).

The role of wild birds in the epidemiology of AIV has been investigated in detail over recent decades, with extensive global surveillance programs targeting the main avian reservoir hosts. Risk analyses indicate a low likelihood of overseas HPAI strains being introduced into Australia via migratory birds (East et al. 2008a; Curran 2012).

Aetiology

Influenza A viruses are RNA viruses belonging to the family *Orthomyxoviridae*. Influenza A viruses are classified according to the serological subtypes of their surface glycoproteins, haemagglutinin (HA) and neuraminidase (NA) (Webster et al. 1992). To date, 16 HA (H1–16) and 9 NA (N1–9) subtypes are recognised in birds and are found in different combinations (Stallknecht et al. 2007). Influenza A viruses are further designated as highly pathogenic avian influenza (HPAI) or low pathogenicity avian influenza (LPAI) based on the molecular sequence of the haemagglutinin protein and the ability to cause disease in poultry. AIV subtypes H5 and H7 have the capacity to mutate from LPAI into HPAI forms when introduced into poultry (Alexander 2007; Feare 2007).

Natural hosts

Anseriformes (waterfowl: ducks, swans, geese) and *Charadriiformes* (gulls, terns and shorebirds) are the natural reservoir for all avian influenza A viruses (Olsen et al. 2006).

Influenza A viruses (including HPAI H5N1) can infect a variety of animals, including wild and domestic birds and mammals (humans, pigs, equids, felids, canids, mink, marten and rodents) (Webster et al. 1992). A referenced list of species in which H5N1 has been reported can be accessed via the USGS website <https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/atoms/files/List%20of%20Species%20Affected%20by%20H5N1%20%28Avian%20Influenza%29.xlsx> (USGS 2018).

World distribution

AIVs have a global distribution and have been isolated from all continents, including Antarctica (Nestorowicz et al. 1987; Stallknecht et al. 2007; Hurt et al. 2016; USGS 2018).

Since 2003 there have been extensive reports of HPAI H5N1 (believed to originate from domestic chickens in China) in a wide variety of avian species. The first report of HPAI H5N1 in a wild bird was from Hong Kong in 2002 (Ellis et al. 2004). HPAI H5N1 and other HPAI H5 strains have resulted in significant losses of poultry in Asia, the Middle East, Europe and North America, as well as causing mortalities in some wild bird species (Alexander 2007; de Vries et al. 2015; Bevins et al. 2016).

Occurrences in Australia

HPAI H5 viruses (including H5N1) have not been detected in Australia. However, HPAI H7 outbreaks occurred in Australian poultry enterprises in 1976, 1985, 1992, 1994, 1997, 2012 and 2013 (Westbury 1997; Selleck et al. 2003; DAWR 2015). HPAI has not been detected in Australian wild birds, other than detection of HPAI H7 in one feral Eurasian starling (*Sterna vulgaris*) trapped inside an affected poultry shed during a 1985 HPAI H7 outbreak (Bunn et al. 1987; Westbury 2003; Arzey 2004; Grillo et al. 2015).

All low pathogenic AIV subtypes (H1-16, excluding H14) have been detected in Australian wild birds. LPAI viruses have been identified in Australian *Gruiformes*, *Pelecaniformes*, *Procellariiformes*, *Anseriformes* and *Charadriiformes* (Downie et al. 1977; MacKenzie et al. 1984; MacKenzie et al. 1985; Peroulis and O'Riley 2004; Hurt et al. 2006; Haynes et al. 2009; Hansbro et al. 2010; Grillo et al. 2015).

Epidemiology

LPAI viruses produce mild or no disease in poultry and generally produce no disease in wild birds. HPAI viruses, including the HPAI H5 virus strains, can result in up to 100% mortality in chickens (Alexander 2000). HPAI H5 virus strains (including H5N1) have also caused mortality events in a variety of wild bird species overseas (e.g. swans, migratory geese, wood ducks) (Bevins et al. 2016; USGS 2018). Wild bird mortality events due to non-HPAI H5 strains are not as well documented.

