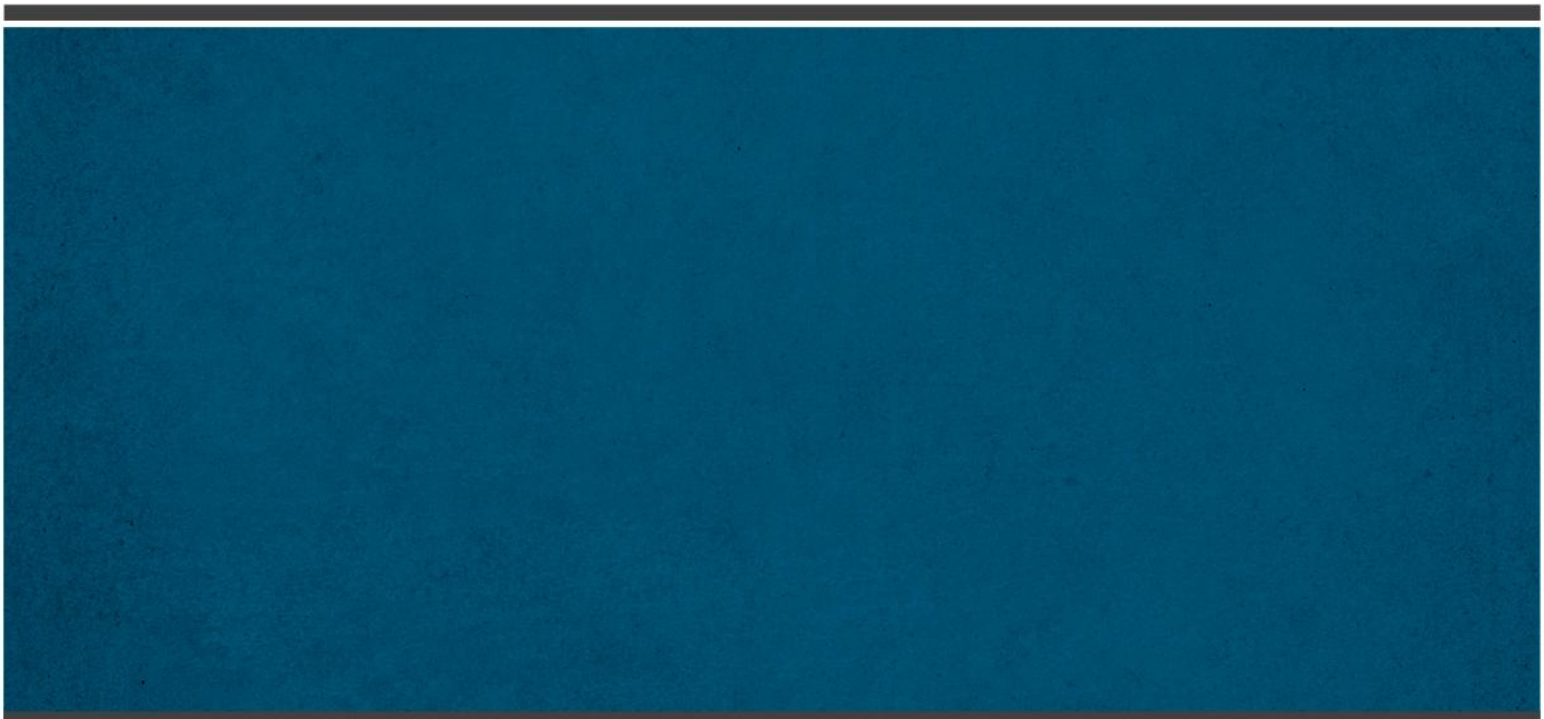
PUBLIC HEALTH AGENCY OF CANADA

AN EPIDEMIOLOGIC AND VIROLOGIC SUMMARY OF SEASONAL AND PANDEMIC INFLUENZA IN CANADA

2008–2009 TO 2009–2010 SEASONS



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Canada

AN EPIDEMIOLOGIC AND VIROLOGIC SUMMARY OF SEASONAL AND PANDEMIC INFLUENZA IN CANADA, 2008-2009 TO 2009-2010 SEASONS

Introduction

FluWatch, Canada's national influenza surveillance system, monitors the spread of influenza and influenza-like-illness (ILI) on an ongoing basis. The first seven months of the 2008-2009 influenza season appeared to follow the routine pattern of influenza activity. However, in late April of 2009, a novel influenza H1N1 virus, that first infected individuals in Mexico and shortly after in the United States of America, was first detected in Canada. The novel influenza virus continued to spread aggressively, infecting more individuals across the country and across the globe. On June 11, 2009, the World Health Organization (WHO) declared that the 2009 influenza pandemic had started; by that time, the pandemic virus had infected nearly 30,000 individuals (laboratory-confirmed infections) in 74 countries[1]. In August 2010, the WHO announced the start of the H1N1 post-pandemic period after which the H1N1 virus (influenza A(H1N1)pdm09) was expected to take on the behaviour of seasonal influenza viruses and continue to circulate for some years to come[2].

Previously published reports[3, 4] described rates and risk of severe outcomes among hospitalized cases of influenza A(H1N1)pdm09. This report provides an epidemiologic and virologic summary of influenza activity in Canada during the pandemic period (Waves 1 and 2) which spanned two influenza seasons (2008-2009 and 2009-2010).

Objectives

The primary objectives of the FluWatch program are early detection and timely reporting of influenza activity in Canada and abroad; monitoring of circulating strains of influenza virus, including antigenic characterization and identification of new subtypes, antiviral resistance; and provision of virologic surveillance information to the World Health Organization (WHO) global influenza surveillance network to contribute to decision-making for the following season's vaccine components. During the pandemic, the objectives were expanded to include the continued monitoring and assessment of the progression of the pandemic virus so that effective public health measures could be adopted and evaluated to best reduce the burden of illness and societal disruption attributable to the pandemic virus.

Methods

Detailed descriptions of core FluWatch data sources and methodologies are described in a previous report[5] however high level summaries are also included below. Unless otherwise specified, information on data received from the sources mentioned below between August 24, 2008 to August 29, 2009 for the 2008-2009 season and between August 30, 2009 to July 17, 2010 for the 2009-2010 season will be presented in this report.

Data Sources

(1) Respiratory Virus Detection Surveillance System (RVDSS)

Aggregate information on positive laboratory detections for influenza viruses, respiratory syncytial viruses, parainfluenza viruses, adenoviruses and human metapneumoviruses were reported weekly by sentinel public health and hospital-based laboratories across Canada through the RVDSS. Detailed case-level information on positive influenza cases was also reported by the majority of the sentinel laboratories.

(2) National Microbiology Laboratory (NML)

The NML, within the Public Health Agency of Canada (PHAC), conducted strain characterizations and

antiviral resistance testing (for amantadine, oseltamivir and zanamivir) on a subset of positive influenza virus detections from sentinel laboratories across Canada.

(3) Sentinel physicians/practitioners
A network of sentinel physicians/practitioners, recruited from across the country, reported weekly aggregated information on patients seen with influenza-like-illness (ILI)[*].

(4) Provincial and Territorial (P/T) Ministries of Health
Weekly aggregate counts of outbreaks[†] due to influenza or ILI as well as influenza activity levels[‡] for each of the 54 influenza surveillance regions across the country were provided by all 13 P/T Ministries of Health. In order to respond to surveillance needs during the pandemic, additional surveillance information was provided by the P/Ts such as detailed information on laboratory-confirmed influenza A(H1N1)pdm09 cases identified during the first four weeks of the pandemic in Canada (April 26, 2009 to May 22, 2009) and information on influenza A(H1N1)pdm09 -specific hospitalizations and deaths (between April 12, 2009 – April 3, 2010).

(5) Immunization Monitoring Program Active (IMPACT) Network
The IMPACT Network provided weekly aggregate data on paediatric influenza-associated hospitalizations and deaths from 12 paediatric tertiary care centres across Canada. Detailed case-level information such as symptom onset date, length of stay at hospital and pre-existing co-morbidities were also provided upon further review and validation at the IMPACT data centre.

