The Impact of the H1N1 Pandemic on Canadian Hospitals

Introduction

Pandemic planning is a critical function for any health system. These plans aim to limit serious illness and death from a pandemic; they also ensure that essential health services are maintained and disruption of other health services is minimized. Achieving the goals of a pandemic plan requires the coordination of many agencies and institutions, from public health to acute care hospitals, and requires the cooperation of sub-national, national and international partners.

Canada implemented its pandemic response in 2009 to address a new strain of influenza A/H1N1 virus (hereafter referred to as H1N1). H1N1 first appeared in North America in April 2009, and spread rapidly around the world. By the start of 2010, it had caused about 17,000 deaths. In June 2009, when 74 countries had confirmed cases, the World Health Organization (WHO) declared it a pandemic. Antibodies to seasonal influenza were found not to protect against the pandemic H1N1, and there was no vaccine available at the outset. Moreover, the new virus peaked at different times of the year than seasonal flu and seemed to affect different population groups.1, 2

Canada’s response to H1N1 was based on lessons learned from 2003, when the country was faced with an outbreak of severe acute respiratory syndrome (SARS). Outside of Asia, Canada was the hardest-hit country, with the disease killing 44 Canadians, causing illness in a few hundred more and resulting in the quarantine of 25,000 residents in the Greater Toronto Area.3

A post-SARS review identified a number of areas that should be strengthened to improve Canada’s responsiveness to future health crises. Recommendations included clear data-sharing protocols among levels of government, development of surge capacity in the clinical and public health systems, more timely access to laboratory testing and results, and improved links between public health and the health care system.
Partly in response to the SARS outbreak, the government established the Public Health Agency of Canada, the Canadian Public Health Network Council and the Canadian Network for Public Health Intelligence and provided increased funding for public health and pandemic influenza preparedness efforts. These actions were to prepare Canada for the next pandemic outbreak of infectious disease.

The H1N1 outbreak required the implementation of the pan-Canadian, provincial/territorial and hospital pandemic plans that were established after the SARS outbreak. One year after the peak of the second wave, H1N1 is in a post-pandemic phase, and it is now important to assess the impact of the pandemic on the health care system and understand whether the system was able to cope appropriately with the challenges. This analysis focuses specifically on the acute hospital sector. Key questions addressed and highlights from the analysis are the following:

What was the impact of H1N1 on acute hospitals?

- Looking at both H1N1 and unspecified influenza hospitalizations combined, the number of pandemic-related hospitalizations was larger than initial estimates.
- H1N1/influenza was one of the leading causes of hospitalization during the peak of the second wave.
- Patients with flu-like symptoms had a significant impact on Ontario emergency departments in fall 2009.

Were hospitals able to cope with the surge of patients?

- At the height of hospital activity during the second wave, hospitals accommodated large numbers of H1N1/influenza patients by increasing overall numbers of patients admitted, managing hospital bed and intensive care unit (ICU) occupancy for patients requiring other types of care and increasing ventilator capacity.

How much did H1N1 cost the acute care system?

- Costs of caring for hospitalized H1N1/influenza patients were substantial (estimated at close to $200 million excluding physician fees), but they were relatively small in the context of overall pandemic spending.

How did H1N1/influenza patients differ from those in a typical flu year?

- Confirming previous findings, H1N1/influenza patients admitted to hospital were younger than in a baseline flu year.
- Comorbidity patterns were different. Hospitalized H1N1/influenza patients were more likely to be pregnant or have respiratory comorbidities (asthma or other chronic lung disease) than in a baseline year.
- H1N1/influenza patients were more likely to need ICU care and ventilation than typical flu patients, but the extent of the differences was less than earlier studies suggested.
Figure 1: The H1N1 Timeline in Canada

- March 16, 2009: H1N1 was declared an epidemic in Mexico
- April 26: First case of H1N1 in Canada
- May 4: First H1N1 death in Canada
- June 11: H1N1 was declared a pandemic by the WHO
- October 21: H1N1 vaccine was approved by Health Canada
- November 2009: Over 1,000 H1N1/ influenza patients needed ICU care
- August 2010: The WHO declared H1N1 in post-pandemic phase
- January 2010: PHAC announced 2nd wave has tapered off

**Note**
The Fine Print

The appendix provides information on the data sources and methodology used in this report. A few points are highlighted to provide context for the analysis.