The incubation period for AI varies with bird species, virus subtype and virulence (CIDRP 2013). HPAI incubation in wild birds can range from a few hours to 7 days.

In wild ducks, viral replication occurs primarily in the gastrointestinal tract with high loads of virus being shed in faeces (Webster et al. 1978). Faecal-oral transmission is thought to be the predominant means of AIV spread in wild bird populations. Recent isolates of HPAI H5N1 have also been found in tracheal samples, suggesting the method of transmission may be species dependent, and airborne transmission may be important in some species, when in close contact (CIDRP 2013).

The duration of virus shedding also appears to vary with host species. Virus can be shed in poultry and wild bird faeces for 30 days or longer (Animal Health Australia 2008). Virus survival outside the host is affected by environmental conditions. AIVs can persist for extended periods in water and faeces, depending on ambient temperatures, pH and salinity (CIDRP 2013).

Although *Anseriformes* and *Charadriiformes* are considered the natural hosts of AIVs, there is a need for more detailed understanding of the natural history of AIVs, including wild reservoirs and host species across the globe. Studies indicate that host species and population ecology are important in AIV maintenance, transmission, and possibly, long-distance movement (Stallknecht and Brown 2007).

Anseriformes species found in Australia are not migratory, however they are nomadic within the Australo-Papuan region (Roshier et al. 2002; Tracey et al. 2004). An assessment of the biological pathways of risk for HPAI H5 entry into Australia from migratory birds estimated the risk of infection in the wild birds of northern Australia to be negligible to very low (East et al. 2008b; Curran 2012). The epidemiology of AIVs is likely to be different in Australia compared to other regions of the world. As much of the current understanding of AIV ecology, molecular phylogenetics and spread is derived from studies in Asia, Europe or North America, it may not be relevant to the Australian situation (Klaassen et al. 2011; Grillo et al. 2015).

Recent studies support the hypothesis that within the Australian context, the drivers for emergence of AIV are likely to be different to those in the northern hemisphere, due in part to the more irregular environmental conditions. Both long- and medium-term rainfall patterns, as well as variation in population size within wild duck species, have been linked to AIV prevalence in wild duck species in south-east Australia. In the Australian context, rainfall events strongly influence breeding opportunities in wild duck species, which can in turn determine age-structures and percentage of immunologically naïve individuals within the flock (Ferenczi et al. 2016).

Recent phylogenetic analysis shows that some segments (genes) of AIVs present in Australia are derived from North American lineages (Vijaykrishna et al. 2013), supporting the existing but limited evidence for viral introductions from North America (Kishida et al. 2008).

Clinical signs

Wild birds infected with LPAI viruses usually show no clinical signs however, reduced foraging and altered migration have been reported in infected swans in one overseas study (Van Gils et al. 2007). In some wild bird species, HPAI can result in sudden death. Experimentally-infected wild bird species have shown watery diarrhoea, depression, inappetence, neurological and respiratory signs and death (Stallknecht et al. 2007), similar to the signs seen in infected poultry.

Diagnosis

The diagnosis of AIV infection must be confirmed by PCR and/or virus isolation. In Australia, samples are tested for influenza A using PCR. All Influenza A positive samples are then tested using a specific PCR for influenza A subtypes H5 and H7. Positive H5 and H7 samples are sent to the CSIRO Australian Animal Health Laboratory, Geelong, for viral culture and sequencing of the HA cleavage site to determine pathogenicity. Serum can be analysed for antibodies to the influenza A virus nucleoprotein using an ELISA. This test has shown to be valid in a number of Australian wild bird species (Hoque 2011; Curran et al. 2013b).

Clinical pathology

There is no reported information associated with clinical pathology in wild birds infected with AIVs. Changes in domestic ducks included anaemia, reduced plasma protein, and increase in a range of biochemical parameters in serum (Mahmoud 2015).

Pathology

There are no pathognomonic lesions for avian influenza in birds (Stallknecht et al. 2007). Severity and distribution of lesions are dependent on the pathogenicity of the virus and host factors (e.g. species, age,

immunity). In LPAI virus infections, there may be no pathological changes, or mild to moderate respiratory lesions may be present. Similarly in HPAI infections, there may be no visible pathology or severe multi-organ involvement with necrosis, inflammation and haemorrhage (Stallknecht et al. 2007).