(6) Statistics Canada
Mortality data for deaths due to pneumonia and influenza (P&I) and seasonal influenza between 2000 and 2005 were obtained from Statistics Canada.

(7) Google Flu Trends (GFT)
Google Flu Trends (GFT) provided near real-time estimates of influenza activity for a number of countries and regions around the world based on aggregated search queries. Some of these estimates have been validated through comparison with official historic influenza data from the relevant country or region. [(6)] GFT data for Canada in the form of an ILI rate per 100,000 physician visits were downloaded directly from the GFT website for the period spanning April 12, 2009 to January 2, 2010.

Analyses

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[*] FluWatch definition for influenza-like illness (ILI) during the 2008-2010 influenza seasons – acute onset of respiratory illness with fever and cough and with one or more of the following: sore throat, arthralgia, myalgia, or prostration, which could be due to influenza virus. In children under 5, gastrointestinal symptoms may also be present. In patients under 5 or 65 and older, fever may not be prominent.

[†] FluWatch definition for outbreaks during the 2008-2010 influenza seasons – **Hospitals and Residential institutions**: two or more cases of ILI within a seven-day period, including at least one laboratory confirmed case. **Schools**: Greater than 10% absenteeism (or absenteeism that is higher (e.g. >5-10%) than expected level as determined by school or public health authority) which is likely due to ILI. Note: it is recommended that ILI school outbreaks be laboratory confirmed at the beginning of influenza season as it may be the first indication of community transmission in an area. **Other settings:** two or more cases of ILI within a seven-day period, including at least one laboratory confirmed case; i.e. closed communities

[‡] FluWatch activity level definitions during the 2008-2010 influenza seasons – **No activity:** no laboratory-confirmed influenza detections in the reporting week, however, sporadically occurring ILI may be reported. **Sporadic**: sporadically occurring ILI and laboratory confirmed influenza detection(s) with no outbreaks detected within the influenza surveillance region. **Localized**: evidence of increased ILI (more than just sporadic as determined by the P/T epidemiologist) and laboratory confirmed influenza detection(s) together with outbreaks in schools, hospitals, residential institutions and/or other types of facilities occurring in less than 50% of the influenza surveillance region. **Widespread**: evidence of increased ILI (more than just sporadic as determined by the P/T epidemiologist) and laboratory confirmed influenza detection(s) together with outbreaks in schools, hospitals, residential institutions and/or other types of facilities occurring in greater than or equal to 50% of the influenza surveillance region.

Basic summary statistics (i.e. counts and proportions) were used to describe the majority of surveillance information collected. For ILI rate calculations, data from sentinel practitioners were weighted by the estimated population for each of the census divisions being represented during the respective week. This was done in order to produce a summary ILI rate for the Canadian population. Each week the weights were re-calculated based on the actual census divisions with data to report. Weighted rates were then summed to create a national ILI rate each week. The mean ILI consultation rates and 95% confidence intervals from the 1996-1997 to 2008/2009 seasons for weeks 40 through 18 were calculated and served as a reference for comparison.

Differences between groups of influenza A(H1N1)pdm09 cases identified during the first four weeks of the pandemic were tested for statistical significance using a Chi-square test or Fisher's exact test, as appropriate. Estimates of expected years of life lost (YLL) were calculated based on information from the deaths due to influenza A(H1N1)pdm09 and on mortality data obtained from Statistics Canada.
Spearman's Rank correlation coefficient was used to calculate the correlation between ILI consultations rates from FluWatch and from GFT for each of the waves.

Results

1) Laboratory-based influenza and other respiratory virus detections

a) Influenza and other respiratory virus detections from the Respiratory Virus Detection Surveillance System (RVDSS) (aggregate data)

In the 2008-2009 season, a total of 214,067 influenza tests were performed by 33 RVDSS laboratories of which 10.9% (23,376/214,067) were positive for influenza viruses. Of these, 83.3% (19,474/23,376) were positive for influenza A viruses and 16.7% (3,902/23,376) were positive for influenza B viruses. Of the 19,474 positive influenza A viruses detected, 62.8% (12,238) were not subtyped, 34.3% (6,676) were confirmed pandemic H1N1, 1.2% (240) were of H1 subtype, and 1.6% (320) were of H3 subtype (Table 1). The distribution of positive influenza detections by report week and by influenza type varied (Figure 1). Percent positive detections for other respiratory viruses were as follows: 6.8% (10,564/ 155,284) for respiratory syncytial virus (RSV); 2.9% (3,903/135,861) for parainfluenza virus; and 1.7% (2,142/127,313) for adenovirus. Furthermore, 24 of the 33 RVDSS labs reported their results for human metapneumovirus (hMPV) testing during the 2008-2009 season. Of the 40,156 tests for hMPV conducted, 1.7% were positive for hMPV. Weekly percent positive trends for influenza compared to the other respiratory viruses are displayed in Figure 2.

During wave 1 of the pandemic (April 12 - August 29, 2009), a total of 123,449 influenza tests were done of which 11.8% (14,616) were positive for influenza. Of these, 97.1% (14,197) were positive for influenza A viruses and only 2.9% (419) were positive for influenza B viruses. Of the 14,197 positive influenza A viruses, 49.0% (6,961) were not subtyped, 47.0% (6,676) were pandemic H1N1, 1.7% (240) were of H1 subtype, and 2.2% (320) were of H3 subtype.

In the 2009-2010 season however, a total of 199,262 influenza tests were done of which 19.6% (39,024) were positive for influenza viruses. Of these, 99.9% (38,995) were positive for influenza A viruses and 0.1% (29) were positive for influenza B viruses. Of the 38,995 positive influenza A viruses, 13.8% (5,402) were not subtyped, 86.0% (33,528) were confirmed pandemic H1N1, 0.03% (11) were of H1 subtype, and 0.14% (54) were of H3 subtype (Table 1). Percent positive detections for other respiratory viruses were as follows: 8.1% (9,547/ 117,661) for RSV; 3.1% (3,282/105,819) for parainfluenza virus; and 1.2% (1,299/107,621) for adenovirus. Furthermore, 17 of the 33 RVDSS labs reported their results for human metapneumovirus (hMPV) testing during the 2009-2010 season. Of the 64,779 tests conducted for hMPV, 3.4% were positive for hMPV.

The laboratory findings for influenza cases and percent positive during the two pandemic waves are presented in Table 2.

Table 1: Influenza detections by type and sub-type, by reporting province, Canada, 2008-2009 and 2009-2010 influenza seasons

Reporting Province	2008 - 2009						2009 - 2010					
	Influenza A					Influenza B	Influenza A					Influenza B
	A (H1)	A (H3)	Pandemic H1N1	A un-subtyped	Total A	Total B	A (H1)	A (H3)	Pandemic H1N1	A un-subtyped	Total A	Total B
BC	11	9	605	1118	1743	210	0	2	5819	565	6386	2
AB	0	8	664	2410	3082	467	2	5	5764	102	5873	3
SK	31	79	878	437	1425	219	0	1	2298	299	2598	0
MB	7	35	774	266	1082	37	0	0	1788	127	1915	0
ON	146	158	3043	3498	6845	1361	4	1	3571	4249	7825	12
QC	0	0	0	3905	3905	1418	4	44	10653	5	10706	11
NB	3	3	122	367	495	95	1	1	1835	19	1856	0
NS	24	24	472	100	620	60	0	0	753	35	788	1
PE	7	0	16	14	37	9	0	0	96	1	97	0
NL	11	4	102	123	240	26	0	0	951	0	951	0
Total	**240**	**320**	**6676**	**12238**	**19474**	**3902**	**11**	**54**	**33528**	**5402**	**38995**	**29**

NOTE: Specimens from NT, YT, and NU are sent to reference laboratories in other provinces.

