McMaster University | HEALTH FORUM

Living Evidence Profile

Identifying features and impacts of public health strategies that can be used to prevent, reduce, and/or mitigate avian influenza spillover to humans

17 July 2024

[MHF product code: LEP 8.3] *Note that this product was previously labelled as rapid evidence profile #64 but has since been changed to a living evidence profile.

Appendices

Appendix 1: Methodological details

We use a standard protocol for preparing living evidence profiles (LEP) to ensure that our approach to identifying research evidence is as systematic and transparent as possible in the time we were given to prepare the profile. The timing, frequency, and scope of future updates of this LEP will be determined in collaboration with the requestor.

At the beginning of each living evidence profile and throughout its development, we engage a subject matter expert who helps us to scope the question and ensure relevant context is taken into account in the summary of the evidence.

Identifying research evidence

For LEP 8.3, we updated our original searches conducted on 18 December 2023, 1 May 2024, and 13 May 2024 in ACCESSSS, Health Systems Evidence, Health Evidence, and PubMed. The updated searches were conducted on 8 July 2024 using the following combination of terms: (avian influenza) OR (H5N1 or AH5N1 or A?H5N1 or H5Nx or H5N*) (limited using the search filters for reviews and systematic reviews). This was supplemented with an additional search originally conducted on 1 May and updated on 13 May 2024 and 8 July 2024 in PubMed for any literature from the last five years related to bovine or ruminant related transmission using this combination of terms: (avian influenza) OR (H5N1 or AH5N1 or A?H5N1 or H5Nx or H5N*) AND (bovine OR cow OR cattle OR dairy OR ruminant). We also searched the USDA National Agricultural Library on 1 May 2024 and updated on 13 May 2024 and 8 July 2024 using the same set of terms with the first set searched in the title and the second set with synonyms for bovine search in the title or abstract. For example, we searched for anything relevant to dairy cattle, other non-human mammals (including ruminants), transmission associated with dairy products, and risk to livestock. Lastly, on 8 July 2024 we updated our original search of MedRxiv and BioRxiv (from 1 January 2024 to 13 May 2024) for pre-print articles by combining (avian influenza OR H5N1 OR AH5N1) in the advanced search with individual searches for each of the following: "bovine," "cattle," "dairy cattle," "cow," and "ruminant." In addition, in previous versions, we reviewed literature compiled from searches that were last conducted by the Public Health Agency of Canada (PHAC) on 13 December 2023. This included reviewing results from searches run by PHAC from 1 October 2022 up to the last search that was run on 13 December 2023.

Each source for these documents is assigned to one team member who conducts hand searches (when a source contains a smaller number of documents) or keyword searches to identify potentially relevant documents. A final

inclusion assessment is performed both by the person who did the initial screening and the lead author of the LEP, with disagreements resolved by consensus or with the input of a third reviewer on the team. The team uses a dedicated virtual channel to discuss and iteratively refine inclusion/exclusion criteria throughout the process, which provides a running list of considerations that all members can consult during the first stages of assessment.

During this process we include published, pre-print, and grey literature. We do not exclude documents based on the language of a document. However, we are not able to extract key findings from documents that are written in languages other than Chinese, English, French, Portuguese, or Spanish. We provide any documents that do not have content available in these languages in an appendix containing documents excluded at the final stages of reviewing. We excluded documents that did not directly address the research questions and the relevant organizing framework.

Assessing relevance and quality of evidence

We assess the relevance of each included evidence document as being of high, moderate, or low relevance to the question.

Two reviewers independently appraised the quality of the guidelines we identified as being highly relevant using AGREE II. We used three domains in the tool (stakeholder involvement, rigour of development, and editorial independence) and classified guidelines as high quality if they were scored as 60% or higher across each of these domains.

Two reviewers independently appraise the methodological quality of evidence syntheses that are deemed to be highly relevant using the first version of the AMSTAR tool. Two reviewers independently appraise each synthesis, and disagreements are resolved by consensus with a third reviewer if needed. AMSTAR rates overall methodological quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. High-quality evidence syntheses are those with scores of eight or higher out of a possible 11, medium-quality evidence syntheses are those with scores between four and seven, and low-quality evidence syntheses are those with scores less than four. It is important to note that the AMSTAR tool was developed to assess evidence syntheses focused on clinical interventions, so not all criteria apply to those pertaining to health-system arrangements or implementation strategies. Furthermore, we apply the AMSTAR criteria to evidence syntheses addressing all types of questions, not just those addressing questions about effectiveness, and some of these evidence syntheses addressing other types of questions are syntheses of qualitative studies. While AMSTAR does not account for some of the key attributes of syntheses of qualitative studies, such as whether and how citizens and subject-matter experts were involved, researchers' competency, and how reflexivity was approached, it remains the best general quality-assessment tool of which we're aware. Where the denominator is not 11, an aspect of the tool was considered not relevant by the raters. In comparing ratings, it is therefore important to keep both parts of the score (i.e., the numerator and denominator) in mind. For example, an evidence synthesis that scores 8/8 is generally of comparable quality to another scoring 11/11; both ratings are considered 'high scores.' A high score signals that readers of the evidence synthesis can have a high level of confidence in its findings. A low score, on the other hand, does not mean that the evidence synthesis should be discarded, merely that less confidence can be placed in its findings and that it needs to be examined closely to identify its limitations. (Lewin S, Oxman AD, Lavis JN, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP): 8. Deciding how much confidence to place in a systematic review. *Health Research Policy and Systems* 2009; 7(Suppl1): S8.)

Identifying experiences from other countries

We hand searched government and stakeholder websites of other select countries (Australia, Brazil, Cambodia, China, France, Japan, New Zealand, Singapore, United Kingdom, and United States), international organizations (World Health Organization, Pan American Health Organization, World Organization for Animal Health, European Centre for Disease Prevention and Control, and Food and Agriculture Organization), and Canadian provinces and territories to identify any publicly available information published since our original jurisdictional

scan for information published between 1 February and 13 May 2024. For this update, all jurisdictional scans were completed by 15 July 2024. While we do not exclude content based on language, where information is not available in English, Chinese, French, Portuguese, or Spanish, we attempt to use site-specific translation functions or Google Translate. A full list of sources is included in Appendix 6.

Preparing the profile

Each included document is cited in the reference list at the end of the LEP. For all included guidelines, evidence syntheses, and single studies (when included), we prepare a small number of bullet points that provide a summary of the key findings, which are used to summarize key messages in the text. Protocols and titles/questions have their titles hyperlinked, given that findings are not yet available.

We then draft a summary that highlights the key findings from all highly relevant documents (alongside their date of last search and methodological quality). In this LEP, we drafted the summary based on all evidence syntheses identified given the limited number included.

Upon completion, the LEP is sent to the subject matter expert for their review.

Appendix 2: Detailed findings from evidence synthesis sorted by relevance

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations
Evidence syntheses from LEP 8.3							

• Public health strategies
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Vaccinations (in animals)
• Outcomes
  ○ Reduction in risk of exposure
  ○ Zoonotic infections
	Highly pathogenic avian influenza vaccines (including inactivated and recombinant types) showed efficacy rates ranging from 78% to 97% against mortality in poultry, with inactivated vaccines demonstrating higher effectiveness against homologous strains compared to heterologous strains (1)	Medium	No	6/11 (rating by McMaster Health Forum)	2023	Yes	None identified

Evidence syntheses from LEP 8.2							

• Public health strategies
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Antiviral medications
	Previous evidence demonstrated that convalescent plasma (CP) was a successful immunotherapy treatment against avian influenza (H5N1) in 2006, with treatment given prior to infection being more efficacious than treatment after infection; however, because of concerns about infectivity of potential CP donors and the lack of historical studies on H5N1 virus isolation from CP, it is likely that efforts to use CP in treatment will be limited by a lack of pathogen reduction technologies (2)	Medium	N/A	N/A	March 2023	N/A	None identified

Evidence syntheses from LEP 8.1							

• Public health strategies
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Vaccinations (in humans)
	Individuals who have received seasonal influenza vaccine (SIV) within the past season or two may have reduced immune responses to H5N1 influenza A vaccination, but additional research is needed to understand the factors contributing to these diminished immune responses (3)	High	No	3/11 (rating by McMaster Health Forum)	2012	No	None identified

• Public health strategies
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Vaccinations (in humans)
• Priority populations
	Two doses of 7.5µg of oil-in-water emulsion-adjuvanted H5N1 vaccine induced a robust antibody response and was well-tolerated among older adults (61 years and older) (4)
	• Inactivated virus vaccines were used in the 10 identified studies, which elicited an antibody
		High	No	6/11 (rating by McMaster Health Forum)	31 January 2020	No	None identified

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations
○ Other equity considerations	response among older adults (61 years and older) after two immunizations of H5N1 vaccines (ranging between 33–88%). • Two doses resulted in a higher antibody response than one dose. ○ The 7.5µg and 15 µg of MF59-adjuvaned vaccines and all doses of AS03-adjuvanted vaccines induced robust antibody responses among older adults. ○ Adverse reactions were mild and self-limiting.						
• Public health strategies ○ Non-pharmaceutical public health strategies to prevent infection ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices)	Live poultry market interventions (e.g., closures, physical separation of poultry from different sources) decreased incidence of avian influenza viruses (including H5 strains) and detection rates; however, the small sample size increased the risk of bias especially in retail or wholesale poultry samples (5) • Live poultry market interventions included quarantine access systems, physically separating poultry from different sources, disinfection and decontamination, daily cleaning, rest days, and live poultry market closures. • Closures were found to have the highest effect among avian influenza viruses generally. • Particular to H5 influenza strain, there were lower detection rates of avian influenza virus after live poultry market interventions, but it was not statistically significant.	High	No	7/11 (rating by McMaster Health Forum)	9 November 2018	No	None identified
• Public health strategies ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in humans)	The authors from the Andalusian Agency for Health Technology Assessment reported that an inactivated split-virion formulation of the pre-pandemic A(H5N1) influenza vaccines that includes a low antigen dose and an oil-in-water emulsion-based adjuvant had a favourable safety profile and immunogenicity (6) • The authors reported that the vaccine was clinically acceptable.	High	No	5/9 (rating by McMaster Health Forum)	2009	No	None identified

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations
	• The authors indicated that an internationally accepted anti-H5 clade 1 antiserum standard is needed and a priority.						