Differential diagnoses

Differential diagnoses may include any cause of sudden death or acute onset of morbidity (e.g. acute poisoning, misadventure such as heat stress or dehydration, chlamydiosis, avian paramyxovirus or acute infections such as *E. coli*) (Animal Health Australia 2008).

Laboratory diagnostic specimens and procedures

Both live and dead birds may be sampled. Swabs (cloacal, oropharyngeal and/or faecal); environmental (faecal) samples are collected for viral testing and serum is collected to test for evidence of exposure to AIVs. Collection procedures are in accordance with the 'Sick and Dead Bird Health Surveillance: sample collection protocol' (Rose 2005). In dead birds, samples should include alimentary tract tissues (proventriculus, pancreas, intestine, caecal tonsils) and respiratory tract tissues (trachea, lung). Samples from live birds should include oropharyngeal and cloacal swabs and/or fresh faeces, and serum for antibody studies (Animal Health Australia 2008).

Treatment

There is no treatment available for LPAI or HPAI AI in wild birds (or poultry).

Prevention and control

There are no specific prevention or control measures for AIV in wild birds. The practices of culling wild birds and the destruction or modification of their habitat (e.g. wetlands, water bodies) have been deemed as ineffective measures for AIV control by global advisory organisations (FAO 2004; Animal Health Australia 2008; FAO 2016).

Vaccination of valuable captive birds (e.g. in zoos and breeding centres) may be considered in the event of a HPAI outbreak in Australia, and has been included in national AUSVETPLAN guidance documents (NAIEVEG 2010; Animal Health Australia 2016).

Surveillance and management

Wildlife disease surveillance in Australia is coordinated by Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. Please contact admin@wildlifehealthaustralia.com.au.

A National Avian Influenza Wild Bird Surveillance Program (the Program) commenced in Australia in 2006. The Program is managed by a Steering Group and was developed to facilitate collaboration between a range of government and non-government organisations to promote coordination of information to inform the national picture. The Program includes: (i) pathogen-specific, risk-based surveillance via convenience sampling of apparently healthy, live and hunter-killed wild birds; and (ii) enhanced passive surveillance via investigation of significant, unexplained morbidity and mortality events in wild birds (Grillo et al. 2015). National AI surveillance activities in wild birds are conducted Australia-wide and are ongoing. The Program

aims to provide valuable ecological and epidemiological background information to assist strategic risk management to minimise the economic, environmental and social impacts of AI (or HPAI) on human health, poultry industries and wildlife in Australia. The program is also a key source of samples that are positive for AIVs, which are used to maintain and develop current and specific diagnostic assays. These are essential for continued confidence that the tests being used in Australia will detect any strains of HPAI H5 or H7. The multi-agency and cross-jurisdictional approach of this Program provides a forum for collaboration on technical aspects of influenza in humans, animals and wildlife.

A summary of surveillance results from July 2005 to June 2007 has been published (Haynes et al. 2009) along with a further summary from July 2007 to June 2012 (Grillo et al. 2015). Further information can be found on the WHA website:

www.wildlifehealthaustralia.com.au/ProgramsProjects/AvianInfluenzaWildBirdSurveillance.aspx

AI outbreaks in Australia (including wild birds) are managed under the 'Disease Strategy: Avian influenza (version 3.3), AUSVETPLAN 2008' (Animal Health Australia 2008).

Statistics

Between July 2005 and June 2007, swabs and blood samples were collected and analysed for AIVs from over 16,000 wild birds in Australia. No HPAI viruses were identified, but 164 PCR tests were positive for the AI type A matrix gene (i.e. 1.0% prevalence) and additional testing confirmed all AI subtypes except H10 and H14-16. Positive samples were from ducks, mixed water-birds or shorebirds. LPAI H5 and/or H7 subtypes were detected in wild birds in New South Wales, Tasmania, Victoria and Western Australia. Antibodies were detected in 15.0% of sampled birds in NSW, NT, Qld, Tas and WA (Haynes et al. 2009).