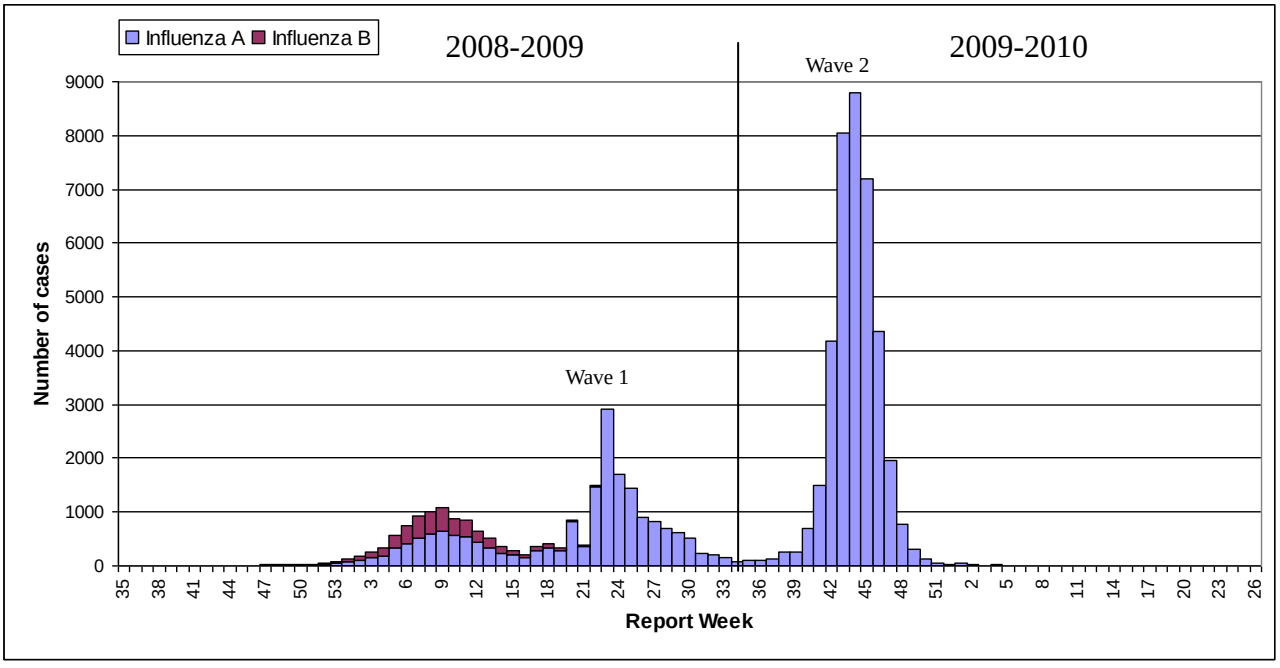

Figure 1. Distribution of positive influenza detections by type and report week, Canada, 2008-2009 and 2009-2010 seasons

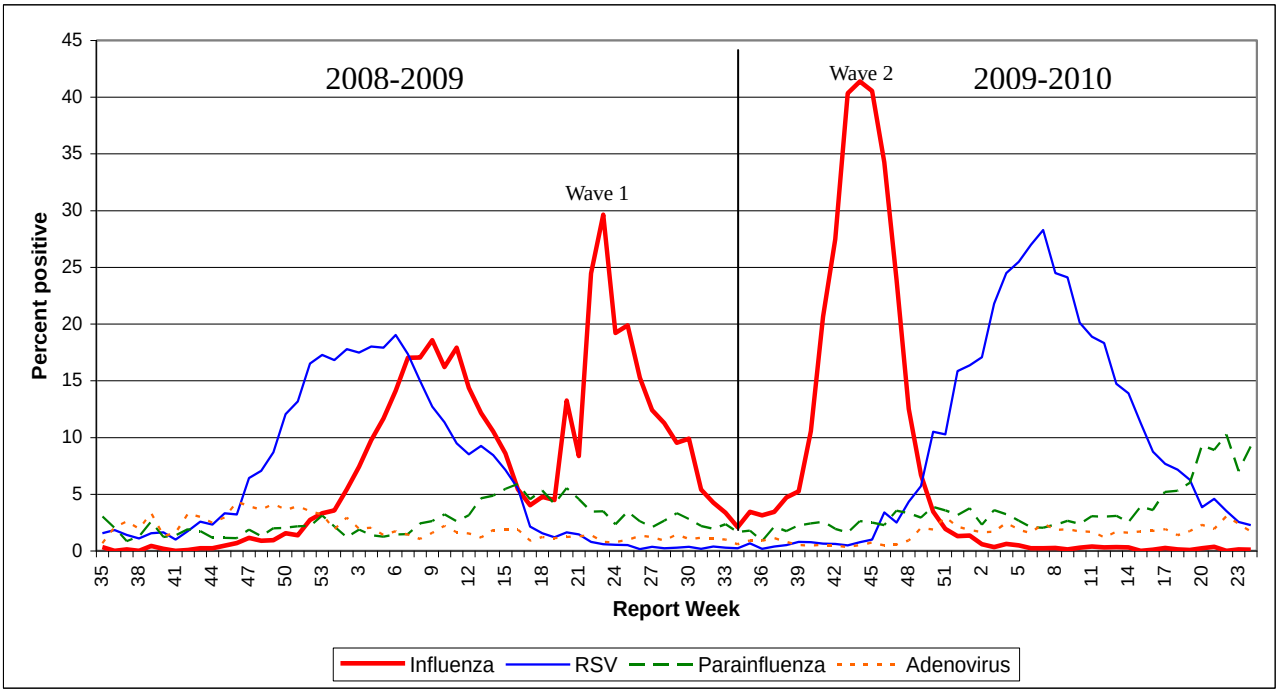

Figure 2. Percent positive influenza tests compared to other respiratory viruses, by report week, Canada, 2008-2009 and 2009-2010 seasons

Table 2: Summary of surveillance data for the pandemic period (April 12, 2009-July 17, 2010) and by wave, Canada

	Wave 1 Apr. 12 - Aug. 29, 2009	Wave 2 Aug. 30, 2009 - July 17, 2010	Pandemic Period Apr. 12, 2009 - July 17, 2010
Laboratory Findings			
Number of cases	14,616	39,024	53,640
Percent positive	11.8%	19.6%	16.6%
Per capita influenza testing rate (per 100,000 population)	371	585	956
Age Group (# & %)			
All ages	8,440	29,138	37,578
0 - 4	874 (10%)	4,764 (16%)	5,638 (15%)
5 - 9	977 (12%)	4,058 (15%)	5,035 (13%)
10 - 14	1,146 (14%)	3,577 (12%)	4,723 (13%)
15 - 24	1,804 (21%)	4,826 (16%)	6,630 (18%)
25 - 44	2,068 (25%)	6,183 (21%)	8,251 (22%)
45 - 64	1,272 (15%)	4,517 (16%)	5,789 (15%)
≥ 65	299 (3%)	1,213 (4%)	1,512 (4%)
Activity Levels			
% of regions reporting widespread or localized activity at the peak of activity	20%	76%	76%
Outbreaks			
All types	88	2,767	2,855
Long-term Care Facility	34 (39%)	57 (2%)	91 (3%)
Hospitals	11 (12%)	31 (1%)	42 (1%)
Schools	24 (27%)	2,638 (95%)	2,662 (93%)
Other Facilities	19 (22%)	41 (1%)	60 (2%)
Paediatric Hospitalizations & Deaths			
# of Hospitalizations	385	948	1,333
# of ICU admissions (%)	67 of 385* cases (17%)	133 of 293* cases (45%)	200 of 678* cases (29%)
# of deaths due to pH1N1	3	6	9

* Number of cases for which information was available

b) Influenza virus detections from the RVDSS (case-level reporting)

For the 2008-2009 season, a total of 15,197 detailed case-level records were reported to FluWatch from seven provinces: 10.3% (1,569) from British Columbia; 30.8% (4,677) from Alberta; 10.8% (1,639) from Saskatchewan; 1.2% (188) from Manitoba; 2.5% (382) from Ontario; 42.7% (6,488) from Quebec; and 1.7% (254) from Nova Scotia. Age information was obtained from 99.3% (15,094) of the 15,197 case records and the distribution varied across age groups (Figure 3).

During wave 1 of the pandemic, age information was obtained from 8,440 cases and the distributions of these cases by age group were as follows: 10.3% (874) were between 0-4 years of age; 11.6% (977) were between 5-9 years; 13.6% (1,146) were between 10-14 years; 21.4% (1,804) were between 15-24 years; 24.5% (2,068) were between 25-44 years; 15.1% (1,272) were between 45-64 years; and 3.5% (299) were 65 years and older (Table 2).