• Public health strategies
  ○ Information and education provision
  ○ Non-pharmaceutical public health strategies to prevent infection
  ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices)
  ○ Non-pharmaceutical measures public health strategies to control the spread of infections
  ▪ Case and contact management
  ▪ Isolation and quarantine
  ▪ Border-control measures
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Vaccinations (in animals)
  ▪ Vaccinations (in humans)
  ▪ Antiviral medications
  ○ Surveillance and reporting
• Priority populations
  ○ Groups at higher risk of exposure
  ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers
  ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons)
	Collaboration between private and public sectors to facilitate data access is needed to better understand animal, human, and fomite movements within commercial poultry production and trade networks to help inform policy to mitigate global spread of avian influenza (7)
	• Limited access to production and trade data for public researchers presents a crucial barrier to informing surveillance and control strategies.
		Medium	No	4/9 (rating by McMaster Health Forum)	2019	No	None identified

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations
▪ Working or visiting live bird or mammal markets • Outcomes o Zoonotic infections							
• Public health strategies o Information and education provision o Non-pharmaceutical public health strategies to prevent infection ▪ Using protective equipment (e.g., masks, gloves) ▪ Washing hands • Priority populations o Groups at higher risk of exposure ▪ Working in healthcare settings and other contacts of cases (if human-to-human transmission starts) • Outcomes o Human-to-human infections	Front-line healthcare workers, particularly those involved in endotracheal intubations, face an increased risk of infection during respiratory pandemics, but protective measures such as gloves, gowns, surgical masks, N95 respirators, face protection, and infection training significantly reduces the risk of infection (8) • The delivery of adequate infection training faces barriers such as constantly changing guidelines, poor communication and enforcement of guidelines, and increased workload and fatigue of healthcare workers.	Low	No	8/11 (rating by McMaster Health Forum)	2020	Yes	None identified
• Public health strategies o Information and education provision	One study in the systematic review focused on H5N1 and the use of educational programs (e.g., lectures, educational songs, interactive quiz, and use of leaflets and posters) and reported some increase in awareness of H5N1 and to seek early access to healthcare (9)	Low	No	8/11 (rating by McMaster Health Forum)	2011	No	None identified
• Public health strategies o Non-pharmaceutical public health strategies to prevent infection ▪ Using protective equipment (e.g., masks, gloves) ▪ Physical distancing o Non-pharmaceutical measures public health strategies to control the spread of infections ▪ Case and contact management	A systematic review of the costs and benefits of interventions aimed at major infectious disease threats (largely focusing on H1N1) revealed that vaccinations and school closures were the most commonly studied interventions, along with other physical distancing strategies (10) • A more standardized and comprehensive approach to economic evaluations of interventions is needed. • Current research focuses largely on high-income countries and pharmaceutical interventions.	Low	No	4/9 (rating by McMaster Health Forum)	2018	No	None identified

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations
▪ Isolation and quarantine ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in humans) ▪ Antiviral medications ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working in healthcare settings and other contacts of cases (if human-to-human transmission starts)							
• Public health strategies ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in humans)	Adjuvanted H7N9 vaccines for humans were found to be immunogenic and safe in healthy individuals (11)	High	No	7/11	2017	No	None identified
• Public health strategies ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in animals)	While vaccines were efficacious to protect chickens from morbidity and mortality, virus shedding may be a biosecurity issue for future avian influenza outbreaks (12) • A meta-analysis was conducted on studies that focused on both inactivated and recombinant fowlpox virus expressing H5 vaccines to determine outcomes for H5N1 and H5N2 avian influenza viruses among chickens.	High	No	5/11	2010	No	None identified
• Public health strategies ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in animals)	Among chickens, recombinant herpesvirus of turkeys (rHVT) and inactivated replicating viral-vectors offer advantages to induce broader immunity as they are more tolerant of variation in the hemagglutinin 1 domain (HA1) (13) • A vaccine-induced antibody titres to the challenge virus of (VIAC) of ≥16 should be the minimum titre that may be sufficient for survival and reduction of virus shed in field studies.	High	No	5/11	25 May 2022	No	None identified

Appendix 3: Detailed findings from other documents organized sorted by relevance

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristics	Equity considerations

• Public health strategies
  ○ Non-pharmaceutical measures to prevent infection
  ▪ Following safe food handling procedures and recommended cooking temperatures
	Researchers assessing the effectiveness of Food and Drug Administration (FDA) approved continuous flow pasteurization methods (72°C for 15 seconds) concluded that these measures inactivated the infectious virus in raw milk (14)
	• The aim of this study was to determine the quantities of infectious highly pathogenic avian influenza (HPAI) virus in raw milk in affected US states where the U.S. Department of Agriculture (USDA) confirmed positive herds and to confirm that FDA-approved continuous flow pasteurization methods (72°C for 15 seconds) will inactivate the virus.
	• The researchers concluded that estimates from heat transfer analysis support the FDA-approved pasteurization measures and that the milk supply was safe.
		High	*Jurisdiction studied:* United States
			
			Publication date: 3 July 2024
			
			Methods used: Case study (pre-print)
				None reported

• Public health strategies
  ○ Information and education provision
  ○ Non-pharmaceutical measures to prevent infection
  ▪ Following safe food handling procedures and recommended cooking temperatures
• Outcomes
  ○ Reduction in risk of exposure
	The current risk for humans becoming infected with avian influenza from a cooked beef patty (20% fat) is negligible (15)
	• The objective of this study was to determine if cooking, including the USDA Food Safety and Inspection Service (FSIS) minimum internal temperature of 71.1°C, will eliminate avian influenza virus from inoculated (80 lean:20 fat) ground beef.
	• Cooking patties on a gas grill to 62.8°C (average cooking time of about 21 minutes) or to the USDA FSIS recommended minimum internal temperature for ground beef of 71.1°C (average cooking time of about 24 minutes) resulted in a reduction to non-detectable levels.
	• Meal preparers can also contribute to risk reduction by using a thermometer properly to ensure that the necessary internal temperature of cooked beef products is reached and maintained for the required holding times, if applicable.
		High	*Jurisdiction studied:* United States
			
			Publication date: 2 July 2024
			
			Methods used: Experimental study
				None identified

• Public health strategies
  ○ Non-pharmaceutical measures to prevent infection
  ▪ Following safe food handling procedures and recommended cooking temperatures
  ○ Surveillance and reporting
	Pasteurization of raw dairy products was found to be effective at inactivating the A(H5N1) virus due to the virus's moderate thermal stability (16)	High	*Jurisdiction studied:* United States
			
			Publication date: 2 June 2024
			
			Methods used: Quantitative study
				None identified

• Public health strategies ○ Non-pharmaceutical measures to prevent infection	Industry standard pasteurization can effectively inactivate the A(H5N1) virus in American dairy cattle; unpasteurized milk has the potential to carry infectious influenza viruses (17)	High	*Jurisdiction studied:* United States	None identified

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristics	Equity considerations
▪ Following safe food handling procedures and recommended cooking temperatures • Priority populations o Groups at higher risk of exposure ▪ Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)	• The method of low-temperature long time (LTLT) heating of 62.5°C for 30 minutes, and high-temperature short time (HTST) heating of 72°C for 15 seconds can effectively inactivate the virus.		*Publication date:* 31 May 2024 *Methods used:* Quantitative study (pre-print)	
• Public health strategies o Non-pharmaceutical measures to prevent infection ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Following safe food handling procedures and recommended cooking temperatures • Priority populations o Groups at higher risk of exposure ▪ Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)	The A(H5N1) influenza virus remains infectious on milking equipment surfaces and presents a transmission risk for dairy cow farm workers (18) • The A(H5N1) cattle virus remained infectious in unpasteurised milk on the stainless steel and inflation lining rubber over a duration of one hour.	High	*Jurisdiction studied:* United States *Publication date:* 22 May 2024 *Methods used:* Quantitative study (pre-print)	None identified
• Public health strategies o Surveillance and monitoring	Surveillance systems in urban areas to monitor the spread of the clade 2.3.4.4b H5N1 virus, where there is significant animal-human interaction, are essential (19) • Whole-genome sequencing of samples from four different bird species in New York City were performed; multiple genotypes of H5N1 viruses were detected. • Surveillance systems at the animal-human interface are lacking despite high density populations of humans and pets in urban areas. • Birds that have been infected with A(H5N1) have been found to be present in urban areas, indicating the need for monitoring in these areas.	High	*Jurisdiction studied:* United States *Publication date:* 15 May 2024 *Methods used:* Surveillance study	None identified
• Public health strategies o Surveillance and reporting	Wastewater treatment works can be used to monitor avian and human influenza A viruses (20) • Assays from six wastewater treatment works across Northern Ireland were collected between August to December 2022. • A variety of influenza virus subtypes and lineages were detected, including avian and human influenza A virus strains (i.e.,	High	*Jurisdiction studied:* Ireland *Publication date:* 13 August 2023 *Methods used:* Cross-sectional study (pre-print)	None reported

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristics	Equity considerations
	including avian segment 8 that was found in recent H5N1 clade 2.3.4.4b), demonstrating the utility of wastewater treatment works monitoring for avian influenza virus surveillance. • There was a low correlation across the population, which may be because of small sample size or dynamic avian viruses.			