Data Sources

Most of the information in this report is drawn from acute hospital discharge data. Discharge data is collected on a routine basis and contains demographic, clinical and service utilization data on individual patients. Data is abstracted from the patient’s chart by health records staff using a standardized coding system.

Complete antiviral information for three provinces (Saskatchewan, Manitoba and New Brunswick) was obtained from the National Prescription Drug Utilization Information System (NPDUIS) Database; other provinces submitted data directly to CIHI. Information on vaccinations delivered, priority groups for vaccine and testing guidelines for hospitalized patients was similarly requested from provincial governments.

Case Definitions of H1N1

In May 2009, CIHI advised hospitals to classify any lab-confirmed H1N1 cases to ICD-10-CA code J09. Given the time lag to have charts completed and abstracted, this directive would have included cases from the beginning of the pandemic period. Based on feedback from hospitals, CIHI modified its guidance in November 2009 to also accept cases where a clinical diagnosis of H1N1 had been made in the patient’s chart, regardless of whether there was a supporting lab report.

The Public Health Agency of Canada (PHAC) collected only lab-confirmed cases throughout the pandemic. While the surveillance guidelines specified that all admitted H1N1 patients should be reported, at least one province did not report information on H1N1 patients admitted for a short period (24 hours or less) for observation. CIHI information includes all admitted patients, regardless of length of stay.

Quebec Data

A special tabulation of Quebec discharge data was provided to CIHI as of June 2010, before the database was officially closed. While the completeness of data from April to September 2009 appears very good (at 97% of the previous year’s activity), information from October to December 2009 was less complete (at 80% of the previous year’s activity) and varied by region. In some analyses (specifically noted in the text), a regional weight was applied to actual case counts for October to December 2009 to compensate for missing data.

Episode Building

To account for transfers from one acute hospital to another, individual abstracts were combined to build episodes of care (or hospitalizations).

Time Period

Most of the analysis focuses on patients discharged from acute hospitals between April 1 and December 31, 2009, after which point few H1N1 cases were reported. Outside of Quebec, 173 H1N1 discharges occurred between January and March 2010, of which 103 (60%) were admitted in 2009 or earlier. At the time of analysis, Quebec data for January to March 2010 was not available.
What Was the Impact of H1N1 on Acute Hospitals?

Looking at both H1N1 and unspecified influenza hospitalizations combined, the number of pandemic-related hospitalizations was larger than initial estimates.

H1N1/influenza was one of the leading causes of hospitalization during the peak of hospital activity in the second wave.

Patients with flu-like symptoms had a significant impact on Ontario emergency departments in fall 2009.

Hospitalizations during the traditional flu season (January to March) were lower than usual but did not offset the April to December 2009 increase resulting from H1N1/influenza.

How many hospitalized cases? A simple question, but one without a simple answer. This report looks at two groups to determine the impact that H1N1 had on hospital systems across the country.

H1N1

Between April and December 2009, 10,406 cases with an H1N1 diagnosis were discharged from Canadian acute care hospitals. These cases were specifically identified as J09–Influenza due to certain identified influenza virus H1N1, as either a main or secondary diagnosis. The number of cases reported in the hospital discharge data is somewhat higher than that recorded by PHAC (8,672) over the corresponding time period, primarily due to differences in case definition (see The Fine Print).