For the 2009-2010 season, a total of 30,550 detailed case-level records were reported to FluWatch from six provinces and two territories: 22.5% (6,877) from British Columbia; 17.9% (5,472) from Alberta; 6.6% (2,014) from Saskatchewan; 13.2% (4,028) from Ontario; 36.0% (10,983) from Quebec; 2.5% (778) from Nova Scotia; 1.1% (339) from the Northwest Territories; and 0.2% (59) from Nunavut. Age information was

obtained from 95.4% (29,138) of the 30,550 case records and the distribution by age group varied (Figure 3). The distribution of cases by age group for the pandemic period (separated by wave and combined) are presented in Table 2.

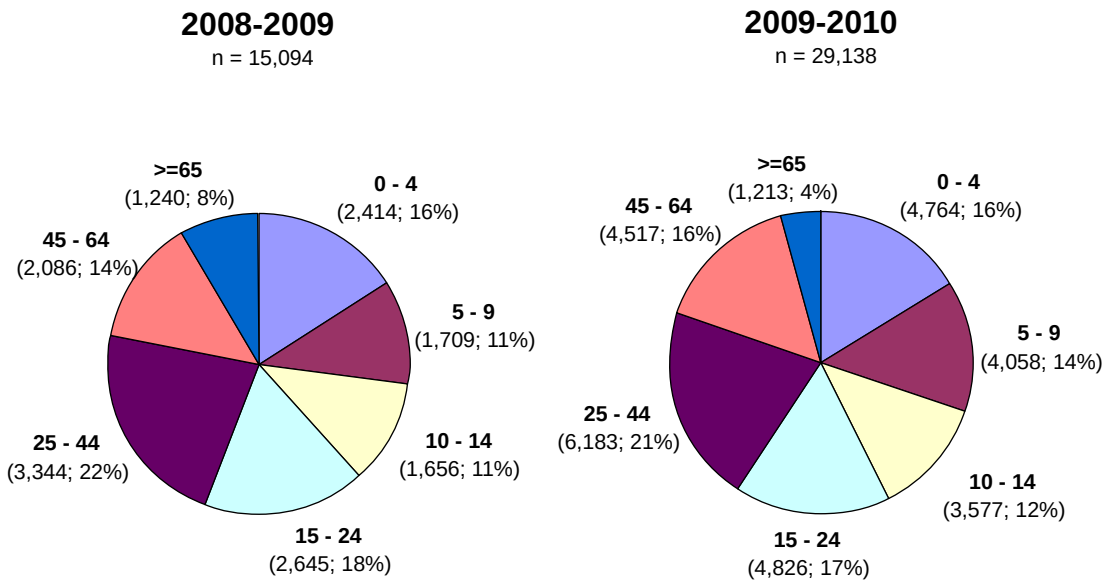

Figure 3. Proportionate distributions of cases, by age group, Canada, 2008-2009 and 2009-2010 seasons

c) Laboratory-confirmed influenza A(H1N1)pdm09 cases during the first 4 weeks of the pandemic (April 26, 2009 to May 22, 2009) from Provincial/Territorial Ministries of Health

A total of 805 laboratory-confirmed cases of influenza A(H1N1)pdm09 were reported to the Public Health Agency of Canada (PHAC) from nine provinces and 1 territory in the first four weeks of the pandemic in Canada. Of those, detailed information was obtained for 91.2% (734) of the cases. The greatest proportion of the cases were reported for individuals between 10 – 19 years of age (41.0%) and 20 – 29 years of age (20.4%). Travel-related information was available for 567 of the 734 cases; 28.7% (163) of these traveled in the 7 days prior to symptom onset. Of the 151 cases that reported the country of travel, 86.1% (130) had visited Mexico, 11.3% (17) had visited the U.S.A., 1.3% (2) had visited both Mexico and the U.S.A., and 1.3% (2) had visited other destinations. The proportion of travel-related cases was significantly higher in the early stage of the pandemic (cases with symptom onset dates occurring in the first half of the time period) than in the late stage (second half of the time period) ($p<0.01$).

2) Strain identification and antiviral resistance for circulating influenza viruses, National Microbiology Laboratory (NML)

a) Influenza virus strain identification

During the 2008-2009 season, the NML received 1,342 isolates from provincial and hospital laboratories across Canada. Of the 1, 342 isolates, 44.6% (599) were influenza A (H1N1), 12.9% (173) were influenza A (H3N2), and 42.5% (570) were influenza B viruses. Of the 599 influenza A (H1N1) isolates characterized, 43.9% (263) were antigenically similar to A/Brisbane/59/2007, the influenza A (H1N1) component of the 2008-2009 vaccine, and 56.1% (336) were characterized as A/California/07/2009-like, which was the

pandemic H1N1 2009 strain. All 173 influenza A (H3N2) isolates tested (100%) were antigenically similar to A/Brisbane/10/2007, which was the influenza A (H3N2) component in the 2008-2009 vaccine. Influenza B viruses that circulated could be divided into two antigenically distinct lineages represented by B/Yamagata/16/1988-like and B/Victoria/2/1987-like viruses. Of the 570 influenza B viruses characterized, 31.6% (180) were antigenically similar to B/Brisbane/60/2008 (Victoria lineage), 66.5% (379) were antigenically similar to B/Malaysia/2506/2004 (Victoria lineage), the B component for the 2007-2008 vaccine and 1.9% (11) were characterized as B/Florida/4/2006-like (Yamagata lineage), which was the recommended B component for the 2008-2009 vaccine.

During the 2009-2010 season (between September 1, 2009 – July 3, 2010), the NML received 875 isolates from provincial and hospital laboratories across Canada. Of these, 98.1% (858) were influenza A (H1N1), 1.1% (10) were influenza A (H3N2), and 0.8% (7) were influenza B viruses. Of the 858 influenza A (H1N1) isolates characterized, 99.7% (855) were antigenically similar to A/California/07/2009, which was the pandemic H1N1 2009 strain, and 0.4% (3) were A/Brisbane/59/2007-like. Of the 10 influenza A (H3N2) isolates tested 20% (2) were antigenically similar to A/Brisbane/10/2007 and 80% (8) were A/Perth/16/2009-like. Of the 7 influenza B viruses characterized, 71.4% (5) were antigenically similar to B/Brisbane/60/2008 (Victoria lineage), 14.3% (1) was antigenically similar to B/Malaysia/2506/2004 (Victoria lineage), and 14.3% (1) was characterized as B/Florida/4/2006-like (Yamagata lineage).

b) Drug susceptibility tests

Amantadine Resistance
In the 2008-2009 season, the NML tested 1,138 influenza A viruses (including 322 seasonal H1N1, 400 seasonal H3N2 and 416 pandemic H1N1 viruses) for amantadine resistance. All of the seasonal H1N1 viruses were sensitive to amantadine; however, all of the seasonal H3N2 and pandemic H1N1 viruses were resistant to amantadine.

In the 2009-2010 season, the NML tested 1,167 influenza A viruses (including 5 seasonal H1N1, 24 seasonal H3N2 and 1,138 pandemic H1N1 viruses) for amantadine resistance. Of the 5 seasonal H1N1 viruses tested, 20% (1) were resistant to amantadine. All of the seasonal H3N2 and pandemic H1N1 viruses tested were resistant to amantadine.

Oseltamivir Resistance
In the 2008-2009 season, the NML tested a total of 1,665 influenza isolates for oseltamivir resistance (including 323 seasonal A(H1N1), 196 seasonal A(H3N2), 573 influenza B, and 573 pandemic A(H1N1) viruses). Of the 323 seasonal A(H1N1) viruses tested, 99.7% (322/323) were resistant to oseltamivir with the H274Y mutation. All of the seasonal A(H3N2) and influenza B viruses tested were sensitive to oseltamivir. Of the 573 pandemic A(H1N1) viruses tested, 0.2% (1) were resistant to oseltamivir.

