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Global Avian Influenza Surveillance in Wild Birds: A Strategy to Capture Viral Diversity

Technical Appendix

Global Avian Influenza Surveillance in Wild Birds

Methods

We analyzed data from 1) a survey of the Organisation for Animal Health (OIE) member countries conducted by OIE, 2) official OIE animal health reports from member countries by using the World Animal Health Information Database (WAHID) interface (http://oie.int/wahid) and the WAHID-Wild interface (http://oie.int/wahidwild); 3) reports of avian influenza wild bird surveillance results published in the peer-reviewed literature by using the Web of Knowledge; and 4) the Influenza Research Database (http://www.fludb.org).

OIE Member Survey

Influenza caused by H7N5 subtype virus that is affecting humans in China is not causing clinical disease in birds. Thus, more proactive approaches to surveillance in birds are necessary to detect viral infection. To determine the scope of current surveillance activities in wild birds, in April 2013, the OIE asked all 178 member countries to provide information on surveillance activities for avian influenza (caused by low pathogenic and highly pathogenic influenza viruses) during the previous 12 months. Results received from 46 of 178 member countries were reviewed.

OIE WAHID Interface Data

We also reviewed avian influenza reporting from the disease timeline database on the WAHID interface (www.oie.int/wahid) during 2008–2012 by using data provided by OIE member countries (data for 2013 were was not available at the time of analysis). Reporting of

avian influenza virus subtypes H5, H7, and highly pathogenic avian influenza virus identified in wild birds to OIE is mandated, and reporting of other subtypes of low pathogenic avian influenza virus is voluntary as part of the OIE Worldwide Monitoring System for Wild Animals. For the purposes of identifying countries reporting surveillance activities for this analysis, we included countries reporting any of the following occurrence categories: confirmed infection but not clinical disease, suspected, confirmed clinical disease, infection/infestation in ≥1 zones, or clinical disease limited to ≥1 zones, disease suspected but not confirmed limited to ≥1 zones, or absent.

Influenza Research Database

To determine other sources of information on avian influenza surveillance in wild birds from outside sources (or potentially in conjunction with) reporting to OIE, we collected wild avian surveillance data from the Influenza Research Database (http://www.fludb.org/) by using a 2-step approach. First, we conducted a search on November 26, 2013, on the Avian Surveillance Summary Search (an option under Search Data→Animal Surveillance) refined for the host type parameter Wild. The search excluded avian surveillance records categorized as captive wild or domestic host type. Total wild bird counts per country were summed. Entries for countries with n = 0 wild bird counts were excluded. By our definition (n>0 wild bird counts per country), reports of avian influenza viruses originating from 40 countries were found. Second, by using the Animal Surveillance Search page, we set display type to customizable summary table. Country was selected as the primary y-axis attribute, and collection year was selected as the primary x-axis attribute. The remaining default search settings were used. The resulting table displayed years with sampling data for each country. For the 40 countries from which there were reports of n>0 wild bird counts, data records were reviewed to determine if wild birds were sampled during January 2008–June 2013 (collection date). Individual collection records were reviewed to ensure that the records reflected n>0 wild birds as opposed to captive wild or domestic birds (noted as behavior classification in the collection record) during the time frame. Most of total effort (sample collection) for countries was reported during 2008–2013.

Web of Knowledge

To explore the extent of reporting on avian influenza surveillance in wild birds in the scientific literature, we searched the Thompson Reuters Web of Knowledge system (www.webofknowledge.com) version 5.12 (all databases) on November 27, 2013, topic search term [Avian Influenza] with publication date parameters for 2008–2013. The search yielded 20,757 results. The search was refined for search term wild bird and yielded 1,220 results. The search was further refined for surveillance, which yielded 431 results. We limited inclusion of reports to those conducting surveillance during 2008–2013. Abstracts were reviewed for surveillance time frames and to confirm n>0 wild bird sampling in the country(s). When results were not clear, full texts were reviewed. Papers needing more review without full-text online versions were searched by using Google Scholar (www.scholar.google.com); if not available on either system, they were not included. Publications focused on surveillance of domestic animals involving experimental infection or investigating surveillance or testing method validation were excluded. In general, information was not included from review papers, except where it was explicit that wild birds had been sampled in a given country within the specified time frame. The list of countries from which reports of conducting wild bird surveillance during January 2008–January 2013 by an article available on Web of Knowledge was compiled (online Appendix Table). Information matching the headings of the OIE survey was also extracted for a subset of 26 countries not responding to the OIE survey but still reporting in the literature available on Web of Knowledge to gain a sense of their sampling, testing, and reporting approaches.

Table. Current and recent surveillance for avian influenza virus in wild birds, by country and income level, reported surveillance by country*

Income level, country	OIE survey	Reporting to OIE	Web of Knowledge	Influenza Research Database
High				
Australia	X	NR	X (*1*,*2*)	X
Austria	NR	X	X (*3*)	NR
Bahrain	NR	X	NR	NR
Belgium	X	X	NR	NR
Canada	X	X	X (*4*,*5*)	X
Chile	NR	X	NR	NR
Taiwan	X	X	NR	X
Croatia	NR	X	NR	NR
Czech Republic	X	X	X (*6*)	NR
Denmark	X	X	X (*7*)	NR
Equatorial Guinea	NR	X	NR	NR
Estonia	NR	X	NR	NR
Finland	X	X	NR	NR
France	NR	X	X (*8*)	NR
Germany	NR	X	X (*3*,*9*)	NR
Guadeloupe	NR	NR	X (*10*)	NR