• Public health strategies
  ○ Non-pharmaceutical measures to prevent infection
  ▪ Following safe food handling procedures and recommended cooking temperatures
  ○ Surveillance and reporting
	While viral A(H5Nx) RNA has been discovered in some retail dairy products in the U.S., infectious A(H5Nx) virus has not been found in these products as of July 2024 (21)
	• Dairy cattle which have been infected with and show clinical symptoms of clade 2.3.4.4b A(H5N1) produce less milk, therefore, there is a reduced amount of milk from infected cows in the food supply.
	• Pasteurization contributes to the inactivation of the A(H5N1) virus in milk products from dairy cattle.
		Medium	*Jurisdiction studied:* United States
			
			Publication date: 3 July 2024
			
			Methods used: Quantitative study
				None identified

• Public health strategies
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Vaccinations (in animals)
  ▪ Vaccinations (in humans)
	Additional research to develop HPAI vaccines is needed to address ongoing health (22)
	• This study explored gaps in the HPAI vaccine development during 2010–2021.
	• A total of 40 patents for vaccines were identified, with only 18 active.
	• Universal influenzas vaccines may be the most valuable, but all 20 identified patents were in early testing stages.
	• All vaccines were in early testing phases with some limitations noted:
	  ○ egg-based processes are too challenging to scale up
	  ○ mRNA technology has limited level of protection
	  ○ vaccines at the animal level is insufficient, as the virus can be mutated to humans.
		Medium	*Jurisdiction studied:* United States
			
			Publication date: 4 June 2023
			
			Methods used: Patent landscape approach (pre-print)
				None reported

• Public health strategies
  ○ Non-pharmaceutical measures to control the spread of infections
  ▪ Case and contact management
• Priority human populations
  ○ Groups at higher risk of exposure
  ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers
• Outcomes
  ○ Reduction in risk of exposure
  ○ Zootonic infections
	Seasonal, temporary, and permanent live poultry market closures are all effective in reducing human transmission of A(H7N9) avian influenza (23)
	• This study collected data from existing cases in Guangdong province between October 2013 to June 2017.
	• A total of 258 A(H7N9) cases were identified.
	• Interventions to prevent transmission included:
	  ○ live poultry market closures are the most effective interventions
	  ○ temporary closures are most effective in the months of December to February, with an estimated 70% reduction in human cases.
		Medium	*Jurisdiction studied:* Guangdong
			
			Publication date: 9 November 2020
			
			Methods used: Model-based assessment
				None reported

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristics	Equity considerations
• Public health strategies ○ Surveillance and monitoring	Detection of novel influenza viruses through community and healthcare testing: Implications for surveillance efforts in the United States (24) • Study estimates suggest that novel influenza virus cases are likely to be detected using the existing healthcare surveillance strategies in the U.S. for community and healthcare settings, with the efficiency of the testing setting being directly impacted by the severity of disease in the setting. • A probabilistic framework was used to estimate the likelihood that cases of novel influenza virus would be detected through testing approaches in different healthcare and community settings during low frequencies of viral occurrence in the U.S.	High	*Jurisdiction studied:* United States *Publication date:* 16 May 2024 *Methods used:* Quantitative study (pre-print)	None identified
• Public health strategies ○ Surveillance and monitoring	Detection of hemagglutinin H5 influenza A virus sequence in municipal wastewater solids at wastewater treatment plants with increases in influenza A in spring 2024 (25) • Influenza A (IAV) RNA wastewater monitoring proved to be valuable after an increase in IAV RNA concentrations was identified in 59 plants in the spring of 2024 when avian influenza A(H5N1) was identified in U.S. dairy cattle. • Researchers developed an RT-PCR assay for the H5 marker and detected the H5 gene in samples from all three of the plants that were tested; at two of these plants, discharges from animal waste and milk by-products were permitted to discharge into the sewer system.	High	*Jurisdiction studied:* United States *Publication date:* 20 May 2024 *Methods used:* Quantitative study (previously a pre-print in LEP 8.2)	None identified

• Public health strategies
  ○ Pharmaceutical measures used as part of public health strategies
  ▪ Vaccinations (in humans)
	Sustained vaccine exposure elicits more rapid, consistent, and broad humoral immune responses to multivalent influenza vaccines (26)
	• Delivery of multivalent influenza vaccines from self-assembled, injectable polymer-nanoparticle (PNP) hydrogels induced consistent, rapid, and potent humoral immune responses against both heterologous and homologous virus subtypes, including A(H5N1).
		High	*Jurisdiction studied:* United States
			
			Publication date: 30 April 2024
			
			Methods used: Experimental study (pre-print)
				None identified

• Public health strategies ○ Surveillance and monitoring	Virome sequencing identifies H5N1 avian influenza in wastewater from nine cities (27) • Using an agnostic, hybrid-capture sequencing approach, avian influenza subtype A(H5N1) was detected in wastewater in nine Texas cities with a population in the millions between 4 March and 25 April 2024. • The best sequencing reads aligned to clade 2.3.4.4b but covered all eight genome segments of A(H5N1).	High	*Jurisdiction studied:* United States *Publication date:* 10 May 2024 *Methods used:* Pre-print	None identified

Appendix 4: Detailed jurisdictional scan about what is known about public health strategies that contribute to preventing, reducing, and mitigating the risk of avian influenza spillover into humans in other countries

Jurisdiction	Dimension of the organizing framework	Key findings

Pan-Organizations	• Public health strategies
	  ○ Information and education provision
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ▪ Using personal protective equipment (e.g., masks, gloves)
	  ▪ Washing hands
	  ▪ Physical distancing
	  ▪ Following safe food handling procedures and recommended cooking temperatures
	  ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices)
	  ○ Non-pharmaceutical measures to control the spread of infections
	  ▪ Case and contact management
	  ▪ Isolation and quarantine
	  ▪ Border-control measures
	  ○ Pharmaceutical measures used as part of public health strategies
	  ▪ Vaccinations (in animals)
	  ▪ Vaccinations (in humans)
	  ▪ Antiviral medications
	  ○ Surveillance and reporting
	• Priority populations
	  ○ Groups at higher risk of exposure
		• The Pan American Health Organization (PAHO) released a public health risk assessment of the spread of avian influenza A(H5N1) clade 2.3.4.4b on 12 July 2024, indicating that the overall risk to the public is low.
		  ○ PAHO recommends that member states should enhance their event-based surveillance, notifiable disease surveillance systems, and laboratory capacity in human and animals for genomic surveillance, and assure availability of personal protective equipment for those exposed to animals that may be infected
		• In two reports from 8 July 2024 and 20 June 2024, the European Centre for Disease Prevention and Control (ECDC) recommended lowering the threshold for testing for avian influenza in humans, such as using a risk-based approach for exposed asymptomatic individuals, asking people admitted to hospitals for respiratory symptoms on whether they were exposed to birds or other animals in the two weeks before symptoms, testing for avian influenza among individuals hospitalized for influenza, and educating primary care clinicians on symptoms compatible with avian influenza infections.
		  ○ They also recommend biosafety and personal protective measures at occupational and recreational sites with increased risk of avian influenza.
		  ○ ECDC have strengthened support for EU countries to continue laboratory activities on zoonotic avian influenza, including preparedness and testing.
		• The World Organisation for Animal Health (WOAH) released two situation reports since 3 May 2024, with the latest covering 5 to 21 June 2024.
		  ○ The organization recommends continued surveillance (especially among species that are unusual hosts) and to implement biosecurity and preventive measures at farms in both poultry and non-poultry species.
		  ○ They also recommended continued protection for humans in close contact with or handling sick cattle or other livestock, and avoiding unjustifiable trade restrictions.
		• PAHO released an epidemiological update of A(H5N1) on 5 June 2024, where they encourage member states to continue implementing surveillance protocols (e.g., detection, notification, rapid response), review their pandemic influenza preparedness and readiness plans, and collaboratively share results from epidemiological and virological investigations (e.g., share genetic information about viruses)
		  ○ The update also provides specific guidance on sample collection in humans with nasopharyngeal swabbing as the optimal collection method, but a combined nasal and pharyngeal swab may be collected.
		  ○ Additional details about sample flow, laboratory testing algorithm, shipment of samples, case investigation, and notification of a human case are provided in the updated report.
		• The World Health Organization (WHO) Global Influenza Surveillance and Response System (GISRS) in collaboration with Food and Agriculture Organization (FAO) and WOAH maintain a database of candidate vaccines (including regular genetic and antigenic characterization of contemporary zoonotic influenza viruses).

Jurisdiction	Dimension of the organizing framework	Key findings
		○ They last updated a list of candidate vaccine viruses and potency testing reagents on 23 May 2024. ○ The WOAH released four situation reports since 1 February 2024, with the most recent update from 3 May 2024 with key recommendations. ▪ Enhanced avian influenza surveillance in domestic and wild birds are recommended. ▪ Highly pathogenic avian influenza (HPAI) should be treated a differential diagnosis in non-avian species including cattle and other livestock (particularly those showing clinical signs, sick or dead domestic animals near affected areas, and suspected animals who may have been exposed to suspected or confirmed cases in birds and cattle). ▪ Cases should be reported to WOAH through the World Animal Health Information System and genetic sequences should be shared in publicly available databases. ▪ Poultry vaccination and strict biosecurity measures in livestock holdings (especially in milking parlours) should be considered as core measures of any avian influenza control strategy. ▪ Hand hygiene and other measures should be implemented for those in close contact with or handling sick cattle or livestock and their products (e.g., wearing personal protective equipment, avoiding visits to other livestock premises after exposure, implementing food safety measures). ▪ Import risk management should be scientifically justified. ▪ Raw milk or raw milk products from infected or exposed cows should not be used to feed animals or for human consumption. • The latest WHO Influenza at the Human-Animal Interface report summarized findings from member states on new human infections, circulation of influenza viruses in animals, and the overall public health risk from known influenza viruses between 4 May to 7 June 2024. ○ All human infections caused by a subtype must be reported under the International Health Regulations. • The WHO provided key recommendations and actions steps for member states as of 23 April 2024. ○ Personal protective equipment, hand hygiene, and other risk-based biosecurity measures will reduce exposure to the virus. ○ Countries should continue to maintain surveillance and report cases of HPAI in all animal species. ○ National Influenza Centres and other influenza laboratories are being asked to remain vigilant and to ensure risk assessments are made for those who are occupationally exposed. ○ Clinicians are encouraged to be aware of potential zoonotic infection and to follow-up with suspected and confirmed human cases. ○ Rapid sharing of information and sequence data from both human and animal sectors are strongly recommended. ○ If humans develop respiratory symptoms or conjunctivitis, they should be rapidly sampled and conduct precautionary infection control measures. ○ The FAO and WHO strongly advise the consumption of only pasteurized milk and to avoid the consumption of raw milk. ○ All member states under the International Health Regulations are required to notify WHO immediately of any laboratory-confirmed case of a recent human infection. • The WHO, FAO, and WOAH are currently monitoring the situation, and have prioritized the development of specific reagents and antigenic characterization at the WHO Collaborating Centres and the Essential Regulatory Laboratories of GISRS.