In the 2009-2010 season, the NML tested a total of 1,108 influenza isolates for oseltamivir resistance (including 5 seasonal A(H1N1), 13 seasonal A(H3N2), 7 influenza B, and 1,083 pandemic A(H1N1) viruses). All of the seasonal A(H1N1) viruses tested were resistant to oseltamivir; however, all of the seasonal A(H3N2) and B viruses tested were sensitive. Of the 1,083 pandemic A(H1N1) viruses tested, 1.1% (12) were resistant to oseltamivir.

Zanamivir Resistance
In the 2008-2009 season, the NML tested 1,345 influenza isolates (including 258 seasonal A(H1N1), 192 seasonal A(H3N2), 578 influenza B, and 317 pandemic A(H1N1) viruses) for zanamivir resistance; all were sensitive to zanamivir.

In the 2009-2010 season, the NML tested 1,076 influenza isolates (including 2 seasonal A(H1N1), 13 seasonal A(H3N2), 4 influenza B, and 1,057 pandemic A(H1N1) viruses) for zanamivir resistance; all were sensitive to zanamivir.

3) Influenza-like illness (ILI)

a) ILI consultations reported by sentinel practitioners

During the 2008-2009 influenza season, ILI consultation rates increased around late January 2009 (week 04) and peaked in early March (week 09) with a rate of 48 per 1,000 patient visits. A second peak was observed in mid-June (week 23), due to the appearance of the pandemic H1N1 virus, with a rate of 41 per 1,000. From the start of the season until the beginning of the first wave of the pandemic (mid-April 2009, week 15), ILI rates remained within or below the expected range, with the exception of week 09 when the ILI rate was higher than expected, based on mean observation rates for the 12 previous seasons (Figure 4). However, during the first wave of the pandemic, from April 12 - August 29, 2009 (weeks 15-34), weekly ILI rates were within or above the expected range for that time of year. The highest ILI consultation rates were reported in children, averaging 39/1,000 patients seen in the 0 to 4-year age group and 32/1,000 in those aged 5 to 19 years prior to the first wave of the pandemic and averaging 44/1,000 patients seen in the 0 to 4-year age group and 42/1,000 in those aged 5 to 19 years during the first wave.

During the 2009-2010 influenza season, ILI consultation rates increased in early September 2009 (week 36), signalling the start of the second wave of the pandemic, and peaked in late October (week 43) with a rate of 112 per 1,000 patient visits. From the start of the season until late November 2009 (week 47), the ILI consultation rates were higher than expected, based on mean observation rates for the 13 previous seasons. Since early December 2009, weekly ILI rates remained within or below the expected range for that time of year. The highest ILI consultation rates were reported in children, averaging 73/1,000 patients seen in the 0 to 4-year age group and 94/1,000 in those aged 5 to 19 years during the second wave of the pandemic (early September to early January, weeks 36-02) and averaging 26/1,000 patients seen in the 0 to 4-year age group and 17/1,000 in those aged 5 to 19 after the second wave.

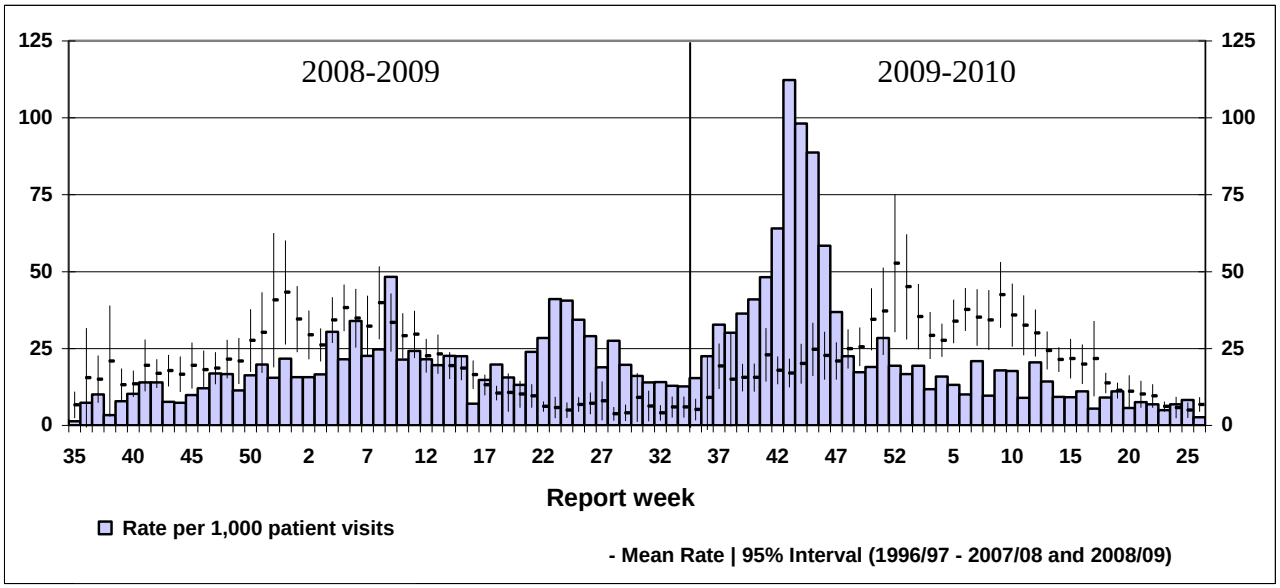

Figure 4. ILI consultation rates, by week, Canada, 2008-2009 and 2009-2010 seasons, compared to baseline (1996/97 to 2007/08 and 2008/09 seasons)

b) Symptoms of influenza collated from initial influenza A(H1N1)pdm09 cases

During the first four weeks of the pandemic, information on symptoms were collected for 218 laboratory-confirmed influenza A(H1N1)pdm09 cases. The most frequent symptoms were cough, fever, rhinorrhea, headache, sore throat, and malaise. Of these 218 cases, 53.2% (116) met the FluWatch case definition for ILI; 20.2% (44) did not report fever as a symptom (median age = 21.5 years); only 1.8% (4) were below the age of 5 years and 0.5% (1) were above the age of 65 years.

c) Comparison of ILI rates (through FluWatch and Google Flu Trends) during the pandemic period

During the first pandemic wave (April 12, 2009 to August 29, 2009), on average the FluWatch ILI rate (mean=21.2 per 1,000) was higher than the ILI rate through Google Flu Trends (GFT) (mean=17.0 per 1,000). In addition, the FluWatch ILI rate showed poor correlation with the ILI rate from GFT (correlation coefficient of 0.30, p=0.19). However, during the second wave of the pandemic (August 30, 2009 to January 2, 2010), the two ILI rates were correlated (correlation coefficient = 0.91, p<0.001). On average, the ILI rate through GFT (mean=63.8 per 1,000) was higher than the FluWatch ILI rate (mean=43.8) during the second wave of the pandemic.