H1N1/Influenza

Hospital discharge data also revealed a significant number of patients diagnosed with influenza, but not specifically with H1N1. In the nine months between April and December 2009, 15,200 patients were diagnosed with either H1N1 or unspecified influenza. This analysis assumes that the approximately 4,800 unspecified influenza cases were probably also H1N1, for the following reasons:

- **There were many more influenza cases than the historic average (baseline).** In a typical year, only about 1,300 unspecified influenza cases are reported between April and December, with an average of 562 (43%) discharged in April (the traditional end of the flu season). In 2009, there were an estimated 4,794 cases with unspecified influenza, with a relatively small number (338) of patients discharged in April.

- **H1N1 displaced other viral illnesses.** Lab information from PHAC indicates that almost all influenza circulating during 2009 was likely H1N1.

- **Testing practices may have been affected by timing, specificity and implementation of provincial guidelines.** Most provincial directives recommended testing all hospitalized patients with influenza-like illnesses. However, the timing of these directives played out differently across the country, potentially affecting which cases were tested for H1N1. Additionally, given that few other viral illnesses were circulating during periods of highest hospital activity related to H1N1, individual hospitals may have decided that complete testing would not alter the clinical treatment of patients with H1N1-like symptoms.

- **The profile of unspecified influenza cases was similar to that of H1N1 patients.** Hospitalized patients with unspecified influenza were similar to H1N1 patients in many respects, including median age and average length of stay. The admission pattern by week was also reasonably similar between the two groups.

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i. Incorporating estimates for Quebec data for October, November and December 2009.
The combined H1N1/influenza group identified in the hospital discharge data represents about 6,500 more cases (75% more) than the lab-confirmed cases reported to PHAC. Both the hospital discharge data and surveillance information are extremely useful sources for understanding the pandemic and its impacts. However, the difference between the two figures highlights the challenges of identifying influenza patients, even when it comes to the more serious cases causing hospitalization and death.

Many countries struggled with the best way to capture and report H1N1-related hospitalizations. The approach and case definitions adopted by PHAC were consistent with those of the WHO. However, some countries chose a different path. The Centre for Disease Control (CDC) in the United States initially reported only lab-confirmed cases but discontinued that approach in late July 2009 amid concerns that laboratory-confirmed data on hospitalizations and deaths was an underestimation of the true number. The CDC attributed underestimation to incomplete testing, use of testing methods that miss many cases and/or diagnoses that attribute hospitalizations and deaths to other causes, such as secondary complications to influenza.

Given that our main objective in this report is to understand the impact of the pandemic on the acute hospital system, looking at the combined H1N1/influenza group is an important aspect of the analysis.
Pandemics put a particular strain on acute care facilities, particularly when there is a large or prolonged peak in cases. The 15,200 hospitalized cases of H1N1/influenza were significantly concentrated in two periods, with the first wave peaking in June and the second wave peaking in November.

Figure 3: Inpatient Hospitalizations by Week: H1N1/Influenza 2009 and Baseline Influenza

Notes
Baseline represents a three-year average of pan-Canadian influenza hospitalizations, from 2006–2007 to 2008–2009. Quebec data for October to December 2009 was adjusted to account for incomplete data availability at the time of analysis.

Sources

What Happened to Influenza Hospitalizations During the Traditional January-to-March Flu Season?

Initially there was concern that seasonal influenza viruses would also cause illness during 2009–2010. During the peak of the pandemic in fall 2009, H1N1 displaced most other viral illness. As we moved into late winter and spring, this trend continued. PHAC reported that overall influenza activity was low for the entire period of January to March 2010, typically the main season for influenza-related hospitalizations. This drop in hospitalizations in January to March (outside of Quebec, 578 fewer cases than the baseline) did not offset the increase seen from April to December 2009 (10,304 cases higher than the baseline, outside Quebec).
Two-thirds of all hospitalized H1N1/influenza cases occurred during a five-week period in the second wave (October 25 to November 28, 2009), with more than 1,000 patients being discharged each week. During this time frame, H1N1/influenza represented just over 3% of all acute discharges. To put this in context, over the five-week period there were as many H1N1/influenza cases as joint replacement, heart attacks or strokes.