Between July 2007 and June 2012, swabs and serum samples were collected from over 50,00 wild birds (mainly *Anseriformes* and *Charadriiformes*), from a variety of locations across Australia. Overall, 988 birds (1.9 ± 0.1%) tested positive for influenza A virus via PCR. In addition, 22.4% (± 1.0%) were positive for influenza A antibody. HPAI H5 or H7 viruses were not detected. There were geographic and temporal fluctuations in AIV detection frequency across the study. LPAI H5 subtypes were the predominant and widespread subtype in wild birds in Australia during this sampling period (Grillo et al. 2015).

National AIV wild bird surveillance data show a low frequency of AIVs in migratory birds soon after their arrival in Australia, indicating that migratory shorebirds do not commonly carry AIVs into Australia from other regions of the world (Hansbro et al. 2010; Curran et al. 2013a). Phylogenetic analysis of some segments (genes) of AIVs present in Australia demonstrates some (limited) evidence of viral introductions (Kishida et al. 2008; Vijaykrishna et al. 2013).

Passive surveillance in wild bird mortality events excluded AI as the cause of death in over 2,500 wild bird mortality events since 2005 (eWHIS data, contact admin@wildlifehealthaustralia.com.au) (Grillo et al. 2016).

Research

There are a broad range of endemic AI virus subtypes in wild birds in Australia. Key research recommendations include:

- further analyses to explore environmental and species-specific variables
- future analyses to explore in more detail spatial and temporal trends, as well as climatic and rainfall zone
- further analysis of AIV phylogeny and gene flow of subtypes, ecology and epidemiology
- further analysis of the pathogenicity, for poultry, of AIV subtypes found in wild birds, in particular, H5 and H7 subtypes. This includes the ability of LPAI H5 and H7 subtypes to mutate to HPAI.

WHA analysis supports continued use of faecal environmental samples for wild bird surveillance due to the relative low cost and logistical ease of collecting these compared to other samples (Grillo et al. 2015).

Human health implications

Although AIVs do not normally infect humans, some subtypes have been associated with disease in humans, ranging from mild illness to severe respiratory disease, resulting in 450 reported human deaths worldwide due to HPAI H5N1 (at 19 July 2016) (WHO 2016). In the past, human infections of H7 were generally non-fatal with mild respiratory symptoms and/or conjunctivitis. More recently, in Asia, some humans have become infected with LPAI H7N9, H9N2 and H10. Most illness and deaths associated with AIV infection in humans occurred after close contact with infected poultry or with objects contaminated by their faeces. Human deaths have also been attributed to close contact with (including de-feathering) infected wild swans in Azerbaijan (Promed Archive number 20060530.1514, 2006). A summary of the confirmed H5N1 human cases can be accessed at: http://www.who.int/influenza/human_animal_interface/H5N1_cumulative_table_archives/en/. See the 'Avian influenza in humans CDNA National guidelines for public health units': [www.health.gov.au/internet/main/publishing.nsf/Content/C40727613D966AD6CA257BF0001ED770/\\$File/Avian-influenza-song.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/C40727613D966AD6CA257BF0001ED770/$File/Avian-influenza-song.pdf)

Conclusions

Although LPAI virus subtypes are currently circulating in Australia, their prevalence is low. HPAIVs have not been detected in Australian wild birds. Given Australia's isolation, both geographically and ecologically, the epidemiology of AIV in Australia is likely to be different to other parts of the world. Although there is the potential for AIVs (including HPAI H5) to be introduced into Australia via migratory birds, the risk is considered to be very low. Introduction of HPAI to Australia is more likely to occur via other routes. Introduction of LPAI viruses to poultry from Australian wild birds, and passage to more highly pathogenic forms, is possible. Continued surveillance activities for AIV in wild Australian birds is recommended.

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To provide feedback on this fact sheet

We are interested in hearing from anyone with information on this condition in Australia, including laboratory reports, historical datasets or survey results that could be added to the National Wildlife Health Information System. Negative data are also valuable. If you can help, please contact us at admin@wildlifehealthaustralia.com.au.

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