Jurisdiction	Dimension of the organizing framework	Key findings

		• There have been two updates to the WHO Influenza at the human-animal interface since 1 February 2024, one reported for 22 December 2023 to 26 February 2024 and the other from 27 February to 28 March 2024.
		  ○ The WHO does not advise any traveller screening but asked the public to avoid contact with animals that are sick or dead for unknown causes, farms, contact with animals in live animal markets, entering areas where animals are being slaughtered, or contact with any animal excreta.
		  ○ Eggs, poultry meat, and other poultry food should be cooked and properly handled.
		  ○ Enhanced surveillance should occur for areas with known outbreaks such as community-based approaches, active screening in hospitals especially among those with higher risk, and inclusion of health professionals such as traditional healers and private entities.
		  ○ The epidemiological update of A(H5N1) on 20 March 2024 provided guidance to member states including intersectoral collaboration, risk communication and community engagement, surveillance in humans, and use of seasonal influenza vaccination for those at risk of infection with H5 viruses (e.g., people in close contact with animals including poultry, areas where avian influenza is circulating, workers in poultry industry, veterinary service personnel, those in contact with wild birds), laboratory diagnosing in humans and animals and genomic sequencing and surveillance.
		  ○ Human H5 vaccines are not recommended at this time due to the low risk.
		• The ECDC released a scientific report on the drivers for a pandemic due to avian influenza and options for One Health mitigation strategies on 14 March 2024.

Australia	• Public health strategies
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ○ Non-pharmaceutical measures to control the spread of infections
	  ▪ Case and contact management
		• The Wildlife Health Australia provides a fact sheet (last updated June 2024) to the public about etiology, One Health implications, epidemiology, clinical signs, diagnosis, treatment, prevention, control, and surveillance and management of avian influenza.
		  ○ Australia's public health strategies for avian influenza include comprehensive biosecurity practices, extensive surveillance, cross-sector coordination, risk-based measures, selective carcass management, targeted vaccination, and specialized poultry farm protocols.
		• The Australia National Wildlife Biosecurity Guidelines (2018) recommend practicing good baseline biosecurity in all situations involving wild animals to minimize risks to wild birds and mammals from people and other sources.
		• Australian Centre for Disease Control recommends public health strategies for avian influenza, including annual seasonal flu vaccination recommendations, maintaining a strategic stockpile of pandemic vaccines and antivirals, providing travel advice, and offering guidelines for handling poultry and reporting illnesses after travel; last updated on 17 June 2024.

Brazil	• Public health strategies
	  ○ Information and education provision
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ▪ Using personal protective equipment (e.g., masks, gloves)
		• The Brazilian Ministry of Agriculture and Livestock declared an animal health emergency for 180 days on 22 May 2023, and subsequently extended it for another 180 days after 139 outbreaks were identified.
		  ○ Only three of these outbreaks occurred in subsistence birds.
		  ○ However, Brazil maintained its status as H5N1-free since no cases were identified in commercial birds.
		• The Brazilian Ministry of Health reports that although rare, transmission of the virus from birds to humans can occur through exposure to infected birds or inhalation of particles contaminated with their excretions.

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Washing hands ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks • Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons)	○ The spread of person-to-person transmission can occur through prolonged and unprotected close contact but is generally inefficient and rarely reported. ○ They also provide information to the public about diagnosis, treatment, prevention and control, and a guide for monitoring the avian influenza in humans. • The Ministry of Agriculture and Livestock provides a guide to help prevent avian influenza, including guidance for good farming practices, safe handling practices, and measures to prevent poultry from encountering foreign birds. • The Ministry of Agriculture and Livestock monitors and records outbreaks of Avian Influenza, with the total number of recorded outbreaks reaching 161.
Cambodia	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands • Surveillance and reporting	• In January 2024, the Cambodian Ministry of Health (MOH) announced on its Facebook page that they detected the first influenza A(H5N1) human infection of 2024 and were working with the Ministry of Environment and Ministry of Agriculture, Forestry and Fisheries to search for sources of transmission in both humans and animals and educate the people in Ta Bruy village where the case was detected. ○ The MOH also informed the public about how avian influenza is transmitted, what the symptoms of bird flu are, and advised them of what to do if they or someone they had been in contact with became sick. ○ Preventive measures were also advised, including handwashing after bird contact and avoiding eating birds. • The Cambodian government used their Facebook page, telegram channel and website to communicate with the public, and provided similar advice when press releases were issue about subsequent A(H5N1) cases. • The U.S. Centers for Disease Control and Prevention (CDC) is working with the Cambodian government, the Wildlife Conservation Society of Cambodia and the WHO in a One Health approach to respond to these human infections of avian influenza
China	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands	• On 15 July 2021, the National Health Commission of the People's Republic of China issued the Technical Guidelines for the Prevention and Control of Human Infection with Zoonotic Influenza (Trial) providing technical guidance on key aspects of outbreak management, including case discovery, reporting, diagnosis, management, epidemiological investigation, management of exposures and contacts, specimen collection, laboratory testing, infection control, risk assessment, information dissemination, and health education. • On 7 May 2020, China's Ministry of Agriculture and Rural Affairs issued the Emergency Implementation Plan for Highly Pathogenic Avian Influenza Epidemics (2020 Edition), which outlines protocols for epidemic reporting, confirmation, response, emergency handling, information dissemination, and aftercare. The plan also includes appendices detailing technical specifications for the diagnosis of highly pathogenic avian influenza and personnel protection. ○ Response personnel and poultry breeders should report any health abnormalities promptly.

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ○ Pharmaceutical measures used as part of public health strategies ▪ Antiviral medications ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks • Other equity considerations	○ Individuals with low immune function, those over 60, and those with chronic heart and lung diseases should avoid participating in epidemic response activities involving poultry. • The Health Commission of Guangdong Province advised the following preventive measures against H5N6 and other avian influenza: frequently wash hands; ensure poultry and eggs are fully cooked before consumption; seek medical treatment promptly for respiratory symptoms and inform doctors of any bird contact; and avoid consuming dead poultry, purchasing poultry from unknown sources, and visiting live poultry markets if possible.
France	• Public health strategies ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Physical distancing ▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management	• The Ministry of Agriculture and Food Sovereignty launched a national vaccination campaign against the avian influenza in October 2023, including mandatory vaccination for the duck production sector (except breeders). ○ As the first innovative avian influenza vaccination campaign across Europe (and France being the first major poultry exporting country in the world to do so), vaccinations focused on targeting farmed ducks in specific regions. ○ France employed complementary preventive measures including biosecurity, sheltering animals, and surveillance. ○ As of 28 June 2024, a total of 41,631,784 ducks have been vaccinated. ○ The vaccination plan is available on the Ministry's webpage. ○ The State is covering an estimate 85% of vaccination related expenses, with professionals financing the remaining 15%. ○ The Boehringer Ingelheim and Ceva Santé Animal laboratories will provide a total of 61 million additional vaccine doses to fulfil the needs for the duration of the 2023–2024 campaign. ○ An epidemiological assessment and feedback will be conducted based on the 2023–2024 campaign and will help to guide the 2024–2025 campaign's efforts. • As of 16 January 2024, no new outbreaks in livestock have been detected, with only 10 outbreaks confirmed in farmed birds for the 2023–2024 season (as compared to 402 from the previous time frame last season).

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Isolation and quarantine ▪ Border-control measures ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in animals) ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons) • Outcomes • Reduction in risk of exposure	• The French Agency for Food, Environmental and Occupational Health and Safety (ANSES) is committed to combating the spread against the disease by coordinating the diagnosis of avian influenza in animals and conducting research to improve virus detection. ○ ANSES's Ploufragan-Plouzané-Niort Laboratory is the National Reference Laboratory for avian influenza testing and diagnosis; standardized samples are sent to veterinary laboratories for RT-PCR testing with the Reference Library confirming any positive results. ○ In May 2022, ANSES partnered with the Ministry of Agriculture to engage in a pilot study/trial to assess the value of vaccinating ducks against the avian influenza and will inform the action plan for the region. • Management measures for avian influenza outbreaks include depopulating households, cleaning and disinfecting sites, increased surveillance, reinforced biosecurity, and prohibiting poultry movement.
Japan	• Public health strategies ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producer), including seasonal/migrant workers	• On 5 January 2024, the Ministry of Agriculture, Forestry and Fisheries of Japan announced that Central Japan culled 50,000 birds after the confirmation of an avian influenza outbreak. • On 12 February 2024, local authorities announced that 14,000 birds were culled in the southern Japanese prefecture of Kagoshima following an avian influenza outbreak in a poultry farm. • An additional 363,000 chickens and quails being raised at 15 farms within 3–10 km form the affected area were imposed with movement restrictions.
New Zealand	• Public health strategies ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in animals) ▪ Vaccinations (in humans) ▪ Antiviral medications ○ Surveillance and reporting	• Health New Zealand Te Whatu Ora offers a control manual for Highly Pathogenic Avian Influenza and supports public health professionals in the prevention and management of this disease (last updated: 19 April 2024). ○ Strong biosecurity and quarantine practices are recommended to control the disease. • Vaccination may help prevent species extinction, particularly in captive breeding populations (accessed 11 July 2024). • A controlled trial of the Poulvac Flufend RG vaccine for five endangered native bird species has been approved in New Zealand. ○ Vaccination requires two injections under the skin, one month apart. • It was recently recommended that Aotearoa New Zealand review and enhance their pandemic preparedness in light of the emergence of H5N1 cases in other countries by reviewing systems to ensure the timely support of testing, vaccinations, infection prevention and control of avian influenza and strengthening the One Health approaches to reduce the risks of influenza emergence (last updated: 15 May 2024).