<table>
<thead>
<tr>
<th>Reason for Hospitalization</th>
<th>Percentage of All Discharges</th>
</tr>
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<tbody>
<tr>
<td>Births</td>
<td>11.8</td>
</tr>
<tr>
<td>H1N1/Influenza</td>
<td>3.4</td>
</tr>
<tr>
<td>Hip/Knee Replacement</td>
<td>3.1</td>
</tr>
<tr>
<td>Heart Attack</td>
<td>2.5</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.6</td>
</tr>
<tr>
<td>Bypass Surgery</td>
<td>0.7</td>
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</tbody>
</table>

**Sources**

**Emergency Department Visits—A Focus on Ontario**

During pandemics, emergency departments are often the first point of access for acutely ill patients. Emergency departments may also see a sharp increase in activity from patients who have mild symptoms but cannot quickly access primary health care services. CIHI has complete emergency department data for Ontario, but not yet for other provinces. While there were variations among provinces in how front-line flu services were provided (such as use of telephone hotlines, stand-alone flu assessment clinics and availability of family physicians), it is nevertheless helpful to understand the Ontario experience during H1N1.

Our analysis looked at patients arriving with flu-like symptomsii to see whether there were more or fewer than in the baseline years. Symptoms reviewed included any one of cough, shortness of breath, fever, malaise and fatigue, and sore throat. Emergency data usually focuses on the single most important issue, so it is not possible to look at these patient-reported symptoms in combination. Overall, between April and December 2009, patients with flu-like symptoms made about 140,000 more visits to Ontario emergency departments than the baseline for the same time period. Visits for all other reasons were unchanged from the baseline. The pattern of emergency department visits for flu symptoms mirrors that of inpatient H1N1/influenza cases, although the increase in emergency department volumes started somewhat sooner in both the first and second waves.

In October and November 2009, there were approximately 230,000 visits to Ontario emergency departments for patients reporting flu-like symptoms, representing one out of every four emergency department patients. Overall, visits for patients with flu-like symptoms were 92% higher than the historical average for October and November. The greatest proportional increase in emergency department use occurred in those age 5 to 19 (up more than 200%, or almost 43,000 visits). However, only a small percentage of patients in this age group were admitted to hospital (2.3%, compared with 3.7% in the baseline). Utilization by seniors changed relatively little (up 14%, or 3,600 visits) over the same October–November time frame. Consistent with baseline data, a high proportion of emergency visits (about 45%) among those age 65 and older were admitted to hospital.

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**ii.** Although some patients were diagnosed with H1N1 in the emergency department, not all patients presenting with flu-like symptoms would have been tested and given a definitive diagnosis before discharge.
Figure 4: Ontario Emergency Department Visits for Patients With Flu-Like Symptoms

Note

Source
Were Hospitals Able to Cope With the Surge of Patients?

At the height of hospital activity during the second wave, hospitals accommodated large numbers of H1N1/influenza patients by increasing overall numbers of patients admitted, managing hospital bed and ICU occupancy for patients requiring other types of care and increasing ventilator capacity.

Complete hospitalization data from the pandemic period may provide some clues as to whether H1N1 had an impact on other parts of the hospital system. For example, did we observe changes—such as fewer cases or shorter lengths of stay—for other diagnostic groups using hospital beds, ICUs or ventilators? We looked at these questions for hospital inpatients outside of Quebec.iii

Outside of the peak of hospital activity during the second wave, H1N1/influenza patients did not represent a substantial component of acute hospital activity. H1N1/influenza patients accounted for only 0.2% of total discharges, 0.4% of ICU patients and 0.7% of patients requiring invasive mechanical ventilation. During this same time frame, there was little change in hospital or ICU admissions for patients requiring other types of care, while ventilator use increased by 8%.

