Avian Influenza.

The current state of affairs: The Public Health Perspective in Canada.

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1. Introduction

In light of Canada's need to deal with respiratory infectious diseases such as tuberculosis, Avian Influenza and severe acute respiratory syndrome (SARS), public health departments across the country have been challenged with the need to develop action plans for both treatment and prevention. Yet the problem is not isolated to Canada but is considered to be a major public health threat both in Canada and internationally.

The emergence of viral respiratory infections in Canada may be attributed to several sources, which include migration from one part of the world to another either for pleasure or business, as a major contributor. Such migrations coupled with inadequate infectious disease prevention strategies not only leads to rapid transmission of respiratory infectious diseases, but there is also a problem in administering effective treatment and vaccines to infected cohorts.Several factors contribute to both the accidental and/or deliberate transfer of microbial agents. For example, economic, cultural and political interactions invoke the emergence of new and unrecognized microbial disease agents (Lashley, 2006). New diseases have the potential to spread across the world in a matter of days, or even hours, making early detection and action more important than ever (BCCDC, 2008).

Avian Influenza (AI) is a contagious viral infection caused by the Influenza virus Type "A". Avian Influenza can affect several species of birds, some of which are consumed by humans (e.g. chickens, guinea fowl, quails,and turkeys), others are domesticated pets, and others are wild. Avian Influenza viruses can be classified into two categories based on the severity of the illness caused in birds:

- low pathogenicity (LPAI)

- high pathogenic (HPAI)(CFIA, 2009).

Pathogenicity refers to the severity of the illness (CFIA, 2009, Shah, 2003). Avian Influenza viruses are classified by type and subtype. For example considering the H5N1 virus type, the letters H and N refer to surface proteins, hemagglutinin (H) and neuraminidase (N), on the Influenza virus. The H5N1 strain is a subtype of Avian Influenza that has been linked to most of the cases found worldwide (CDC, n.d). Outbreaks of highly pathogenic H5N1 Avian Influenza in Southeast Asia, Europe and Africa have led to devastating consequences for poultry, and have been suggested to cause infections in humans. Although these infections from the animal reservoir continue to accumulate, the virus does not seem to spread extensively among humans. However, a process of genetic reassortment could occur in a human who is co-infected with Avian Influenza A virus and a human strain of Influenza A virus. The resulting new virus might then be able to easily infect humans and spread from human to human (Iwami, Takeuchi & Liu, 2008).

The transportation of domestic poultry and wild birds throughout various market places and market types worldwide is considered one of the vectors of outbreak transmission (Dinh, Long, Tien et al., 2006). Recently the Avian Influenza has led federal inspectors to cull, gas and compost about 60,000 birds on a Fraser Valley poultry farm in British Columbia. These were found to be subtype H5N2, and likely low in pathogenicity (CFIA, 2009). In Canada, Avian Influenza is a reportable disease under the Health Of Animal Regulations and all cases must be reported to the Canadian Food Inspection Agency (CFIA, 2009).The Canadian food inspection agency is in charge of laws regulating movement of food items and livestock in and out of Canada. Yet an important question still arise which is: How effective is this Avian Influenza surveillance process within Canada?

The severe acute respiratory syndrome crisis (SARS) demonstrated that there may be serious deficiencies in Canada's public health system, with specific regard to the spread of infection. A rapid spread of SARS across the world and eventually to Canada lead to a high incidence rate for morbidity and mortality. The presence of the virus in Canada alerted public health officials to the inadequate preparedness of Canada in terms of outbreak prevention strategies.

Responding to disease outbreaks are part of the protective role of the public health agency. A coherent plan that includes a rapid and effective response will reduce incidence rates for morbidity, mortality and potential years of life lost (PYLL). Likewise, an effective prevention strategy will also have a better cost-benefit outcome than treating the diseases/ infections when it has already occurred.

The major tenet of an effective public health care system is to prevent diseases that will be a reduction in the need to treat outcomes. There is an old saying "Prevention is better than cure"(a quote from the goddess Hygiene; Loefler (2004). Shah (2003) strongly believes in prevention. Primary prevention aims at preventing disease before it occurs, thereby reducing the incidence (Shah, 2003). Preventive measures such as vaccines were developed to ensure that infection rates are minimized. Adopting healthy lifestyle behaviours not only ensure reductions in diseases such as cardiovascular and respiratory diseases, but specific lifestyle behaviours can also reduce the rate and spread of infectious diseases.

Following the SARS epidemic in Canada, there was an explicit campaign by public health agencies to increase awareness of the benefits of hand washing, covering a cough or a sneeze with a tissue, and getting vaccinated before the typical flu season starts.