Jurisdiction	Dimension of the organizing framework	Key findings

Singapore	• Public health strategies
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ▪ Using personal protective equipment (e.g., masks, gloves)
	  ▪ Washing hands
	  ▪ Physical distancing
	  ▪ Following safe food handling procedures and recommended cooking temperatures
	  ○ Non-pharmaceutical measures to control the spread of infections
	  ▪ Border-control measures
	  ○ Pharmaceutical measures used as part of public health strategies
	  ▪ Vaccinations (in humans)
	  ▪ Antiviral medications
	  ○ Surveillance and reporting
		• The Ministry of Health of Singapore has issued guidelines for protecting against bird flu, recommending precautions such as avoiding visits to poultry farms and live bird markets, avoiding contact with wild and live birds, avoiding raw or undercooked poultry and eggs, and practicing good personal and environmental hygiene.
		  ○ If a bird flu infection is suspected, inform a doctor of any contact with birds or recent travel to affected areas, wear a surgical mask, avoid public transportation, and refrain from travelling until medically cleared.
		• The Ministry of Health of Singapore reports that treatment for human infection with the bird flu virus varies based on symptoms; if detected early, Tamiflu (oseltamivir) along with symptomatic treatment is recommended, and may also be provided to exposed family members as prophylaxis, although there is currently no vaccine for bird flu available for humans, and seasonal influenza vaccines do not offer protection against it.
		  ○ Recent A(H5N1) viruses are susceptible to oseltamivir but there are reports of resistance to the M2 inhibitors (amantadine and rimantadine).
		• The Animal & Veterinary Service (AVS) requires countries exporting poultry, poultry products, and eggs to Singapore to be free from highly pathogenic avian influenza (HPAI) and H5/H7 low pathogenicity avian influenza (LPAI); it also monitors outbreaks of bird flu worldwide and takes measures to suspend sources that have outbreaks of bird flu.
		  ○ The National Parks Board (NParks) and Animal & Veterinary Service (AVS) implemented a temporary ban on the importation of poultry and poultry products from Gifu prefecture, effective from 29 April 2024, following an outbreak of HPAI in poultry in Chiba prefecture, Japan.
		• The Animal & Veterinary Service (AVS) has a contingency plan to deal with an outbreak of bird flu in Singapore

United Kingdom	• Public health strategies
	  ○ Information and education provision
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ○ Pharmaceutical measures used as part of public health strategies
	  ▪ Vaccinations (in animals)
	  ○ Surveillance and reporting
	• Priority populations
	  ○ Groups at higher risk of exposure
	  ▪ Working with non-commercial or backyard flocks
	  ▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters)
		• The U.K. has developed a mitigation strategy for avian influenza in wild birds in England and in Wales (last updated 18 March 2024), which includes the following mitigation measures:
		  ○ routine surveillance of disease risk both in the U.K. and around the world, whereby virologists and epidemiologists collaborate with colleagues to share data on outbreaks in poultry, captive birds, and those found in wild birds
		  ○ the ornithological expert panel is a group established to provide expert advice and support the development of policy specific to avian influenza – a variety of other stakeholder and expert advisory groups have been created to support the development of mitigation strategies
		  ○ the potential for restrictions on activities based scientific evidence but could include restrictions on bird ringing, access to sites where poultry and captive birds are held, feeding wild birds, shooting, lethal control licenses, and game bird release.
		• As of the 26 April 2024, the U.K. is not vaccinating poultry or captive birds against avian influenza but notes that some zoo birds in England can get authorization for vaccination.
		• The Animal and Plant Health Agency carries out year-round surveillance for avian influenza in dead wild birds in Great Britain as well as monitoring avian influenza viruses in wild mammals through the routine testing of land mammals found dead and marine mammals found dead.

Jurisdiction	Dimension of the organizing framework	Key findings
		• A number of guidance documents have been produced for priority populations, including how to spot and report avian influenza, reporting dead wild birds, how to safely maintain captive birds, and how to safely house birds, but these guidance documents were all produced in 2023.

United States	• Public health strategies
	  ○ Information and education provision
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ▪ Using personal protective equipment (e.g., masks, gloves)
	  ▪ Following safe food handling procedures and recommended cooking temperatures
	  ○ Non-pharmaceutical measures to control the spread of infections
	  ▪ Case and contact management
	  ○ Pharmaceutical measures used as part of public health strategies
	  ▪ Antiviral medications
	  ○ Surveillance and reporting
	• Priority populations
	  ○ Groups at higher risk of exposure
	  ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers
	  ▪ Working with non-commercial or backyard flocks
	  ▪ Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)
		• As of 28 June 2024, the Food and Drug Administration (FDA) has continued a step-wise approach to scientific analysis of commercial milk safety, which included testing 297 retail dairy samples, all of which have been negative for the virus,
		  ○ The FDA continues to test the efficacy of the pasteurized milk ordinance on the effective elimination of known pathogens in the milk supply.
		  ○ An additional 155 samples are being tested, including additional dairy products such as aged raw milk cheeses and select pasteurized products.
		• The CDC has multiple surveillance systems that are used year-round to monitor key flu indicators, including:
		  ○ case reporting
		  ○ public health laboratory monitoring
		  ○ clinical laboratory trends
		  ○ emergency department reporting
		  ○ wastewater surveillance.
		• On 6 June 2024, the FDA issued an open letter to state regulators asking them to:
		  ○ distribute messaging to the public about the health risks of consuming raw milk and raw milk products
		  ○ monitor dairy cattle herds for signs of illness that would indicate infection with H5N1
		  ○ implement a surveillance testing program in the state to identify the presence of H5N1 virus in dairy herds that might be engaged in producing raw milk for intrastate scale
		  ○ use regulatory authority or implement other measures to stop the sale of raw milk.
		• The CDC and U.S. Department of Agriculture (USDA) have made the following recommendations:
		  ○ avoid unprotected exposures to sick or dead animals including wild birds, poultry, other domesticated birds and other wild or domesticated animals, as well as animal feces, litter, or materials contaminated by birds
		  ○ those that must have contact should wear recommended personal protective equipment
		  ○ people should not prepare or eat uncooked or undercooked food or related uncooked food products such as unpasteurized milk or raw cheeses
		  ○ people exposed to virus-infected birds should monitor themselves for new respiratory illness symptoms, including conjunctivitis and new respiratory symptoms.
		• The CDC issued the following recommendations on 14 June 2024 for those that had direct contact with birds or other animals infected with avian influenza A virus and become sick.
		  ○ Those who become sick within ten days should isolate at home away from their household members and should not go to work or school until they are proven not have avian influenza.
		• Specific recommendations have been made for farmers, poultry, and backyard bird flock owners:
		  ○ avoid unprotected direct physical contact or close exposure with animals and materials potentially infected or confirmed to be infected with the A(H5N1) virus, including sick birds, carcasses of birds,

Jurisdiction	Dimension of the organizing framework	Key findings
		livestock or other animals, feces or litter, raw milk, and surfaces and water that may be contaminated with animal excretions o farmers should wear appropriate personal protective equipment and should receive training in wearing, putting on, and taking off personal protective equipment. • State health departments are being told to investigate potential human cases of A(H5N1) and should notify the CDC within 24 hours of identifying a case under investigation. • Symptoms of persons with bird or other animal exposures should be treated with antiviral treatment (oseltamivir) while awaiting laboratory results or with chemoprophylaxis, which can be considered for any person meeting epidemiologic exposure criteria. o Antiretroviral treatment works best when started as soon as symptoms begin and can be given soon after unprotected exposure to a sick person with confirmed or probably A(H5N1) virus infection. • The CDC and the USDA have also published the following guidance documents: o protective actions around wild birds (e.g., avoid direct contact and observe them only from a distance) o what to do if you find a dead bird (e.g., avoid contact with wild or domestic birds that appear ill or have died and call to report sick of dead birds) o preparing food (e.g., eating properly handled and cooked poultry in the U.S.) o get a seasonal flu vaccine to protect from co-infection of seasonal flu and bird flu. • The CDC and the USDA are undertaking widespread monitoring which includes case reporting, public health laboratory monitoring, clinical laboratory trends, emergency department trends, and wastewater surveillance. • As of 2 February 2024, 94 California condors have been vaccinated with at least one initial dose of a two-dose HPAI vaccine series as part of a conservation strategy by the U.S. Fish and Wildlife Service's Incident Command Team to help reduce the severity of an influenza infection and minimize the likelihood of mortality. o All condors are vaccinated by licensed veterinarians of the state. • The U.S. government is developing vaccines against avian influenza A(H5N1) in case they are needed.

Appendix 5: Detailed jurisdictional scan about what is known about public health strategies that contribute to preventing, reducing, and mitigating the risk of avian influenza spillover into humans in Canadian provinces and territories

Jurisdiction	Dimension of the organizing framework	Key findings

Pan-Canada	• Public health strategies
	  ○ Information and education provision
	  ○ Non-pharmaceutical measures to prevent infection
	  ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
	  ▪ Using personal protective equipment (e.g., masks, gloves)
	  ▪ Washing hands
	  ▪ Following safe food handling procedures and recommended cooking temperatures
	  ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices)
	  ○ Non-pharmaceutical measures to control the spread of infections
	  ▪ Case and contact management
	  ▪ Border-control measures
	  ○ Pharmaceutical measures used as part of public health strategies
	  ▪ Vaccinations (in humans)
	  ▪ Antivirals
	  ○ Surveillance and reporting
	• Priority populations
	  ○ Groups at higher risk of exposure
	  ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers
	  ▪ Working with non-commercial or backyard flocks
	  ▪ Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)
		• In light of the recent detection of highly pathogenic avian influenza (HPAI) in unpasteurized milk of dairy cattle in the U.S., the Canadian Food Inspection Agency (CFIA) in collaboration with Health Canada and the Public Health Agency of Canada (PHAC) has been proactively testing commercial milk samples across Canada to detect fragments of the virus.
		  ○ As of 16 July 2024, all tested samples have been negative for fragments of HPAI.
		• According to the federal government of Canada, as of 15 July 2024 over 11 million domestic birds were estimated to have been affected by HPAI throughout the current outbreak of A(H5N1) in poultry in Canada.
		  ○ Estimates of the number of birds in infected flocks are provided for each province.
		• Cattle producers, consumers, and veterinarians are advised to report any suspected detection of HPAI infection to CFIA as they aim to promote consistency in their support for provinces, territories, and industry when managing the disease in cattle.
		• As of 29 April 2024, CFIA requires an addendum to the export certificate of cattle imported from the U.S. that certifies that the lactating dairy cows:
		  ○ have tested negative by PCR for influenza A virus at a National Animal Health Laboratory Network laboratory
		  ○ if they tested positive for influenza A virus, have completed a 60-day waiting period, and have re-tested negative
		  ○ have not been in a location where HPAI has been detected during the 60 days prior to exportation.
		• PHAC provides guidelines on handling wildlife to protect health for hunters and members of the public on their website, including precautionary measures for handling sick or dead birds and steps to take in the event of exposure or the development of flu symptoms.
		• PHAC also provides guidance on human health issues and information for health professionals and the public about avian influenza A(H5N1) transmission, symptoms, and treatment on their website.
		  ○ To mitigate and manage an outbreak of avian influenza using a One Health approach, the guidance on human health issues recommends that the leading agencies among government, industry, agriculture, environmental, and public health sectors work collaboratively and in a timely manner to ensure that ongoing animal and human surveillance takes place.
		  ○ Specific recommendations are provided for infection prevention (e.g., avoid touching face and mucous membranes, clean hands frequently, wearing personal protective equipment) and managing human contacts after exposure in the community (e.g., active monitoring of contacts, evaluate contacts for antiviral prophylaxis and/or immunization, implementing measures to reduce the risk of spread).
		• High-level recommendations for antivirals and vaccines are provided by PHAC and include:
		  ○ oseltamivir for treatment and post-exposure prophylaxis (PEP) in individuals over one year of age after close contact with an infected individual