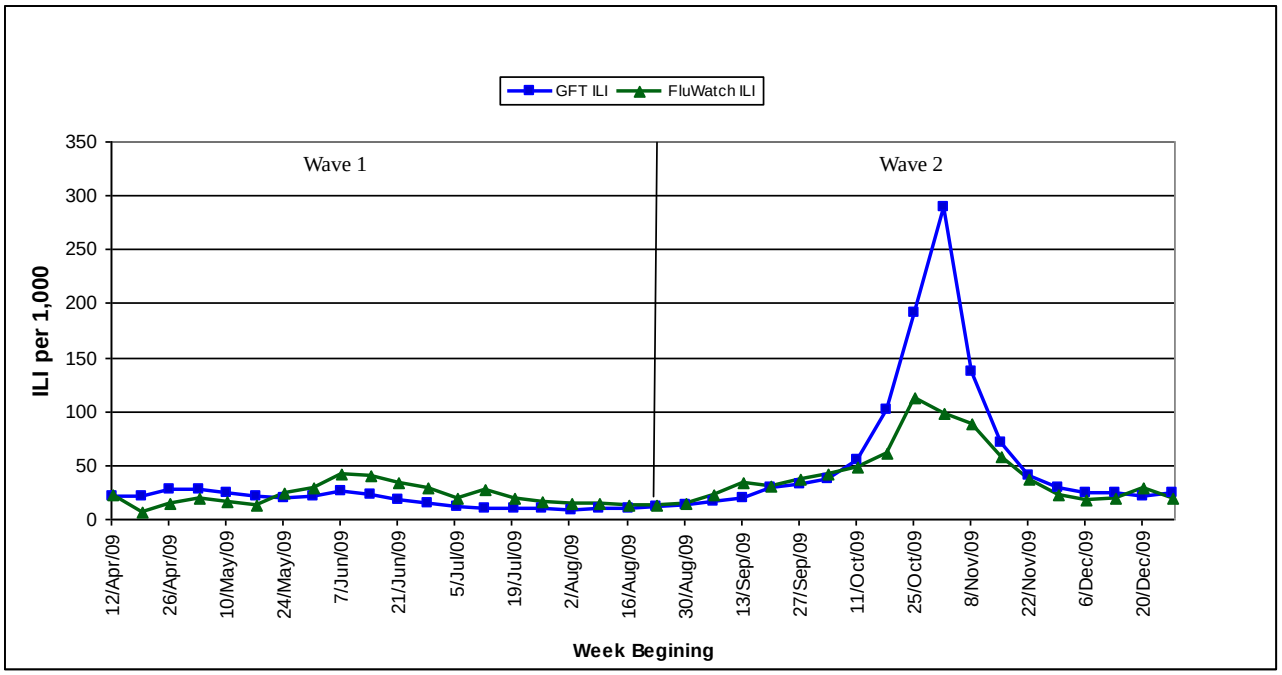

Figure 5. ILI rates for FluWatch and Google Flu Trends (GFT), by reporting week, Waves 1 and 2, Canada

4) Regional influenza activity levels as assigned by provincial and territorial FluWatch representatives

a) Influenza activity levels

During the 2008-2009 season, sporadic influenza activity was first reported in regions of Ontario and Alberta in early September. Localized influenza activity was first reported in a region of Ontario during early September (week 36), however activity remained low in Ontario and across the country until mid-December 2008. The peak period in reporting of widespread and localized influenza activity occurred between mid-February 2009 (week 07) and the end of March (week 12), when 34% (115/337) of the widespread and localized activity was reported. The number of regions reporting widespread and localized activity peaked at

the end of March (week 12) at 39% (21/54) with two smaller peaks that occurred in early May (week 18) and mid-June (week 23) due to the appearance of the pandemic virus (Figure 6).

During the 2009-2010 season, increased influenza activity started early with several regions in the Atlantic provinces (Newfoundland and Labrador and New Brunswick), Ontario, the Prairies (Saskatchewan and Alberta), British Columbia and Northwest Territories reporting widespread and localized activity in September 2009. The number of regions reporting widespread and localized activity peaked in early November (week 44) at 76% (41/54) (Table 2). The peak period in reporting of widespread and localized influenza activity occurred between mid-October 2010 (week 41) and late November (week 47) where 80% (215/268) of the widespread and localized activity was reported (Figure 6).

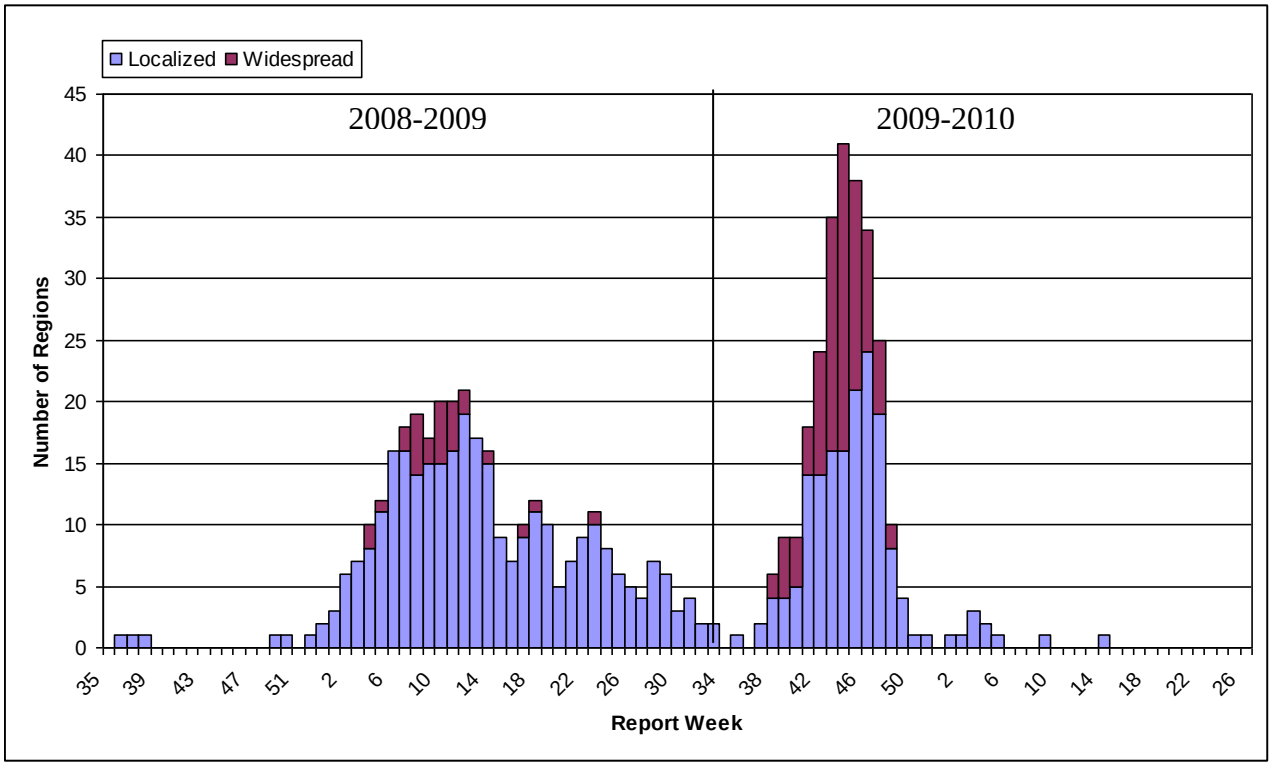

Figure 6. Number of surveillance regions reporting localized or widespread influenza activity, by week, Canada, 2008-2009 and 2009-2010 seasons

b) Outbreaks of influenza and ILI

During the 2008-2009 influenza season, a total of 375 outbreaks of influenza or ILI were reported. Of these, 41%(153) were in long-term care facilities (LTCF); 6% (24) in hospitals; 45% (168) in schools and 8% (30) in other types of facilities. During wave 1 of the pandemic alone (April 12 - August 29, 2009, weeks 15-34), a total of 88 outbreaks were reported: 39% in LTCFs; 11 (12%) in hospitals; 27% in schools; and 22% in other types of facilities (Table 2).

During the 2009-2010 influenza season, a total of 2,767 outbreaks of influenza or ILI were reported. Of these, 2% (57) were in LTCFs; 1% (31) in hospitals; 95% (2,638) in schools and 1% (41) in other types of facilities. The vast majority of the outbreaks (92%) were reported between mid-October (week 41) to late November 2009 (week 47), corresponding to the peak period of the second wave of the pandemic (Table 2).