However, to really understand how hospitals coped with the surge in volume, we focused our analysis on the period of highest hospital activity during the second wave, October 25 to November 28, 2009, when at least 1,000 H1N1/influenza patients were discharged from hospital each week.

Hospitalizations

During this period, H1N1/influenza patients represented 3.4% of all acute care discharges. About half of the H1N1/influenza patient group were accommodated through doing more—overall hospitalizations were up by 1.7% compared to historic averages. Data suggests that the other half of H1N1/influenza patients were likely accommodated by managing occupancy in other areas.

- Emergency department data from Ontario shows that patient visits (other than those for flu-like symptoms) were consistent with baseline levels. This suggests that fear of contracting H1N1 did not keep patients away from emergency departments—a situation that was markedly different than that experienced during SARS, where there was a notable drop in emergency visits.14

- Most of the modest decrease in hospitalizations for patients with other health problems occurred in two areas. There was a change in the number of patients with pre-booked admissions (down 2.7%, or 1,162 cases), indicating that some planned surgical procedures may have been deferred. There were also fewer hospitalizations for patients with angina or chest pain (down 20%, or more than 800 cases). It is possible that these patients would have been given guidance on managing their symptoms at home and asked to return to emergency if their condition worsened.

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iii. Because complete Quebec information was not available for the peak of the second wave (defined in this analysis as patients discharged between October 25 and November 28, 2009), data from that province was excluded from the analysis.
Table 2: Percentage Change in Hospital Utilization Compared to Historic Average—Focus on Peak Period of H1N1-Related Hospital Activity (October 25 to November 28, 2009, Canada Excluding Quebec)

<table>
<thead>
<tr>
<th></th>
<th>Hospital Discharges</th>
<th>ICU</th>
<th>Ventilations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Patients</td>
<td>+1.7%</td>
<td>No change</td>
<td>+14%</td>
</tr>
<tr>
<td>Total Patients Excluding H1N1/Influenza</td>
<td>-1.7%</td>
<td>-4.6%</td>
<td>+7%</td>
</tr>
</tbody>
</table>

Source
Discharge Abstract Database, 2006–2007 to 2009–2010, Canadian Institute for Health Information.

Intensive Care

ICUs typically operate at high occupancy levels, leaving limited flexibility to accommodate an unexpected surge in volume.\(^{15–16}\) During the peak of second-wave hospitalizations, almost 1,000 (970) H1N1/influenza patients outside Quebec required ICU care. Over this time frame the number of ICU patients remained about the same as in previous years: more H1N1/influenza patients in the ICU meant fewer admissions (down 4.6%) to ICU for patients with other health problems.

Pandemic and other disaster plans help hospitals proactively manage ICU capacity when they expect an unusual surge in activity, as with H1N1.\(^ {15}\) For example, some patient groups who would normally be admitted to ICU could also—with increased monitoring—be cared for in regular wards. The patient groups which experienced reduced ICU use relative to the baseline appear to be consistent with a managed occupancy approach:

- Normal newborns: Overall, admissions to ICU for full-term babies without documented health issues were down 44% compared to baseline. ICU use for low birth weight newborns or those with significant health problems remained about the same.

- Cardiology: There was a 14% decrease in ICU admissions for cardiology patients with conditions such as chest pain, angina and arrhythmia when compared to baseline.

- Cardiac surgery: The number of cardiac surgery patients remained about the same as baseline, indicating no widespread cancellation of cardiac procedures. However, during this time frame the proportion of cardiac surgery patients admitted to ICU declined by 2% over previous years. While the percentage change is small, cardiac surgery patients are one of the largest groups using ICU care.

Together, these three patient groups represented 85% of the decline in ICU usage (compared to baseline) during the peak period of hospitalization during the pandemic.

Ventilation

At the height of hospital activity during the second wave, the number of patients requiring invasive mechanical ventilation increased by 14% over baseline. Half of the increase was accounted for by H1N1/influenza patients needing ventilation, while the other half of the increase was for patients with a diverse range of health problems, including valve surgery, respiratory ailments (such as chronic obstructive pulmonary disease, pneumonia and respiratory failure), septicemia, poisoning/toxic effects of drugs and palliative care.