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters)	○ Zanamivir for both treatment and prophylaxis of individuals seven years of age and older. • There are no widely available influenza A(H5N1) vaccines for public use in Canada, but the decision to use a targeted vaccine for H5 influenza would depend on the risk of infection during an outbreak. • CFIA provides national biosecurity standards, protocols and strategies for those in the poultry and dairy service industry as well as information to the public on their website on facts about avian influenza, including information on how avian influenza is detected and treated. ○ The national farm biosecurity standards recommend implementing the principles of assessing the biosecurity risks, developing a biosecurity plan that addresses risks, implementing biosecurity measures, monitoring flock health and gathering disease and pest information, and reassessing risks. • The Canadian Wildlife Health Cooperative (CWHC) has a dashboard where it displays suspected and confirmed cases of HPAI infections in wildlife in Canada; it also provides a list of provincial telephone hotlines for individuals to contact them if they find sick or dead wildlife. ○ The dashboard is managed in collaboration with CFIA and Environment and Climate Change Canada (ECCC), and the data on suspected and confirmed cases can be filtered by province, data, and species. ○ Between January 2022 and July 2024, over 3,000 suspected and confirmed positive cases were reported in Canada across both birds and mammals.
British Columbia (B.C.)	• Public health strategies ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Physical distancing ▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ▪ Border-control measures ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in animals) ▪ Antiviral medications	• The government of B.C. maintains an avian influenza webpage with a list of resources to help individuals with potential exposure to birds and flocks to detect and prevent disease, including guidance from CFIA and Environment Canada. • The Provincial Infection Control Network of British Columbia (PICNet) released interim infection prevention and control recommendations for health care settings. ○ PICNet has classified the risk of HPAI infections in human as low, as the majority of human cases are sporadic upon exposure to A(H5) virus through exposed environments. ○ As of June 2023, sustained human-to-human transmission has not yet been observed. ○ Recommendations include being alert, implement appropriate precautions (e.g., medical mask/N95 respirator, hand hygiene, gown, eye protection), notify clinical authorities, and test for influenza virus. • Risk reduction strategies include the seasonal influenza vaccination, antiviral treatment with oseltamivir, and post-exposure prophylaxis. • In Spring 2023, British Columbia announced an investment of $5 million dollars to support a Farmed Animal Disease Program initiative that is designed to enhance biosecurity measures, equipment, research and training, and preventative response. • In June 2023, the BC Centre for Disease Control released their Management of Specific Diseases Interim H5N1 Avian Influenza Outbreak report, which aims to provide public health officials with guidance on the management of human exposure to avian influenza and management strategies. • The CFIA national avian influenza dashboard has reported a total of 389 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in British Columbia.

Jurisdiction	Dimension of the organizing framework	Key findings
	○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons) ▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters) ▪ Working with live or recently killed poultry, cattle, or other livestock (e.g., butcher, processing plant worker, poultry culler)	
Alberta	• Public health strategies ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producer), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks	• In response to an A(H5N1) outbreak detected 19 February 2024 at a commercial poultry operation in Mountain View County, the CFIA declared a primary control zone around the poultry farm, preventing the movement of birds, their products, and by-products as well as things exposed to the birds into, out of, within, or through the zone without permission from the agency. • To prevent the spread of avian influenza, the Alberta government recommends that producers and veterinarians be familiar with clinical signs of avian influenza in poultry, control access to and contact with domestic poultry and avoid wild birds, ensure that poultry equipment is disinfected before use, and make sure to use personal protective equipment. • The CFIA national avian influenza dashboard has reported a total of 471 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in Alberta.
Saskatchewan	• Public health strategies ○ Information and education provision	• Basic biosecurity recommendations from the Saskatchewan government for protecting flock health include:

Jurisdiction	Dimension of the organizing framework	Key findings
	○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working with non-commercial or backyard flocks • Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters)	○ prevent contact with wild birds (e.g., avoid directly handling or feeding wild birds, avoid providing untreated water that may have come into contact with wild waterfowl, set up proper fencing and feed storage) ○ maintain cleanliness (routine cleaning and disinfection of facilities and equipment, not sharing equipment between barns or bird owners) ○ monitor the flock (daily monitoring of the flock, report usual signs to a flock veterinarian and the CFIA). • The Saskatchewan Small Flock Poultry Surveillance Program allows small flock and backyard poultry producers to submit dead birds for testing. • It is required for all poultry producers to register with the Saskatchewan Premises Identification system to facilitate animal health issues and emergency response. ○ Direct contact with sick or dead birds should be avoided, especially the secretions where the virus is shed (fecal droppings, saliva, nasal discharges). ○ Gloves should be worn when handling dead birds which should be double bagged if being submitted for testing. ○ Routine precautions are to be taken for hunters handling game birds. • Saskatchewan has participated in the National Inter-Agency Wild Bird Influenza Survey since 2006. ○ The Government of Saskatchewan, ECCC, and the CWHC conduct regular avian influenza surveillance in wild birds. ○ Saskatchewan's Ministry of Environment actively participates in dead wild bird surveys, prioritizing investigations and collections based on strategic importance. • The Animal Health and Biosecurity Program supports producers in sectors like apiculture, beef cattle, bison, cervids, small ruminants (e.g., sheep/goats), dairy, poultry, and swine. ○ The program's goal is to increase participation in biosecurity and animal welfare initiatives by promoting industry standards and certification (e.g., meeting recognized benchmarks), improving producer knowledge about biosecurity and animal welfare requirements, and implementing better practices through education, expert assessments, audits, and equipment funding. • The CFIA national avian influenza dashboard has reported a total of 375 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in Saskatchewan.
Manitoba	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands	• Manitoba Health provides recommendations for handling dead birds or other wildlife: ○ contact a veterinarian if suspecting a case of HPAI ○ do not make contact with bare hands ○ use protective equipment including eyewear, masks, or N95 respirators ○ clean hands with soap and water or alcohol-based hand sanitizer after contact ○ wear gloves if contact must be made ○ keep the dead animal in a plastic bag ○ contact a conservation officer using a toll-free line upon the discovery of: ▪ groups of six or more dead wild waterfowl, such as ducks or geese ▪ large groups of dead birds (20+ of a species). • Recommendations for living in or having travelled to an area with H5N1 include: ○ proper etiquette for coughing and sneezing

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ○ Working with non-commercial or backyard flocks	○ avoiding visits to poultry farms and live animal markets ○ avoiding contact with alive or dead livestock, birds, and other animals (including chickens, ducks, and wild birds) ○ keeping pets away from sick or dead animals ○ avoiding surfaces with bird droppings ○ only consuming pasteurized milk ○ properly cooking dishes with poultry and eggs ○ if working or being exposed in an area with avian influenza virus, individuals should monitor for symptoms for 10 to 14 days ○ if experiencing symptoms, individuals should isolate and inform health care provider for proper testing and treatment. • As of 5 April 2024, the Ministry of Agriculture advised that: ○ until affected animals recover, their milk should be discarded ○ unpasteurized and raw milk products should not be used for human consumption ○ to prevent HPAI spread, those who own poultry and non-poultry flocks are to keep flocks indoors for as long as possible (especially during the migration season) and prevent contact between flocks (e.g., through trades, sales or exhibitions) and with wild birds. • An application with the province's Premises Identification Program is required for owners of a small or non-commercial flock. • The province's Small Flock Avian Influence Program allows small flock owners to submit dead birds for testing in the presence of potential signs of avian influenza (e.g., abnormal morality or egg production rates). • The CFIA national avian influenza dashboard has reported a total of 200 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in Manitoba.
Ontario	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Physical distancing ▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices)	• Public Health Ontario has a list of resources on its website about best practices for infection, control, and prevention of avian influenza and other infectious respiratory diseases, including guidance for veterinary clinics and an evidence brief on reducing health risks associated with backyard chickens. • Public Health Ontario uses real-time PCR molecular tests as part of its surveillance strategy to detect the presence of A(H5N1). • The Ontario government's website has an avian influenza in poultry page that details the signs, transmission and prevention measures of avian influenza in poultry. ○ The government strongly recommends that all producers working with cows and goats as well as livestock and poultry get the seasonal influenza vaccine. ○ Additional infection control measures recommended included additional personal protective equipment for people with occupational exposure to live birds. • In its 2023 guideline on management of avian influenza or novel influenza in birds or animals, the Ontario Ministry of Health details that: ○ all laboratory directors and veterinarians are lawfully required to report known or suspected cases of animals infected with avian influenza to the local Medical Officer of Health immediately ○ Medical Officers of Health report cases to the board of health, which reports to the Ministry of Health

Jurisdiction	Dimension of the organizing framework	Key findings
	○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in humans) ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks ▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters) ▪ Working with live or recently killed poultry, cattle, or other livestock (e.g., butcher, processing plant worker, poultry culler) ▪ Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)	○ an inter-agency response to avian influenza outbreaks in birds and humans in Ontario is coordinated between the Ontario Ministry of Health, Ministry of Agriculture, Food and Rural Affairs, Indigenous Affairs Ontario, the poultry industry, and the CFIA ○ for settings with confirmed cases of avian influenza, asymptomatic contacts are advised by the board of health to self-monitor for the development of symptoms; symptomatic individuals are laboratory tested. • Biosecurity recommendations for commercial poultry flocks in Ontario recommended by the Ontario government include measures that ensure both exclusion and containment access management, health management, and operational management of flocks. • The CFIA national avian influenza dashboard has reported a total of 545 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in Ontario.
Quebec	• Public health strategies ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Physical distancing ▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Pharmaceutical measures used as part of public health strategies	• The Government of Quebec has reported the H5N1 virus circulating as of April 2022, affecting wild birds across all regions within the province. ○ In Quebec, only the poultry sector has been affected and no cases have been detected within cattle or other livestock. ○ An intervention plan was developed from the provincial government, in coordination with the CFIA, to curb the spread of the avian influenza. ▪ Control measures may be applied in a zone of three to 10 km around the positive case depending on the type of establishment. ▪ In avian influenza outbreaks, severe measures may be in effect, including prohibiting the organization of events bringing together birds (e.g., fairs, exhibitions, competitions), prohibiting visits to breeding sites, requiring outdoor bird owners to set up an enclosure of free water, and a roof/netting device that prevents wild birds from landing there. ○ A range of measures have been implemented within the province to ensure that cows and the milk consumed is safe, including the ban on isolating poultry in a dairy barn, the exclusion of milk from sick animals during milking, and pasteurization. • The Avian Network and Farmyard Group carries out flu surveillance within the province. ○ It supports information dissemination and recommendations to improve vigilance and biosecurity on farms.