Yet there have also been noted cases of transmission of infections from patients to patients via health care workers due to breaks in aseptic techniques, reduced frequency of hand washing among health care workers before and between caring for patients, and decreased attention to infection control practices which include a lack of use of protective devices such as gloves, face masks, isolation gowns, using equipments such as thermometer, stethoscopes, otoscopes from patient to patient without using proper aseptic techniques. (Manning, Archibald, Bell, et al., 2001; de Vries, Baas, van der Ploeg, 2006).

In the following document, a review of Avian flu will be presented with emphasis on:

- Vectors, modes of viral transmission, prevention and treatment,
- Epidemiology,
- Clinical features,
- Public health programs in Canada will be reviewed and recommendations will be made on how to improve these programs as well as how awareness of Avian flu can be made to the public so as to increase vigilance and early reporting of Avian flu, thereby decreasing the morbidity and mortality of a potential pandemic.

Public health programs are in place to fight Avian Influenza . Despite the different measures Canada has organized to reduce the rate of infection from Avian Influenza, cases of Avian Influenza are still being reported in different parts of Canada. While Canada is prepared against Avian Influenza outbreak, some challenges still exist that need to be addressed .This paper will review these challenges and make reccomendations.

2: Review of literature for Avian Influenza

2:1 Vectors, modes of transmission, prevention and treatment of Avian Influenza

Avian Influenza has been commonly referred to as "bird flu"(WHO, 2006a; CDC, n.d). Wild birds are vectors but usually do not show clinical symptoms (WHO, 2006a). One strain of Avian Influenza, the H5N1 virus, is endemic in much of Asia and has spread into parts of Europe and Africa (Pandemic flu, n.d; CDC, n.d, WHO 2006a). Most human cases of H5N1 infection were associated with the direct handling of infected poultry, slaughtering or preparing sick poultry for consumption, consumption of uncooked poultry products such as raw blood, or close contact with live poultry (Chotpitayasunondh, Ungchusak, Hanshaoworakul et al .,2004; Dinh, Long, Tien et al., 2006; Tran, Nguyen, Nguyen et al., 2004; WHO, 2006).

Influenza A viruses are enveloped RNA viruses with an eight-segmented, single-stranded, negative-sense genome belonging to the family Orthomyxoviridae. Influenza virus type A (and type B) causes recurrent epidemics almost every year, leading to significant human morbidity and mortality. However, only Influenza A virus is associated with Influenza virus pandemics, where an antigenically novel Influenza virus emerges to spread rapidly worldwide in an immunologically naïve population (Peiris, de Jong, & Guan, 2007). The segmented genome allows Influenza A viruses from different species to mix and create a new Influenza A virus if viruses from two different species infect the same person or animal (reassortment). Antigenic shift results when a new Influenza A subtype to which most people have little or no immune protection infects humans. If this new virus causes illness in people and can be transmitted easily from person to person, an Influenza pandemic can occur. (CDC, n.d).

Avian Influenza A viruses may be transmitted from animals to humans in two main ways:

- Directly from birds or from Avian virus-contaminated environments to people (CDC, n.d, PAHO 2004, Gill et al., 2006, Gilsdorf et al., 2006, Rimmelzwaan et al., 2006, Songserm et al., 2006, Wong and Yuen 2006, Gu et al., 2007). Bird-to-human transmission of the Avian Influenza virus is likely by the oral–fecal route (Thomas & Noppenberger, 2007).
- Through an intermediate host, such as a pig (CDC, n.d; Ludwig, Stitz & Planz , 1995).

Antigenic drift and antigenic shifts have been linked to most previous cases of Influenza pandemics. Antigenic drift refers to small, gradual changes that occur through point mutations in the two genes that contain the genetic material to produce the main surface proteins, hemagglutinin and neuraminidase. These point mutations occur unpredictably and result in minor changes to these surface proteins. Antigenic drift produces new virus strains that may not be recognized by antibodies to earlier Influenza strains. This process works as follows: a person infected with a particular Influenza virus strain develops antibody against that strain. As newer virus strains appear, the antibodies against the older strains might not recognize the "newer" virus, and infection with a new strain can occur. This is one of the main reasons why people can become infected with Influenza viruses more than one time and why global surveillance is critical in order to monitor the evolution of human Influenza virus stains for selection of which strains should be included in the annual production of Influenza vaccine (CDC, n.d).

Antigenic shift refers to an abrupt, major change to produce a novel Influenza A virus subtype in humans that was not currently circulating among people (see more information below under Influenza Type A and Its Subtypes). Antigenic shift can occur either through direct animal (poultry)-to-human transmission or through mixing of human Influenza A and animal Influenza A virus genes to create a new human Influenza A subtype virus through a process called genetic reassortment. Antigenic shift results in a new human Influenza A subtype(CDC, nd).