5) ***Influenza-associated paediatric hospitalizations and mortality***

a) 2008-2009 Influenza Season

During the 2008-2009 influenza season, a total of 767 influenza-associated paediatric hospitalizations were reported through the Immunization Monitoring Program Active (IMPACT) Network of which 75.9% (582) were due to influenza A and 24.1% (185) were due to influenza B (Figure 7). Of the 582 hospitalizations due to influenza A, 58.9% (343) were due to influenza A(H1N1)pdm09. Two distinct peaks were observed: the first due to seasonal influenza A and B infections, which occurred in late February 2009 (week 8) and the second due to influenza A(H1N1)pdm09, which occurred in mid-June (week 23). Forty-four percent of the hospitalizations occurred between late January and early April 2009 (weeks 4-13) and 42% between mid-May and early July 2009 (weeks 20-26). Of the 767 paediatric hospitalizations, 0.8% (6) resulted in deaths attributable to influenza or influenza-related complications; 50% of the deaths were attributable to influenza A(H1N1)pdm09 infection. Of the 767 cases, 48.8% (374) had at least one underlying medical condition, 15.6% (120) were admitted to ICU and 7.7% (59) had a secondary bacterial co-infection. The median delay between symptom onset and hospitalization was 2 days (mean=3.4 days) and the median length of stay in hospital for the cases was 3 days (mean=5.7 days). The distribution of hospitalized cases by age group was as follows: 12.0% (92) were aged 0 to 5 months; 24.2% (186) were 6 to 23 months; 21.9% (168) were 2 to 4 years; and 41.9% (321) were 5 years and older. Antiviral treatment for influenza was given to 25% (192) of the cases.

b) Wave 1 of Pandemic

During wave 1 of the pandemic (April 12 - August 29, 2009), a total of 385 hospitalizations were reported of which 98.2% (378) were due to influenza A and 1.8% (7) due to influenza B. Of the 378 hospitalizations due to influenza A, 90.7% (343) were confirmed to be pandemic H1N1. Four deaths occurred during wave 1, 75% (3) of which were attributable to pandemic H1N1 infection. Of the 385 hospitalizations, 52.2% (201) had at least one underlying medical condition, 17.4% (67) were admitted to ICU and 7.5% (29) had a secondary bacterial co-infection. The median delay between symptom onset and hospitalization was 3 days (mean=3.7 days) and the median length of stay in hospital for the cases was 4 days (mean=5.9 days). Antiviral treatment for influenza was given to 44% (170) of the cases. The distribution of hospitalized cases by age group was as follows: 9.9% (38) were aged 0 to 5 months; 19.0% (73) were 6 to 23 months; 19.7% (76) were 2 to 4 years; and 51.4% (198) were 5 years and older.

c) Wave 2 of Pandemic (2009-2010 Influenza Season)

During wave 2 of the pandemic, a total of 948 influenza-associated paediatric hospitalizations were reported through IMPACT. All 948 hospitalizations were due to influenza A; 98% (930) of which were confirmed to be pandemic H1N1. Hospitalizations peaked in early November (week 44; n=252) and 80% of the hospitalizations occurred between late October and November 21, 2009 (weeks 43-46). Of the 948 paediatric hospitalizations, 0.6% (6) resulted in deaths attributable to influenza A(H1N1)pdm09 or influenza-related complications. Of the 948 cases, 61% (580) had at least one underlying medical condition. The median length of stay for the cases was 5 days (mean=8.5 days). The distribution of hospitalized cases by age group was as follows: 11.2% (106) were aged 0 to 5 months; 18.4% (175) were 6 to 23 months; 22.7% (215) were 2 to 4 years; and 47.7% (452) were 5 years and older. The subsequent information is only based on 30.9% (293) of the 948 cases for which more detailed information was available at time of analysis. Of the 293 cases, 45.4% (133) were admitted to ICU and 12.3% (36) had a laboratory-confirmed secondary bacterial co-infection. The median delay between symptom onset and hospitalization for the 293 cases was 2 days (mean=3.7 days). Antiviral treatment for influenza was given to 88.7% (260) of the cases.

The number of hospitalizations, ICU admissions, and deaths during the pandemic period and by wave are

presented in Table 2.

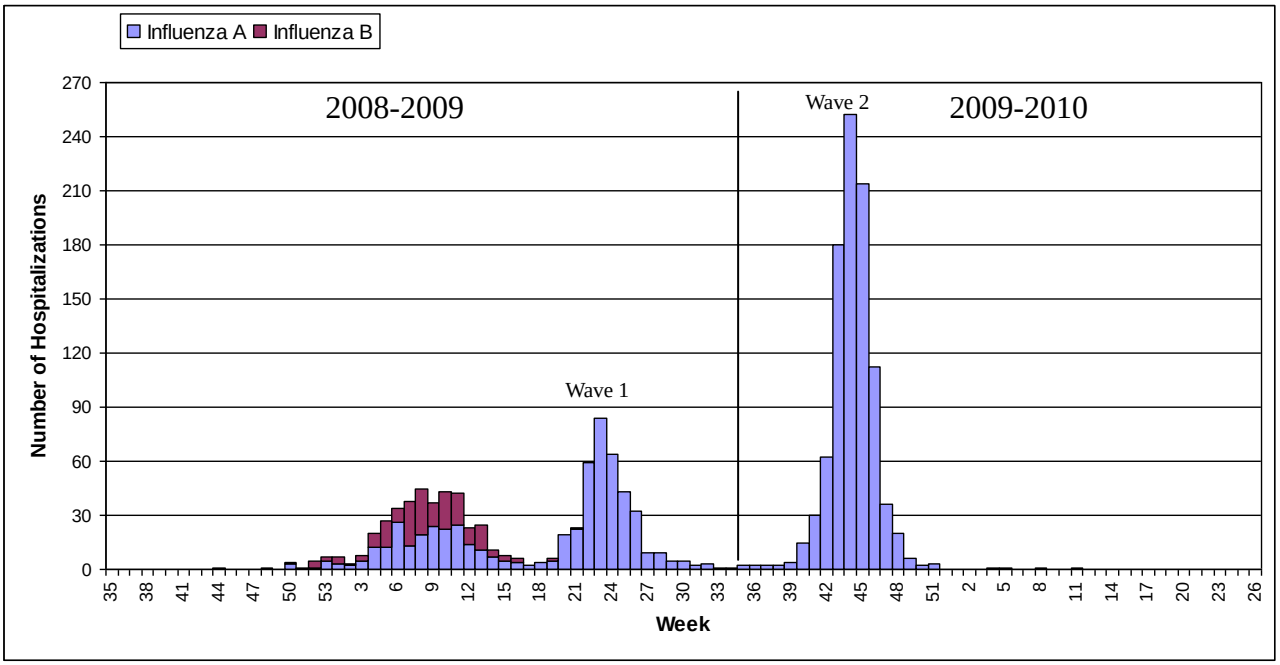

Figure 7. Weekly paediatric admissions to IMPACT hospitals, by influenza type, Canada, 2008-2009 and 2009-2010

d) Estimates of expected years of life lost (YLL) associated with influenza A(H1N1)pdm09

From April 12, 2009 to April 3, 2010, 428 laboratory-confirmed influenza A(H1N1)pdm09-associated deaths were reported to the Public Health Agency of Canada (PHAC). Information on age and sex were available on 98.8% (423) of the deaths. In comparison, the average number of annual deaths attributed to seasonal influenza was 346 and for pneumonia and influenza (P&I) was 5,165. For influenza A(H1N1)pdm09, the largest proportion of deaths occurred among those under the age of 65 years (73%). In contrast, for seasonal influenza and P&I, only 5% and 8% of the deaths were among those under the age of 65 years respectively. The estimate of the expected YLL for influenza A(H1N1)pdm09 was 13,134 years while the YLLs for seasonal influenza and P&I were 3,413 and 46,085 years respectively. The ratio of expected YLL per death was much higher for influenza A(H1N1)pdm09 (31 years of life lost per death) compared to seasonal influenza (9.9 years) and P&I (8.9 years).

Discussion

Up to May 2009, the 2008-2009 influenza season was relatively mild overall with seasonal influenza A and B viruses co-circulating. The pandemic H1N1 virus (influenza A(H1N1)pdm09) emerged in Canada in late April 2009 and quickly became the predominant virus for the remainder of the 2008-2009 season (wave 1) and for all of the 2009-2010 season (wave 2 and post-peak period). Both waves of the pandemic occurred during periods where low influenza activity is normally observed (i.e. late spring/summer months and early fall). Heightened influenza activity was observed during the first and second waves of the pandemic; however once the peak of the second wave ended (late December 2009), influenza activity remained very low for the remainder of the 2009-2010 season.

The second wave of the pandemic affected more of the Canadian population (close to three times more

laboratory confirmed cases detected and reported) compared to the first wave, even though community testing was dramatically reduced prior to or early in the second wave due to community laboratory testing restriction policies implemented in most provinces and territories. Several influenza surveillance indicators (i.e. laboratory percent positive, ILI, number of regions reporting widespread or localized activity) displayed a two- to three-fold difference in magnitude between the peak periods of the first and second waves.