The ability to accommodate H1N1/influenza patients and increase ventilation services for patients with other health problems may point to an increase in ventilation capacity in Canada. While approximately 1,400 patients with any health problem received invasive ventilation during the busiest week of the pandemic, even more patients (about 1,500 discharged during the week of March 7, 2010) received ventilation care a few months later. One factor contributing to the increased ventilator capacity may have been concerns raised by critical care physicians after the first wave of H1N1.\(^ {17}\)
Many jurisdictions expanded ventilator capacity through the purchase of additional ventilator equipment as well as increased staff training in use of the machines. In addition, provinces could draw on emergency resources through the National Emergency Stockpile System if they struggled to cope with the strain of severely ill H1N1/influenza patients. In July 2009, PHAC announced plans to purchase 370 additional ventilators to bring the total to 500 in the National Emergency Stockpile System.18

**How Much Did H1N1/Influenza Cost the Acute Hospital System?**

Costs of caring for hospitalized H1N1/influenza patients were substantial (estimated at close to $200 million excluding physician fees), but they were relatively small in the context of overall pandemic spending.

It is possible to estimate the cost of H1N1/influenza patients to the acute hospital system. The cost estimates presented here include the costs incurred by hospitals in providing services but exclude physician fees, since physicians are normally paid directly by the jurisdiction and not by the hospital.

**Resource Intensity Weights**

Costs are estimated based on Resource Intensity Weight (RIW), a value that represents the relative resources used compared to an average patient. The average patient across all diagnostic categories seen in an acute hospital would have an RIW of 1. Resources used by H1N1 patients were somewhat higher than the average patient. The average RIW for H1N1 was 2.0; for H1N1/influenza it was 1.7. As is the case for many disease groups, the RIW for H1N1/influenza patients increased with age, with a low of 1.3 for pre-school age children and a high of 2.1 for those 65 and older.

Using costs per weighted case for 2008–2009, and looking across all age groups, an H1N1 patient had an average cost of about $11,000 per admission, while the average cost for the combined H1N1/influenza group was $9,600.

Between April and December 2009, the estimated total inpatient cost of H1N1/influenza was $146 million ($114 million if looking only at cases with H1N1 specifically identified). This estimate assumed that costs in Quebec (which does not use the RIW system) were similar to those in the rest of the country.

During the pandemic, acute hospitals also incurred costs related to increased emergency department activity. In Ontario, about 140,000 more patients with flu-like symptoms visited emergency departments than in a baseline year. Again using cost per weighted case, the additional emergency visits in Ontario are estimated to have cost $19.6 million. Data is not available on emergency department activity in other provinces. Even if information was available it might not be directly comparable, as some jurisdictions had different models, such as flu assessment clinics, for treating H1N1 patients. However, if all provinces experienced a per capita emergency department shift similar to that seen in Ontario, additional emergency department costs across the country were likely in the range of $50 million.

How does the cost of hospitalizations for H1N1 compare with other costs incurred in responding to the pandemic? A comprehensive analysis of the costs of responding to H1N1 had not yet been released at the time of this analysis. Media reports have estimated total costs, provincial and federal, of greater than $2 billion. Costs include such items as the purchase and administration of vaccinations; antiviral purchase and dispensing; enhanced emergency responsiveness, including surveillance and outbreak management and rapid research; public education and self-care information; as well as physician visits and hospitalizations. Overall, pan-Canadian hospitalization costs appear to be a small proportion of estimated totals.
How Were H1N1/Influenza Patients Different From Those in a Typical Flu Year?

Confirming previous findings, H1N1/influenza patients admitted to hospital were younger than in a typical flu year.

Comorbidity patterns were different. Hospitalized H1N1/influenza patients were more likely to be pregnant or have respiratory comorbidities (asthma or other chronic lung disease) than in a typical flu year.