Human Influenza is transmitted by inhalation of infectious droplets and droplet nuclei, by direct contact, and perhaps, by indirect (fomite) contact, with self-inoculation onto the upper respiratory tract or conjunctival mucosa (Salgado, Farr, Hall & Hayden 2002; Bridges, Kuehnert & Hall 2003). Although most human infections by Avian Influenza viruses are attributable to exposure to infected poultry, human infections resulting from exposure to Avian Influenza viruses from wild birds have been documented from Eurasia (H5N1: Azerbaijan), North America (H11N9: United States), and Africa (H10N7: Egypt) (PAHO 2004, Gill et al., 2006, Gilsdorf et al., 2006).

Human-to-human transmission has been documented for H5N1 and H7N7 Avian Influenza viruses (Bridges et al. 2000, du Ry van Beest Holle et al., 2005, Unguchusak et al., 2005), and human-to-human transmission of an H7N2 Avian Influenza virus may have occurred during a May 2007 outbreak in the United Kingdom (DEFRA 2007 a,b).

Oseltamivir (Tamiflu) and Zanamivir (Relenza) have proven efficacy as seasonal or postexposure prophylaxis against human Influenza virus (Mayoclinic website, n.d;

Nicholson, Wood & Zambon. 2003; ASHP, 2008). Chemoprophylaxis with 75 mg of oseltamivir once daily for 7 to 10 days is warranted for persons who have had a possible unprotected exposure (Hayden, Belshe, Villanueva, et al., 2004; Welliver, Monto, Carewicz, et al., 2001). The use of preexposure prophylaxis warrants consideration if evidence indicates that the Influenza A (H5N1) strain is being transmitted from person to person with increased efficiency or if there is a likelihood of a high-risk exposure (e.g., an aerosol-generating procedure) (WHO Writing committee, 2005). Offering prophylactic treatment to families of infected patients and health care personnels may help prevent outcome of Avian Influenza by stopping the spread of the flu virus in the body. Oseltamivir and Zanamivir help shorten the time you have flu symptoms such as a stuffy or runny nose, sore throat, cough, muscle or joint aches, tiredness, headache, fever, and chills (ASHP, 2008). Prophylactic treatment with oseltamivir has been offered to potentially exposed individuals during the poultry outbreaks of H7N7 and H7N3 viruses in The Netherlands and Canada, respectively (Tweed, Skowronski, David et al., 2004; Koopmans, Wilbrink, Conyn , 2004). Oseltamivir is used to treat Avian flu in adults and children (older than 1 year of age) who have had symptoms of the flu for no longer than 2 days. Zanamivir on the other hand is used in adults and children at least 7 years of age. Both drugs belong to the class of medications called neuraminidase inhibitors. Oseltamivir will not prevent bacterial infections, which may occur as a complication of the flu (AHFS, 2008).

The Food and Drug Administration approved the first human vaccine to prevent infection with one strain of H5N1 bird flu virus in April 2007. When tested, the bird flu vaccine fully protected only about 45 percent of those vaccinated but still may help reduce the severity of the disease and decrease the risk of hospitalization and death in those who aren't fully protected. Other preventive methods of the Avian flu include: avoiding domesticated birds, avoiding open-air markets, washing hands properly, avoid substances made with raw eggs, cleaning and disinfection of environmental surfaces, use of gloves and protective attire, covering nose and mouth while coughing, not sharing dishes and cutleries used in eating (CDC, n.d; Mayoclinic website, n.d). As far as handling poultry is concerned, poultry should be well cooked reaching a minimum temperature of about 165° F (74° C), and hands properly washed and disinfected after handling poultry (Mayoclinic website, n.d).

2:2 Clinical features of Avian Influenza

Initial symptoms of avain Influenza include a high fever, usually with a temperature higher than 38° C, and Influenza-like symptoms (WHO, 2006a, Burnet institute, 2005). In many patients, the disease caused by the H5N1 virus follows an unusually aggressive clinical course, with rapid deterioration and high fatality (WHO, 2006a). Human infections with most Avian Influenza viruses have been shown to typically involve mild symptoms and non-contagious infections. On the other hand, fatal human disease and human-to-human transmissions have been confirmed from persons infected with Avian Influenza viruses of the H5N1 and H7N7 subtypes (Chan 2002, Koopmans, Wilbrink, Conyn, et al., 2004, du Ry van Beest Holle , Meijer, Koopmans et al., 2005, Ungchusak, Auewarakul, Dowell et al., 2005, Kandun , Wibisono, Sedyaningsih et al., 2006, Yang et al., 2007, WHO 2008.).