Although the majority of influenza detections after April 2009 were for influenza A(H1N1)pdm09, seasonal influenza A (H1), A (H3) and B viruses were still detected at extremely low levels throughout the season (2% from April 12, 2009 to July 17, 2010). However, from the beginning of May 2010 to July 17, 2010, 25 positive influenza detections were reported to the RVDSS of which 54% were non-influenza A(H1N1)pdm09 viruses (8% were seasonal influenza A (H3) viruses, 24% were unsubtyped influenza A viruses and 24% were influenza B viruses).

There were considerably more influenza cases detected and reported in 2008-2009 (n=23,376; in wave 1 only n=14,616 from April 12-August 29, 2009) and 2009-2010 (n=39,024) and during the pandemic period (n=53,640) compared to the average number of cases reported over the three previous seasons from 2005-2008 (average per year=9,270). However, influenza testing rates had also been increasing over the years (i.e. 271 influenza tests per 100,000 population in 2005-2006 to 379 per 100,000 in 2007-2008) and may be due to the increased awareness of the importance of influenza, present concerns over emerging viruses (e.g. human infection with avian influenza), as well as the increasing ease and use of rapid tests for influenza diagnosis. Testing rates increased considerably during the pandemic period as well (956 influenza tests per 100,000 population), which was not surprising given the emergence of the pandemic virus and the need to monitor and asses its progression across, and effect on, the population.

During the 2008-2009 season, the average percent positive for influenza detections was 10.9% (11.1% in wave 1 alone) which is similar to the average percent positive observed over the three previous seasons (2005-2008) which was 9%. However the average percent positive for influenza in 2009-2010 (19.6%) was more than double the three year average, which was not surprising given the prevalence of the pandemic virus in the population, especially during the second wave of the pandemic.

The age distribution of laboratory confirmed influenza cases varied between the pandemic and seasonal influenza years, where the majority of cases seen in seasonal years were among very young children (less than 5 years of age) and the elderly (65 years and older) while the majority of cases seen in pandemic years were among school-aged children (5-24 years of age) and younger adults (25-44 years of age). During the 2008-2009 and 2009-2010 seasons, 40-43% of the influenza cases were between the ages of 5 and 24 years and 21-22% were between the ages of 25-44 years. Those 65 years and older only represented between 4%-8% of the cases. In contrast, for the 2006-2007 and 2007-2008 seasons, those 5-24 years of age represented only 20-21% of the cases, while those 65 years and older represented 20% or more of the cases. Pre-existing immunity among the elderly population due to exposure to previous circulating H1N1 strains may have contributed to their low infection rates compared to younger age groups during the pandemic period. Higher rates of influenza A(H1N1)pdm09 infection among school-aged children may be due to higher transmission rates in that cohort compared to younger children (under 5 years).

During the 2008-2009 and 2009-2010 seasons, 72% and 87% respectively of the 54 influenza surveillance regions reported localized or widespread activity at least once during the season. On average over the three previous seasons between 2005-2008, 45% of the regions reported localized or widespread activity at least once during the season. The number of LTCF outbreaks reported in 2008-2009 (n=153) and 2009-2010 (n=57) was less than the average number reported over the 2005-2008 seasons (average per year=200). The number of outbreaks of ILI in schools reported in 2008-2009 (n=168) was considerably lower than the number reported in 2009-2010 (n=2,638) but fairly similar to the average number of school outbreaks reported over the 2005-2008 seasons (average per year=218). The increased number of school outbreaks reported in

2009-2010 was due to several factors: firstly, it was a reflection of a true increase in the number of school outbreaks due to the high attack rates of the new influenza A(H1N1)pdm09 virus among school-aged children; secondly, it was also due to the change in surveillance protocol for that season where enhanced monitoring and reporting of school outbreaks by provincial/territorial health ministries were strongly encouraged. For example, in previous seasons, only 4 of the 10 provinces consistently monitored and reported school outbreaks to the Public Health Agency of Canada (PHAC). In 2009-2010, 8 of the 10 provinces and one of the 3 territories reported outbreaks of ILI in schools to PHAC.

Based on the limited data on symptoms reported by the initial cases of influenza A(H1N1)pdm09, the frequency of influenza A(H1N1)pdm09 cases without fever appeared to be higher than that of seasonal influenza. Hence, the reason why only half (53.2%) of the initial influenza A(H1N1)pdm09 cases met the Canadian FluWatch definition for ILI. Although there was a strong correlation between ILI rates observed through FluWatch sentinel data and Google Flu Trends (GFT), the difference in average weekly ILI rates between the two sources suggested that the intensity of ILI rates as reported through GFT may at times be exaggerated. However, because GFT data have the advantage of being published on a daily basis compared to FluWatch ILI rates which are published a week or two later, GFT data has the potential to be the earliest indicator of influenza activity and changing trends.

During the 2008-2009 and 2009-2010 seasons, IMPACT reported 767 (385 during wave 1 alone) and 948 influenza-associated hospitalizations respectively, which is approximately twice the average number of hospitalizations reported over the 2005-2006 and 2007-2008 seasons (average per year=414). The number of hospitalizations during the pandemic period was 1,333 which is more than three times the average number reported during regular seasons. The number of deaths due to pH1N1 alone reported within the pandemic period (9 in total; 3 during wave 1 and 6 in wave 2) was considerably higher than those observed in previous non-pandemic years (range: 2-5 deaths due to influenza per year).

Limitations

Results from the influenza surveillance system should be interpreted with caution for several reasons:

1. Laboratory testing protocols changed over the course of the pandemic (i.e. increased laboratory testing was encouraged from the start of the first wave until partway through the second wave after which testing was decreased due to laboratory capacity issues) and within jurisdictions (i.e. some jurisdictions performed more targeted testing of high risk individuals or outbreak-related cases whereas other jurisdictions encouraged more community-based testing). Therefore comparisons of laboratory findings (i.e. percent positive and number of positive laboratory-confirmed cases) over time and differences in findings between jurisdictions need to be interpreted in light of these.

2. Changes or upgrades to software or electronic datasets in public health laboratories which house laboratory information on positive influenza specimens, as well as the increased amount of work and backlog for data entry created by the pandemic, led to delays in reporting of the case information to FluWatch for some provinces and territories (P/Ts). Therefore case information from some P/Ts were either incomplete or not received in time to be included in the analysis for this report.

3. In previous years, surveillance of outbreaks of ILI in schools varied between P/Ts (i.e. some P/Ts had well established surveillance systems whereas others did not have systems in place at all). Enhanced surveillance of outbreaks of ILI in schools was established across all P/Ts in response to the pandemic and contributed partly to the increase in school outbreaks reported during the 2009-2010 influenza season. Therefore caution should be applied when comparing the numbers of school outbreaks reported during the 2009-2010 season with those reported prior to that period.

4. ILI consultation rates observed during the second wave may have been affected by the availability and use of Flu Assessment Clinics across several provincial/territorial jurisdictions – the main objective of which was to divert individuals experiencing ILI symptoms from seeking care from already over-burdened emergency rooms and doctors' offices.

5. Age-specific data may be affected by biases in health care utilization and physician testing behaviour. For example, ILI surveillance does not capture influenza activity occurring in the elderly in LTCFs, children who visit paediatricians or the majority of consultations that occur in emergency departments and after-hours clinics. Also, ILI consultation rates across time may vary with sentinel participation and coverage rates as well as co-circulation of other respiratory viruses.

6. For the 2009-2010 season, the case definition for IMPACT was expanded to include children up to 18 years of age, when previous seasons only included children up to 16 years of age. For the 2009-2010 season however, only a small proportion (2.0%) of cases were between the ages of 17-18 years.

7. Detailed case reporting during the first four weeks of the pandemic in Canada became burdensome for the provincial and territorial ministries of health that were collecting the data. Therefore, only follow-up of hospitalized cases was requested due to the high burden of disease. Therefore, the subset of laboratory-confirmed influenza A(H1N1)pdm09 case information presented during the first four weeks of the pandemic were biased towards more severe cases.

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