Income level, country	OIE survey	Reporting to OIE	Web of Knowledge	Influenza Research Database
Hong Kong	NR	NR	X (*11,12*)	NR
Ireland	NR	X	NR	NR
Israel	NR	X	NR	NR
Italy	X	X	X (*13,14*)	NR
Japan	X	X	X (*15–21*)	X
South Korea	X	X	X (*22–28*)	NR
Kuwait	NR	X	NR	NR
Latvia	NR	NR	NR	X
Lithuania	NR	NR	X (*29*)	X
the Netherlands	NR	X	X (*30*)	X
New Caledonia	NR	X	NR	NR
New Zealand	X	X	NR	NR
Norway	X	X	X (*31*)	NR
Oman	NR	NR	NR	X
Poland	X	X	X (*32,33*)	NR
Portugal	X	X	X (*34,35*)	NR
Russia	NR	NR	X (*36–38*)	X
San Marino	NR	X	NR	NR
Saudi Arabia	NR	X	NR	NR
Singapore	X	X	NR	NR
Slovakia	NR	X	X (*39*)	NR
Slovenia	X	X	X (*40*)	NR
Spain	X	X	X (*41*)	NR
Sweden	NR	X	NR	NR
Switzerland	NR	NR	X (*3,42*)	NR
United Kingdom	X	X	X (*43,44*)	NR
United States	X	X	X (*5,44–51*)	X
Uruguay	NR	X	NR	NR
Upper middle				
Algeria	NR	X	NR	NR
Argentina	X	X	X (*52*)	NR
Azerbaijan	NR	X	NR	NR
Bosnia and Herzegovina	X	X	NR	NR
Botswana	NR	X	X (*53,54*)	NR
Brazil	NR	X	NR	NR
Bulgaria	NR	X	X (*55*)	X
China	NR	X	X (*56,57*)	X
Colombia	X	NR	NR	X
Greece	X	NR	NR	X
Greenland	NR	NR	X (*7*)	X
Hungary	X	X	NR	X
Iceland	NR	X	NR	X
Iraq	X	NR	NR	NR
Kazakhstan	X	NR	X (*38*)	NR
Lebanon	NR	NR	NR	X
Libya	NR	X	NR	NR
Malaysia	X	X	NR	NR
Mauritius	X	NR	NR	NR
Mexico	NR	X	X (*5,58*)	NR
Montenegro	NR	X	NR	NR
Namibia	NR	X	NR	NR
Peru	X	X	X (*59*)	NR
Romania	NR	X	NR	X
Serbia	X	X	NR	NR
South Africa	NR	X	X (*53,54*)	NR
Thailand	X	X	X (*60*)	X
Tunisia	X	X	NR	NR
Turkey	X	NR	X (*61*)	X
Lower middle				
Armenia	NR	X	NR	NR
Bhutan	NR	NR	NR	X
Cameroon	NR	NR	NR	X
Côte d'Ivoire	X	X	NR	NR
Egypt	NR	NR	X (*62,63*)	X
El Salvador	NR	X	NR	NR
Georgia	NR	NR	X (*64*)	X
Ghana	NR	NR	X (*65*)	X
Guatemala	NR	NR	X (*66*)	X

Income level, country	OIE survey	Reporting to OIE	Web of Knowledge	Influenza Research Database
India	NR	X	X (*67*)	NR
Lesotho	NR	X	NR	NR
Mauritania	NR	NR	X (*54*)	NR
Mongolia	X	X	X (*21,38,68,69*)	X
Morocco	NR	X	NR	NR
Nigeria	NR	X	X (*70*)	NR
Pakistan	NR	NR	X (*71*)	NR
Papua New Guinea	NR	NR	NR	X
Paraguay	NR	X	NR	NR
Moldova	NR	X	NR	NR
Republic of the Congo	NR	NR	NR	X
Senegal	NR	X	X (*54*)	NR
Sri Lanka	NR	NR	NR	X
Sudan	NR	X	NR	X
Swaziland	NR	X	NR	NR
Ukraine	NR	NR	X (*72*)	NR
Vanuatu	NR	X	NR	NR
Vietnam	X	NR	X (*73,74*)	X
Yemen	X	NR	NR	NR
Zambia	NR	NR	X (*75*)	NR
Low				
Bangladesh	X	X	X (*76*)	X
Benin	NR	X	NR	X
Cambodia	NR	NR	X (*77*)	X
Central African Republic	NR	NR	NR	X
Eritrea	NR	X	NR	NR
Ethiopia	NR	X	NR	NR
Guinea	NR	X	NR	NR
Haiti	NR	X	NR	NR
Kenya	NR	NR	X (*76*)	NR
North Korea	X	NR	NR	NR
Madagascar	NR	X	NR	NR
Mali	NR	NR	X (*54*)	NR
Mozambique	NR	NR	X (*53,54*)	NR
Nepal	NR	X	NR	NR
Tanzania	NR	X	NR	NR
Uganda	NR	X	NR	X
Zimbabwe	NR	X	X (*53,54*)	X

*Reported surveillance by country as per 1) responses to OIE survey confirming surveillance activity; 2) official reports to OIE indicating surveillance activities, 2008–2012; 3) Web of Knowledge literature indicating surveillance activities during 2008–2013; and 4) information reported to the Influenza Research Database. Country income levels are based on the 2013 United Nations categorization. OIE, World Organisation for Animal Health; X, ≥1 report was found in the relevant reporting category; NR, no report. Values in parentheses are references.

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