Some manifestations of Avian Influenza have been from mild conjunctivitis to fatal systemic disease and multiorgan failure, including severe or fatal respiratory, gastrointestinal, or neurological syndromes ((WHO, 2006a, de Jong and Hien 2006, Sandrock & Kelly 2007, Abdel-Gafar Chotpitayasunondh, Gao, et al., 2008).
Lower respiratory tract manifestations develop early in the course of illness and are usually found at presentation (WHO, 2006a; Chotpitayasunondh, Ungchusak, Hanshaoworakul, et al.2004). In one series, dyspnea (shortness of breath) developed a median of 5 days after the onset of illness (range, 1 to 16) (Chotpitayasunondh, Ungchusak, Hanshaoworakul, et al., 2004). Almost all patients have clinically apparent pneumonia (Chotpitayasunondh, Ungchusak, Hanshaoworakul, et al, 2004, Brunet institute, 2005; WHO, 2006a). Progression to respiratory failure has been associated with diffuse, bilateral, ground-glass infiltrates and manifestations of the acute respiratory distress syndrome (ARDS) (Fouchier, Schneeberger, Rozendaal et al., 2004; WHO, 2006a). Multiorgan failure with signs of renal (kidney) dysfunction and sometimes cardiac compromise, including cardiac dilatation (an increase in the size of the cavities of the heart) and supraventricular tachyarrhythmias (characterized by rapid, irregular heart beats associated with an atrial rate of a 100 or more a minute), have been common (Chan, 1997; Tam 2002; Chotpitayasunondh, Ungchusak, Hanshaoworakul, et al., 2004; Hien, Liem, Dung et al., 2004; Burnet Institute, 2005). Other complications have included ventilator-associated pneumonia, pulmonary hemorrhage (bleeding into the lung tissues), pancytopenia (reduction in red/white blood cells and platelets as a result of the disease affecting the bone marrow), pneumothorax (collapsed lungs), Reye's syndrome (a potentially fatal disease that causes numerous detrimental effects to many organs,

especially the brain and liver; it is associated with aspirin consumption by children with viral diseases), and sepsis syndrome (is a complex systemic inflammatory condition associated with infection) without documented bacteremia (presence of bacteria in the blood) (Yuen, Chan, Peiris et al., 1998; Tran , Nguyen, Nguyen et al., 2004; Beigel, Farrar, Han et al., 2005; Chotpitayasunondh , Ungchusak, Hanshaoworakul et al., 2005) .

2.3 Epidemiology

The epidemiological characteristics of the H5N1 virus in humans have changed significantly since the time of the 1997 Hong Kong epizootic, with higher observed rates of morbidity and mortality occurring among children and adolescents recorded in laboratory confirmed cases reported since 2003 (Tran et al. 2004, Chotpitayasunondh et al. 2005, Areechokchai et al. 2006, WHO Regional Pacific Office 2007).

According to the Weekly Epidemiological Record published online by WHO (2006a) from the first analysis of epidemiological data on all 205 laboratory-confirmed H5N1 cases officially reported to WHO by onset date from December 2003 to 30 April 2006,

- The overall case-fatality rate was highest in 2004 (73%), followed by 63% to date in 2006, and 43% in 2005.
- The overall case-fatality rate was 56%. Case fatality was high in all age groups but was highest in persons aged 10 to 39 years.
- Half of the cases occurred in people under the age of 20 years; 90% of cases occurred in people under the age of 40 years.
- The case-fatality profile by age group differs from that seen in seasonal Influenza, where mortality is highest in the elderly.

This skew in age distribution is not explainable by the population-age structure of the affected countries (Smallman-Raynor & Cliff, 2007). The unusual age distribution of case incidence and case fatality may reflect age-related patterns of exposure or risk behavior (e.g., close contact with sick poultry) or age-related host resistance (Peiris, de Jong & Guan' 2007). Significant numbers of family clusters were reported among the human H5N1 cases (Olsen, Ungchusak, Sovann et al., 2005; Kandun, Wibisono, Sedyaningsih et al., 2005; Beigel, Farrar, Han et al., 2005; WHO, 2006b). It is difficult to ascertain whether these clusters represent infection from a common environmental source or limited human-to-human transmission. Excluding a common source of infections is epidemiologically exceedingly difficult, and only unusual circumstances allow unequivocal proof of this (Ungchusak Auewarakul, Dowell et al., 2005). The frequencies of human infection have not been determined, and seroprevalence studies are urgently needed (Peiris, de Jong & Guan, 2007). The largest number of cases so far has been reported in Indonesia, followed by Vietnam, Egypt, China, Thailand and other countries (WHO, 2009). See *table 1* for more details.

Taken overall, it appears that while exposure to a source of H5N1 infection is necessary, such exposure alone is not sufficient to explain the observed epidemiology of H5N1 disease. Other as-yet-undetermined factors appear to be crucial in determining who gets infected and ill. Among other possibilities, the role of host genetic susceptibility factors and hitherto-unrecognized host resistance mechanisms deserve investigation (Sandbulte, Jiminez, Boon et al., 2007).

Table 1:Cumulative Number of Confirmed Human Cases of Avian Influenza A/(H5N1) Reported to WHO. (WHO, 2009).