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Vaccinations (in animals) ▪ Vaccinations (in humans) ▪ Antiviral medications ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons) ▪ Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)	○ Domestic birds aged 14 days and older are submitted for avian influenza testing. ○ Wild bird monitoring is undertaken in collaboration with the Ministry of the Environment. ○ Network activities include practicing veterinary doctors working in poultry farms to collaborate and discuss avian health and disease. • Public health recommendations to follow are listed by the Quebec Ministry of Agriculture, Fisheries and Food. • The CFIA national avian influenza dashboard has reported a total of 465 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in Quebec.
New Brunswick	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Physical distancing ▪ Following safe food handling procedures and recommended cooking temperatures ▪ Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices) ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ▪ Border-control measures ○ Surveillance and reporting • Priority populations	• The Government of New Brunswick website has an undated advisory notice regarding avian influenza ○ The notice specifies the difference in pathogenicity of avian influenza and contains disposal guidelines for dead wild birds which does not fall in line with other provincial/territorial guidelines for reducing contact with potentially infectious wild birds. • The Government of New Brunswick has an undated visual fact sheet with descriptions of biosecurity measures to protect and observe one's own birds, and protective measures to prevent transmission to humans. ○ The fact sheet specifies that the virus is shed in the droppings and secretions of infected birds, and commonly occurs in wild waterfowl. ○ The infected bird droppings can contaminate equipment and clothing, be carried on the body of rodents, or be transmitted through trade of infected live poultry. ○ The fact sheet outlines the increased risk of people who work around poultry and handle birds. • The CFIA national avian influenza dashboard has not reported any new positive or suspected cases of HPAI in birds or mammals from January 2024 to 11 July 2024. • The Canadian federal government page on the status of ongoing avian influenza response by province has not been updated since the previous version of this living evidence profile and continues to report an estimated number of under 100 birds affected by HPAI in New Brunswick, with two previously infected premises and without specification of strain as of 10 April 2024. • A 2022 notice from the New Brunswick department of Agriculture, Aquaculture and Fisheries states that HPAI subtype H5N1 can result in major economic losses in the provincial and national poultry industry. ○ This raises an equity concern related to job security and workplace safety standards for individuals handling poultry or poultry processing.

Jurisdiction	Dimension of the organizing framework	Key findings
	○ Groups at higher risk of exposure ○ Other equity considerations	
Nova Scotia	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Following safe food handling procedures and recommended cooking temperatures ○ Non-pharmaceutical measures to control the spread of infections ▪ Case and contact management ▪ Isolation and quarantine ○ Surveillance and reporting	• The Nova Scotia government website has a short article and a visual fact sheet on avian influenza. ○ The article contains symptoms for humans and specifies that the virus can be transmitted through direct contact with an infected bird or a contaminated surface. ○ The fact sheet displays clinical signs for birds as well as biosecurity measures to limit transmission such as washing hands, using protective equipment, maintaining sanitation standards, and controlling contact with wild birds. ▪ The fact sheet specifies isolating and quarantining new arriving birds as a preventative measure. ○ The biosecurity measures include registering with the Nova Scotia Premises Identification Program, which amongst other services: ▪ notifies premises owners of disease outbreaks in their vicinity and recommends biosecurity precautions to protect animal/human health ▪ determines which species are located in close proximity to a disease outbreak. • The Canadian federal government page on the status of ongoing avian influenza response by province has not been updated since the previous version of this living evidence profile and continues to report an estimated number of 12,000 birds affected by HPAI in Nova Scotia without specification of strain as of 10 April 2024. • The CFIA national avian influenza dashboard has reported a total of 204 positive and suspected cases of HPAI across both birds and mammals between January 2022 and March 2024, concentrated in coastal areas. • The CFIA national avian influenza dashboard has reported a total of 17 new positive and suspected cases of HPAI A(H5Nx) across both birds and mammals as of 11 July 2024, concentrated in coastal areas.
Prince Edward Island (P.E.I.)	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Following safe food handling procedures and recommended cooking temperatures ○ Surveillance and reporting • Priority populations ○ Groups at higher risk of exposure	• The P.E.I. government website edited a previous published article on avian influenza on 21 June 2024, which focuses on the current outbreak of HPAI A(H5N1). ○ The page provides information about the symptoms and incubation period in birds, as well as the transmission and spread of avian influenza. ▪ There is a list of recommended biosecurity practices for farmers to protect their flock. ▪ A link is provided to a backyard flock biosecurity poster with a scannable QR codes. ○ Transmissibility to humans remains low. ○ The article mentions recent (March 2024) instances of HPAI H5N1 infecting other mammals, specifically dairy herds. ▪ A link to a Canadian federal government article on HPAI in livestock is provided. ○ The page specifies transmission to humans has occurred when people have had close contact with infected birds or heavily contaminated environments. ○ The page mentions that the CFIA has not detected HPAI in retail Canadian milk, dairy cattle or other livestock in Canada. ○ As of 29 April 2024, all lactating dairy cattle being imported into Canada from the U.S. must test negative for HPAI (H5N1) within seven days of crossing the border. ○ As of 24 May 2024, Canada requires an export certificate for lactating dairy cattle imported from the U.S. for immediate slaughter.

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons) ▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters) ▪ Working with live or recently killed poultry, cattle, or other livestock (e.g., butcher, processing plant worker, poultry culler)	• The CFIA national avian influenza dashboard has reported a total of 162 positive and suspected cases of HPAI between January 2022 and April 2024 across both birds and mammals, concentrated in coastal areas. • The CFIA national avian influenza dashboard has reported a total of three new positive and suspected cases of HPAI appearing only in mammals (specifically the red fox) as of 11 July 2024, concentrated in coastal areas.
Newfoundland and Labrador	• Public health strategies o Surveillance and reporting	• The CFIA national avian influenza dashboard has reported a total of 201 suspected and confirmed cases of HPAI as of 14 July 2024 across both birds and mammals in Newfoundland and Labrador.
Northwest Territories	• Public health strategies o Information and education provision o Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Following safe food handling procedures and recommended cooking temperatures o Surveillance and reporting	• The Northwest Territories government website has a section on avian influenza last updated in 2022. o The page is written in plain language and lists information about the virus, transmissibility, symptoms in wildlife and in domestic animals, and safety precautions for individuals to take when hunting or handling birds. o The section includes a list of resources linking to articles the Canadian federal government on protective measures for hunters, farmers, and small flock or pet owners as well as contacts and resources for reporting animal diseases. ▪ The page provides contact information for the Canadian Wildlife Service (ECCC). • The wildlife diseases section of the Northwest Territories government website does not list avian influenza. o The attached field guide also does not list avian influenza. • The CFIA national avian influenza dashboard reported only two confirmed positives for H5N1, both in dead birds collected in June and October 2022. • According to the CFIA national avian influenza dashboard, there have been no recent confirmed cases of A(H5Nx) in Northwest Territories from 13 May 2024 to 11 July 2024.
Yukon	• Public health strategies o Information and education provision o Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands	• The Yukon government website has a page within the health and wellness section, Avian Influenza in the Yukon, which contains several sub-sections: o What We Know about Avian Flu: HPAI (H5N1), is spreading in birds and can spread to other mammals (domestic livestock and wild). o Human Health Risks: Risk of infection from H5N1 is low but can occur, displays list of symptoms. o If You Think You Were Exposed: Watch for symptoms, call Yukon Communicable Disease control, and isolate self from family. o Signs and Symptoms: Can be mild to severe, develop within 10 days of exposure. o Prevention: Provides a detailed list of protocols for handling birds, game, cleaning, and wearing protective equipment.

Jurisdiction	Dimension of the organizing framework	Key findings
	▪ Following safe food handling procedures and recommended cooking temperatures ○ Surveillance and reporting ○ Pharmaceutical measures used as part of public health strategies ▪ Vaccinations (in humans) • Priority populations ○ Groups at higher risk of exposure ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers ▪ Working with non-commercial or backyard flocks ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons) ▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters) ▪ Working with live or recently killed poultry, cattle, or other livestock (e.g., butcher, processing plant worker, poultry culler) • Outcomes ○ Reduction in risk of exposure ○ Zoonotic infections ○ Health-related outcomes for individuals infected	○ Wildlife Testing Results ○ Resources: Links to separate Yukon article on keeping wildlife healthy, with further recommendations on limiting the spread of other diseases such as chronic wasting disease. • The Yukon monitors avian influenza in wildlife in partnership with ECCC's Canadian Wildlife Service (no link provided). • The Yukon site encourages civilian reporting of potential cases in live birds through the TIPP system (Turn in Poachers and Polluters) and provides contact information of the Yukon's Animal Health Unit. • The website identifies those who handle live birds as being at greater risk of exposure and recommends they receive annual influenza immunization (e.g., poultry farmers or processors). • A separate section on protecting livestock from the avian flu contains other further resources specific to bird and poultry owners and pig farmers. ○ Contains a list of techniques for bird owners to reduce theirs and their livestock's risk of exposure: ▪ keeping birds and animals away from wild birds, bird carcasses ▪ cleaning and disinfecting equipment used by or for the birds (feeders, baths, areas contaminated with feces) ▪ learning to identify symptoms (with a link to the federal government article from 2023) ▪ the federal government article links to the CHWC's online reporting tool for citizens to report cases. • The CFIA national avian influenza dashboard of reported avian influenza cases indicates nine confirmed or suspected positives for avian influenza in Yukon wildlife. ○ Most recent confirmed positive identification collected in November 2022. • According to the CFIA national avian influenza dashboard, there have been no recent confirmed cases of A(H5Nx) in the Yukon from 13 May 2024 to 11 July 2024.
Nunavut	• Public health strategies ○ Information and education provision ○ Non-pharmaceutical measures to prevent infection ▪ Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments) ▪ Using personal protective equipment (e.g., masks, gloves) ▪ Washing hands ▪ Following safe food handling procedures and recommended cooking temperatures ○ Surveillance and reporting	• As of 2 May 2024 the health programs section of the Nunavut government website produced an updated visual fact sheet about preventing the spread of avian influenza in wild birds. Although the text on the webpage references 2022, the information on the fact sheet was updated in 2024. ○ The fact sheet is a plain language summary of transmissibility and preventative measures. ▪ The sheet specifies that the risk of transmissibility to humans is low. ○ It is safe to consume fully cooked waterfowl meat and eggs. ○ Preventative measures include cooking well (cooking temperatures are provided), wearing gloves, washing hands, disinfecting equipment, and washing or changing clothing to avoid contamination. ○ Hunters and bird handlers are the only groups specifically mentioned. ▪ Fact sheet encourages northern residents in general to be aware of birds with HPAI, particularly during the spring migration. ○ In addition to the general information and protective methods, the fact sheet provides contact information to regional environment health offices and encourages citizens to report suspected cases to their local wildlife office.