2 March 2009

Country	2003		2004		2005		2006		2007		2008		2009		Total	
	Cases (C)	Deaths (D)	C	D	C	D	C	D	C	D	C	D	C	D	C	D
Azerbaijan	0	0	0	0	0	0	8	5	0	0	0	0	0	0	8	5
Bangladesh	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Cambodia	0	0	0	0	4	4	2	2	1	1	1	0	0	0	8	7
China	1	1	0	0	8	5	13	8	5	3	4	4	7	4	38	25
Djibouti	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Egypt	0	0	0	0	0	0	18	10	25	9	8	4	5	0	56	23
Indonesia	0	0	0	0	20	13	55	45	42	27	24	20	0	0	141	115
Iraq	0	0	0	0	0	0	3	2	0	0	0	0	0	0	3	2
Lao People's Democratic Republic	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	2
Myanmar	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Nigeria	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1
Pakistan	0	0	0	0	0	0	0	0	3	1	0	0	0	0	3	1
Thailand	0	0	17	12	5	2	3	3	0	0	0	0	0	0	25	17
Turkey	0	0	0	0	0	0	12	4	0	0	0	0	0	0	12	4
VietNam	3	3	29	20	61	19	0	0	8	5	6	5	2	2	109	54
Total	4	4	46	32	98	43	115	79	88	59	44	33	14	6	409	256

Total number of cases includes number of deaths.
WHO reports only laboratory-confirmed cases.
All dates refer to onset of illness.

3. Public health programs in Canada to fight Avian Influenza

The World Health Organization (WHO) considers the Avian Influenza A/H5N1 virus a public health risk with pandemic potential. The next human Influenza pandemic, if caused by the Avian Influenza A/H5N1 virus, is estimated to have a potential mortality rate of more than a hundred million (Thomas &Noppenberger, 2007). Avian Influenza has become a global problem that needs a global response. Canada has provided strong and influential leadership in the global response to Avian and pandemic Influenza. Avian Influenza threatens the health of humans and animals, as well as our global economy. More recent commitments have taken a more global approach and have focused on strengthening the capacity of key multilateral organizations to prepare for and respond to Avian/pandemic Influenza around the world (CIDA, n.d). There are 43 total quarantined premises reported in Canada as of February 2009 (CFIA, 2009), but no human cases have been reported yet, nevertheless, public health authorities are taking precautionary measures as warranted.

Programs in place to fight against Avian flu include:

- ***Health Canada's Global Public Health Intelligence Network (GPHIN),*** managed by the Centre for Emergency Preparedness and Response. This is a primary source of information for the WHO as well as international governments and other non-government public health organizations. GPHIN is an internet-based, early warning system that gathers preliminary media reports of public health significance 24 hours a day, 7 days a week. The information is filtered, analyzed and made available to subscribers. Notifications about public health events that may have serious public health consequences are immediately forwarded to users. GPHIN is currently being enhanced to offer service in all six WHO official languages (Arabic,English, French, Russian, Simplified Chinese and Spanish). It was the GPHIN system that first identified an unusual outbreak of pneumonia, later identified as SARS, as it was emerging in southern China (PHAC, 2003b).

- Health Canada has a comprehensive national surveillance system for Influenza, established in the 1996-1997 Influenza season. Laboratory surveillance for respiratory viruses has been in place since 1993. Surveillance information and alerts are communicated to Canada's public health community via disease surveillance networks such as the Influenza surveillance system "FluWatch"(PHAC, 2003b)
- **The *Quarantine Act*** and regulations enable Health Canada's quarantine officers to institute a range of screening and detention measures at airports and ports, including the following: -detaining people and goods in order to conduct medical examinations, analysis of goods or inspection of conveyances; -requiring airline carriers to distribute health information materials and conduct active screening of travellers en route, before departure and after arrival (PHAC, 2003b). Quarantine services are located at the Toronto, Vancouver, Montreal (Pierre Elliot Trudeau), Calgary, Edmonton, Halifax and Ottawa international airports.
- ***Travel advisories:*** Health Canada's Travel Medicine Program provides information for people travelling outside Canada and for travel medicine professionals who provide advice to international travellers. Travel

medicine information can be accessed 24 hours a day through the Internet and offers details on international disease outbreaks, immunization recommendations, general health advice for travellers, the location of travel clinics in Canada, and disease-specific treatment and prevention guidelines (PHAC, 2003b).

- ***Canada Food and Inspection agency (CFIA) regulations on the import of poultry products from other countries:*** These regulations are enforced through port-of-entry inspections. In the event of an outbreak of a foreign animal disease, the goal of the Agency's emergency response is to prevent further spread of the disease and protect animal health. In an AI outbreak, the CFIA would employ a "stamping out" policy in an effort to eradicate the disease. Actions include: humane destruction of all infected and exposed animals; -surveillance and tracing of potentially infected or exposed poultry; -strict quarantine and controls on movement of poultry; and thorough decontamination of infected premises (CFIA, 2008). Canada can regain its disease-free status and resume normal trade in poultry products three months after the disease control operations are completed and AI has been eradicated (CFIA, 2009)
- ***Bird Health Basics*** led by the Canadian Food Inspection Agency (CFIA), are simple steps that owners of backyard flocks and pet birds can take to help protect their birds from dangerous diseases, such as Avian Influenza and exotic Newcastle disease (CFIA, 2008)

- **Health Canada's Respiratory Illness Outbreak Response Protocol** outlines basic roles and responsibilities, general principles and operating procedures agreed upon by the federal, provincial and territorial governments. This will help ensure coordinated efforts around investigation and control of severe respiratory illness outbreaks in Canada that have international and multi-jurisdictional implications (PHAC, 2003b)
- Health Canada gathers infectious disease intelligence from a variety of sources. Reports are received from the WHO, the CDC, ministries of health in other countries, and provincial and territorial reports. Health Canada's infectious disease programs perform daily scans of information published by international surveillance systems(PHAC, 2003b).
- ***Canadian centre for occupational health and safety website*** has information for pandemic preparedness for the home, work place and communities.
- **National Emergency Stockpile System** (NESS). The NESS contains everything that you would expect to find in a hospital, from beds and blankets and a supply of pharmaceuticals. This includes a stockpile of antiviral medication (PHAC, n.d).
- **Real-time alert system for serious respiratory illnesses** (SRIs), including SARS and Avian Influenza, to ensure timely dissemination of information to the provinces and territories (PHAC, n.d).

- **Hospital-based surveillance system** to detect cases and clusters of severe or emerging respiratory infections and to effectively prevent and contain their spread in acute care facilities (PHAC, n.d).
- Establish a contract for **pandemic vaccine production**. Canada is the first country worldwide to plan for a secure vaccine supply through the contracting of a domestic supplier (PHAC, n.d).

4. Recommendations to overcome challenges faced in the prevention, treatment and eradication of Avian Influenza

Despite the current measures Canada has in place to reduce the current incidence of Avian Influenza and other respiratory infectious diseases, the Avian Influenza continues to exist in poultry in Canada. The virus has not been eradicated worldwide and therefore its presence signifies the challenges we face in preventing and controlling Avian Influenza outbreaks in Canada.

Some countries may be better prepared to fight Avian Influenza than others. However it appears that the best approach will be to create a multi-collaborative strategy to prevent the spread of Avian Influenza. Recent statistics for the human cases/death from the Avian Influenza suggest that primarily countries in Southeast Asia are most affected by this virus (WHO, 2009). This may be attributed to over-population, poor hygiene, poor handling of poultry and, from a medical perspective to a lack of the availability of neuraminidase inhibitors. Most disturbing is that human cases might be transmitted to Canadians leaving from countries where infection rates are highest. These same Canadians might decide to come back to Canada for a visit, thereby infecting others through global travel or upon their return to Canada. This can lead to an increase in the distribution of the disease and may be a precursor to a pandemic.

Considering such risk of the spread of infectious outbreaks, the following recommendations are suggested:

- ***Tight monitoring of sea-ships:*** Programs are in place for airport monitoring and other port of entry monitoring of imports of poultry. These should be tightened in order to be more effective. If possible poultry from other countries should be quarantined at the port of entry until the incubation period of Avian flu is over to be sure the birds are not harbouring the disease before being released. Travelling by sea,is another method of travelling thou not used as often as air. Monitoring travellers or ship crews and train crews is very important (Onishchenko, 2006)
- ***Media awareness***: The media (television, radio, newspapers) has been used as form of advertising for commercial products and this has seen rise in the purchases of these products. This same approach can be used to make awareness of Avian flu and other respiratory infectious diseases. The population can be informed of the warning signs to look for in poultry and also in humans. They should also be informed of the preventive measures against Avian flu listed earlier on. This should be on a continuous basis, not only when there is an outbreak.
- ***"Health watch of the day":*** With the cell phone era, people subscribe to jokes of the day, horoscope, and so on. Public health agency of Canada can partner with cell phone companies, so that as soon as one wakes up in

the morning and turn on their cell phone, they get an educational material on medical issues, updates and thinks to watch out for. They can also partner with major search engines like Google and Yahoo, for this awareness to be made.

- ***Community awareness:*** The community should be informed of the signs and symptoms of Avian flu by organizing gatherings at community centres,churches public library, schools and other places where people normally gather. Those in close contact with poultry should also be well informed in the signs to look for in their poultry and to report immediately to the CFIA or Health Canada when any abnormal signs are noted in the poultry or in humans.
- ***Compensation for culled birds:*** Incentives given to the farmers for culled poultry should be good enough as to encourage them to report any abnormalities seen in the poultry.
- ***Emotional support to farmers:*** Emotional support should be available to farmers whose birds are culled for most of them doing farming love animals and become emotionally attached to the poultry, and culling these birds brings emotional stress to them. Other farmers will be encouraged to report symptoms early if they know they will be supported.
- Arranging regular workshops for health care professionals to recognize signs and symptoms of Avian flu and how to take precautions accordingly.