Jurisdiction	Dimension of the organizing framework	Key findings

	• Priority populations
	  ○ Groups at higher risk of exposure
	  ▪ Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers
	  ▪ Working with non-commercial or backyard flocks
	  ▪ Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons)
	  ▪ Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters)
	  ▪ Working with live or recently killed poultry, cattle, or other livestock (e.g., butcher, processing plant worker, poultry culler)
		▪ Citizens are encouraged to report dead or strangely behaving birds, as well as protective guidelines if handling of dead birds is unavoidable (protective equipment, avoiding contact with body fluid and feces, and washing hands thoroughly).
		○ The fact sheet includes a link to CWHC bi-weekly reports on AIV, which displays no recent confirmed cases of A(H5Nx) in birds in Nunavut.
		• The CFIA national avian influenza dashboard of reported avian influenza cases in Nunavut displayed only 2 confirmed cases of birds with avian influenza A(H5N1) since 2022 (one in September 2022 and the other in June 2023).
		○ There were two additional suspected cases of H5, both collected 2022.
		• According to the CFIA national avian influenza dashboard, there have been no recent confirmed cases of A(H5Nx) in Nunavut from 13 May 2024 to 11 July 2024.

Appendix 6: Key list of sources for identifying relevant technical reports and documents in Canada and other countries

Jurisdiction	Key sources
International organizations	• WHO, FAO, WOAH joint assessment • European Food Safety Authority • European Centre for Disease Control and Prevention – weekly bulletins • WHO Influenza at the human-animal interface summary and assessment • WAHIS: World Animal Health Information System
Australia	• Wildlife Health Australia • Health Direct Australia
France	• Ministry of Agriculture and Food Sovereignty • ANSES's Ploufragan-Plouzané-Niort Laboratory
Brazil	• WHO, FAO, WOAH joint assessment • WAHIS: World Animal Health Information System
China	• European Centre for Disease Control and Prevention – weekly bulletins • Chinese Center for Disease Control and Prevention
Cambodia	• U.S. Centers for Disease Control and Prevention and Cambodia • Avian influenza overview December 2023–March 2024
Singapore	• Ministry of Health of Singapore
Japan	• Ministry of Agriculture, Forestry, and Fisheries of Japan
United Kingdom	• U.K. Health Security Agency – Bird flu (avian influenza): Latest situation in England • Animal & Plant Health Agency • NHS – Bird Flu • Department for Environment, Food & Rural Affairs
United States	• U.S. Centers for Disease Control and Prevention • USDA Animal and Plant Health Inspection Service • Updates on HPAI – U.S. Food & Drug Administration
Canada	• Government of Canada • Public Health Agency of Canada • Canadian Food Inspection Agency • Canadian Food Inspection Agency – H5Nx wildlife dashboard (in collaboration with Environment and Climate Change Canada and Canadian Wildlife Health Cooperative) • Canadian Food Inspection Agency – HPAI detection across provinces

Jurisdiction	Key sources
	• Canadian Food Inspection Agency – Guidance for cattle and livestock • Canadian Animal Health Surveillance System • Government of British Columbia • B.C. Centre for Disease Control • Government of Alberta • Government of Saskatchewan • Government of Manitoba • Public Health Ontario • Avian Influenza (Quebec) • Government of New Brunswick • Government of Newfoundland • Nova Scotia • Prince Edward Island • Northwest Territories • Yukon • Nunavut

Appendix 7: Documents excluded at the final stages of reviewing

Document type	Hyperlinked title
Evidence syntheses	Antivirals for influenza in healthy adults: Systematic review
	Serological evidence of human infection with avian influenza a(h7n9) virus: A systematic review and meta-analysis
Literature reviews with no systematic searches	A brief introduction to avian influenza virus
	A brief history of bird flu
	A comprehensive review of highly pathogenic avian influenza (HPAI) H5N1: An imminent threat at doorstep
	A global perspective on H9N2 avian influenza virus
	A literature review of the use of environmental sampling in the surveillance of avian influenza viruses
	A review of avian influenza A virus associations in synanthropic birds
	A review of H5Nx avian influenza viruses
	A review of knowledge discovery process in control and mitigation of avian influenza
	A review on current trends in the treatment of human infection with H7N9-avian influenza A
	Adenoviral vectors as vaccines for emerging avian influenza viruses
	Alarming situation of emerging H5 and H7 avian influenza and effective control strategies
	An outbreak of highly pathogenic avian influenza (H7N7) in Australia and the potential for novel influenza A viruses to emerge
	An overview of avian influenza in the context of the Australian commercial poultry industry
	Avian influenza (H5N1) virus, epidemiology and its effects on backyard poultry in Indonesia: A review
	Avian influenza A (H7N9) virus: From low pathogenic to highly pathogenic
	Avian influenza A virus associations in wild, terrestrial mammals: A review of potential synanthropic vectors to poultry facilities
	Avian influenza in the greater Mekong subregion, 2003–2018
	Avian influenza in wild birds and poultry: Dissemination pathways, monitoring methods, and virus ecology
	Avian influenza overview June–September 2023
	Avian influenza revisited: Concerns and constraints
	Avian influenza viruses at the wild–domestic bird interface in Egypt
	Avian influenza viruses in humans: Lessons from past outbreaks
	Avian influenza: Strategies to manage an outbreak
	Backyard poultry: Exploring non-intensive production systems
	Control of avian influenza in China: Strategies and lessons
	Controlling avian influenza virus in Bangladesh: Challenges and recommendations
	Emerging and re-emerging infectious diseases in the WHO Eastern Mediterranean region, 2001-2018
	Emerging and re-emerging zoonotic viral diseases in Southeast Asia: One Health challenge
	Emerging diseases of avian wildlife

Document type	Hyperlinked title
	Emerging HxNy influenza A viruses
	Evolution and adaptation of the avian H7N9 virus into the human host
	Evolution and current status of influenza A virus in Chile: A review
	Evolutionary pressures rendered by animal husbandry practices for avian influenza viruses to adapt to humans
	Global patterns of avian influenza A (H7): Virus evolution and zoonotic threats
	H5 influenza viruses in Egypt
	H7N9 influenza virus in China
	Highly pathogenic avian influenza in Bulgaria – A review
	Immune control of avian influenza virus infection and its vaccine development
	Immune responses to avian influenza viruses
	Influenza A virus infection in cats and dogs: A literature review in the light of the "One Health" concept
	Influenza virus infections in cats
	Inventory of molecular markers affecting biological characteristics of avian influenza A viruses
Single studies	Managing the challenges of a highly pathogenic avian influenza H5N8 outbreak in Uganda: A case study
	Novel avian influenza A virus infections of humans
	Opening pandora's box at the roof of the world: Landscape, climate and avian influenza (H5N1)
	Pandemic potential of highly pathogenic avian influenza clade 2.3.4.4 a(h5) viruses
	Peering into avian influenza A(H5N8) for a framework towards pandemic preparedness
	Potential cross-species transmission of highly pathogenic avian influenza H5 subtype (HPAI H5) viruses to humans calls for the development of H5-specific and universal influenza vaccines
	Rational approach to vaccination against highly pathogenic avian influenza in Nigeria: A scientific perspective and global best practice
	Review of poultry recombinant vector vaccines
	Strategies for enhancing immunity against avian influenza virus in chickens: A review
	Synthesis and biological evaluation of benzothiazolyl-pyridine hybrids as new antiviral agents against H5N1 bird flu and SARS-COV-2 viruses
	The emergence and decennary distribution of clade 2.3.4.4 HPAI H5Nx
	The epidemiology, virology, and pathogenicity of human infections with avian influenza viruses
	The neuropathogenesis of highly pathogenic avian influenza H5Nx viruses in mammalian species including humans
	Vaccination and antiviral treatment against avian influenza H5Nx viruses: A harbinger of virus control or evolution
	Wastewater-based surveillance is an efficient monitoring tool for tracking influenza A virus in the community
	Highly pathogenic avian influenza A(H5N1) virus infection in a dairy farm worker
	Highly pathogenic avian influenza (HPAI) H5 Clade 2.3.4.4b virus infection in birds and mammals
	Baloxavir marboxil use for critical human infection of avian influenza A H5N6 virus

Document type	Hyperlinked title
	Cow's milk containing avian influenza A(H5N1) virus – heat inactivation and infectivity in mice
	Inactivation of avian influenza A(H5N1) virus in raw milk at 63°C and 72°C
	Emerging threats in public health: H5N1 transmission from dairy cattle to humans
	Pandemic preparedness through vaccine development for avian influenza viruses
	Epidemiology, biosafety, and biosecurity of avian influenza: Insights from the East Mediterranean region
	Bird flu outbreak in dairy cows is widespread, raising public health concerns
	Persistence of influenza H5N1 and H1N1 viruses in unpasteurized milk on milking unit surfaces
	Early surveillance and public health emergency disposal measures between novel coronavirus disease 2019 and avian influenza in China: A case-comparison study

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