- Arranging "mock" sessions of a pandemic flu in the health care setting and seeing how health care workers respond to it, in order to see loopholes in the emergency preparedness.
- ***Strong national and global collaboration*:** Developed countries can be as prepared as they can both pharmaceutical and non-pharmaceutical means but as long as developing countries are not prepared pharmaceutically (because they cannot afford stockpiles of anti-viral agents, and also the vaccines cannot be produced in a timely manner) Avian Influenza will still be brought into Canada through travelling and international trade. The World Health Organization should look for means of utilising global resources. Open communication is also critical to fight the Avian flu. The virus should also be identified and contained at the source, so that it doesn't become a pandemic. These can only be successful through strong national and global collaboration.
- ***Research:*** Research should be ongoing to define the basic transmission patterns of Avian Influenza viruses. To date it is not exactly certain how poultry to human or human-to-human transmission occurs. Research is the only way that will get us ready in case of antigenic shift and antigenic drift of the virus leading to resistant strains. Neuraminidase inhibitors are the only anti-virals studied so far to be effective for Avian Influenza. More pharmaceutical research should be done to get other drugs that will be effective, in the case of drug resistance to neuraminidase inhibitors.

- ***Adherence to the WHO guidelines of Epidemic and Pandemic Alert and Response (WHO, 2006c).*** Health care workers should adhere strictly to these guidelines; such as performing hand hygiene before and after any patient contact and after contact with contaminated items, whether or not gloves are worn and also use standard and droplet precautions when providing care for patients with acute, febrile, respiratory illness, regardless of whether Avian Influenza infection is suspected. Facial protection and hand hygiene are the most critical elements of these precautions and should be prioritized.

5. Conclusion

Canada has a solid system in place to fight viral respiratory infectious diseases, with the creation of the Public Health Agency of Canada (PHAC), and emergency preparedness plans provincially and federally. Despite these plans, some challenges still exit that need to be addressed on an ongoing basis.

The virus by itself is virulent; it undergoes antigenic shift and antigenic drift like any other virus, making it difficult to control. On the other hand Canada cannot prevent people from travelling for trade or for pleasure. However the government can monitor potential high-risk locations for clinical signs and symptoms of potential Influenza outbreak.

Considering the severe acute respiratory syndrome (SARS) and the rapid spread of this infectious outbreak globally, the number of cases and mortality, and the speed of infection, Canada and the world must be prepared to deal with new and emerging outbreaks of infectious diseases to prevent the chance that a pandemic of respiratory infections could result.

A global Influenza pandemic (worldwide spread) may occur if three conditions are met (CDC, n.d):

- A new subtype of Influenza A virus is introduced into the human population.
- The virus causes serious illness in humans.
- The virus can spread easily from person to person in a sustained manner.

Canada might have all the plans in place but as long as the world doesn't have a working globalized preparedness plan, all efforts made by Canada will be futile because the virus will still be propagated elsewhere.

More research is needed on vaccine production and on developing new neuraminidase inhibitors. Likewise the population has to be made aware on an ongoing basis about emergency preparedness scenarios to reduce the risk of an emerging pandemic. Communication is essential between the WHO, CDC, PHAC, CFIA, and other decision makers involved in the prevention of respiratory as well as other types of infectious diseases.

If all these recommendations are followed, Canada will be moving in the right direction to prevent the spread and reduce the incidence of Avian Influenza.

Appendix 1

Instances of Avian Influenza A virus infections in humans (CDC, n.d)

Confirmed instances of Avian Influenza A virus infections of humans since 1996 include:

- **H7N7, United Kingdom, 1996**: One adult developed conjunctivitis after a piece of straw contacted her eye while cleaning a duck house. Low pathogenic Avian Influenza A (H7N7) virus was isolated from a conjunctiva specimen. The person was not hospitalized and recovered.
- **H5N1, Hong Kong, Special Administrative Region, 1997**: Highly pathogenic Avian Influenza A (H5N1) virus infections occurred in both poultry and humans. This was the first time an Avian Influenza A virus transmission directly from birds to humans had been found to cause respiratory illness. During this outbreak, 18 people were hospitalized and six of them died. To control the outbreak, authorities culled about 1.5 million chickens to remove the source of the virus. The most significant risk factor for human H5N1 illness was visiting a live poultry market in the week before illness onset.
- **H9N2, China and Hong Kong, Special Administrative Region, 1999**: Low pathogenic Avian Influenza A (H9N2) virus infection was confirmed in two hospitalized children and resulted in uncomplicated Influenza-like illness. Both patients recovered, and no additional cases were confirmed. The source is unknown. Several additional human H9N2 virus infections were reported from China in 1998-1999.

- **H7N2, Virginia, 2002**: Following an outbreak of low pathogenic Avian Influenza A (H7N2) among poultry in the Shenandoah Valley poultry production area, one person developed uncomplicated Influenza-like illness and had serologic evidence of infection with H7N2 virus.
- **H5N1, China and Hong Kong, Special Administrative Region, 2003**: Two cases of highly pathogenic Avian Influenza A (H5N1) virus infection occurred among members of a Hong Kong family that had traveled to China. One person recovered, the other died. How or where these two family members were infected was not determined. Another family member died of a respiratory illness in China, but no testing was done.
- **H7N7, Netherlands, 2003**: The Netherlands reported outbreaks of highly pathogenic Avian Influenza A (H7N7) virus among poultry on multiple farms. Overall, 89 people were confirmed to have H7N7 virus infections associated with poultry outbreaks. Most human cases occurred among poultry workers. H7N7-associated illness was generally mild and included 78 cases of conjunctivitis (eye infections); five cases of conjunctivitis and Influenza-like illness with fever, cough, and muscle aches; two cases of Influenza-like illness; and four cases that were classified as "other." One death occurred in a veterinarian who visited one of the affected farms and developed complications from H7N7 virus infection, including acute respiratory distress syndrome. The majority of H7N7 cases occurred through direct contact with infected poultry. However, Dutch authorities reported three possible instances of human-to-human H7N7 virus transmission from poultry workers to family members.

- **H9N2, Hong Kong, Special Administrative Region, 2003**: Low pathogenic Avian Influenza A (H9N2) virus infection was confirmed in a child in Hong Kong. The child was hospitalized with Influenza-like illness and recovered.
- **H7N2, New York, 2003**: In November 2003, a patient with serious pre-existing medical conditions was admitted to a hospital in New York with respiratory symptoms. The patient recovered and went home after a few weeks. Testing revealed that the patient had been infected with a low pathogenic Avian Influenza A (H7N2) virus; the patient's underlying medical conditions likely contributed to the severity of the patient's illness.
- **H7N3, Canada, 2004**: In March 2004, two poultry workers who were assisting in culling operations during a large Influenza A (H7N3) poultry outbreak had culture-confirmed H7N3 conjunctivitis, one of whom also had coryza. Both poultry workers recovered. One worker was infected with low pathogenic H7N3 and the other with high pathogenic H7N3.
- **H5N1, China, Thailand and Vietnam, 2003-2004**: In late 2003 and early 2004, severe and fatal human infections with highly pathogenic Avian Influenza A (H5N1) viruses were associated with widespread poultry outbreaks. Most cases had pneumonia and many had respiratory failure. Additional human H5N1 cases were reported during mid-2004 and late 2004. Most cases appeared to be associated with direct contact with sick or dead poultry. One instance of possible, limited, human-to-human spread of H5N1 virus is believed to have occurred in Thailand. Overall, 50 human H5N1 cases with 36 deaths were reported from these three countries.

- **H5N1, Cambodia, China, Indonesia, Thailand, Vietnam, 2005**: Severe and fatal human infections with highly pathogenic Avian Influenza A (H5N1) viruses were associated with the ongoing H5N1 epizootic among poultry in the region. Overall, 98 human H5N1 cases with 43 deaths were reported from five countries.
- **H5N1, Azerbaijan, Cambodia, China, Djibouti, Egypt, Indonesia, Iraq, Thailand, Turkey, 2006**: Severe and fatal human infections with highly pathogenic Avian Influenza A (H5N1) viruses occurred in association with the ongoing and expanding epizootic. While most of these cases occurred as a result of contact with infected poultry, in Azerbaijan, the most plausible cause of exposure to H5N1 in several instances of human infection is thought to be contact with infected dead wild birds (swans). The largest family cluster of H5N1 cases to date occurred in North Sumatra, Indonesia during May 2006, with seven confirmed H5N1 cases and one probable H5N1 case, including seven deaths. Overall, 115 human H5N1 cases with 79 deaths were reported in nine countries.
- **H5N1, Cambodia, China, Egypt, Indonesia, Laos, Myanmar, Nigeria, Pakistan, Vietnam, 2007**: Severe and fatal human infections with highly pathogenic Avian Influenza A (H5N1) viruses occurred in association with poultry outbreaks. In addition, during 2007, Nigeria (January), Laos (February), Myanmar (December), and Pakistan (2007) confirmed their first human infections with H5N1. Overall nine countries reported a total of 86 human cases with 59 deaths in 2007.

- **H7N2, United Kingdom, 2007**: Human infection with low pathogenic Avian Influenza A (H7N2) virus resulting in Influenza-like illness and conjunctivitis were identified in four hospitalized cases. The cases were associated with an H7N2 poultry outbreak in Wales.
- **H9N2, Hong Kong, Special Administrative Region, 2007**: In March 2007, low pathogenic Avian Influenza A (H9N2) virus infection was confirmed in a 9-month old Hong Kong girl with mild signs of disease.

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