H1N1/influenza patients were more likely to need ICU care and ventilation than typical flu patients, but the extent of the difference was less than earlier studies suggested.

Age

Effective pandemic preparation requires hospitals to make assumptions about the number and timing of admissions and also about the profile of patients requiring care. For example, children may require different care arrangements (care by parent) and staffing resources than other age groups.

H1N1/influenza had a broad impact. Across all age groups, rates of hospitalization for H1N1/influenza between April and December 2009 were higher than for seasonal influenza. Caution must be used when interpreting the magnitude of the difference from baseline, as there are known issues with under-investigation and under-documentation of seasonal influenza in the discharge data.¹⁹
In a typical flu year, young children and the elderly have the highest rates of hospitalization. H1N1/influenza patients showed a different pattern in two distinct ways:

- Young children were hospitalized at a significantly higher rate than any other age group.
- A higher hospitalization rate among those age 20 to 64 (the widest age group) means that the greatest number of hospital patients (47%) were between age 20 and 64.

Comorbidities

Planning assumptions regarding the proportion of patients who are medically complex also have an impact on hospital care and staffing levels required. Initial fears about H1N1/influenza centred on the fact that the virus was attacking younger and seemingly healthy patients. PHAC identified that pregnant women and children younger than five (and particularly younger than two) were at heightened risk of developing complications from H1N1, as were persons with chronic heart disease, kidney disease, diabetes, asthma, chronic lung disease, suppressed immune systems and obesity and current smokers.
Many (but not all) of these conditions can be explored in the hospital discharge data. H1N1/influenza patients admitted to hospital were more likely to have certain respiratory health issues (chronic lung disease or asthma) or be pregnant when compared with those hospitalized with influenza in baseline years. On the other hand, patients with chronic heart conditions, diabetes or kidney disease were somewhat less likely to be found in the H1N1/influenza group than in baseline influenza cases. The discharge data does not contain comprehensive information on obesity or smoking status.

It is not clear why these variations in comorbidity patterns exist. Some of the difference from baseline may be attributed to more comprehensive testing during the pandemic period (where guidelines indicated that all patients with influenza-like illness should be tested), whereas seasonal influenza testing may be more focused on those with chronic conditions.

Figure 6: Comorbidity Profile of Hospital Patients: H1N1/Influenza and Baseline

Note

Sources

ICU and Ventilation

Some studies have suggested that pandemic planning has focused mainly on public health, with the impact on inpatient hospital care—and particularly on specialized inpatient services—sometimes overlooked. We know that the distribution of H1N1/influenza patients, in terms of length of hospital stay, was not too different from baseline seasonal flu patients. A typical H1N1/influenza patient stayed in hospital for three days, although there was considerable variation in experience. A large proportion (40%) of patients were hospitalized for only a day or two, while a significant number (25%) were in hospital for a week or more. It is the latter group, with its higher utilization of ICU care and invasive mechanical ventilation, which is of greatest concern for pandemic planning. Most Canadian intensive care units operate at near full capacity, so even a small increase in patients can have a major impact on the system.
Early studies suggested that 25% to 35% of H1N1 patients required ICU care.\textsuperscript{21–25} The Canadian hospital data reveals that an estimated 2,165 patients needed ICU care, representing 15% of hospitalized H1N1/influenza cases (versus 11% in baseline years). An estimated 1,130 H1N1/influenza patients were treated with invasive mechanical ventilation (8% in 2009 versus 5% in baseline years). While the ICU and invasive ventilation needs were higher for H1N1/influenza patients than in baseline years, the extent of this difference is much smaller than initial estimates, if both H1N1 and influenza groups are considered. The proportion of patients who were seriously ill was somewhat higher among those with an H1N1 diagnosis than among those in the combined H1N1 and influenza group.

The impact of the pandemic on ICU resources was affected not only by the number of patients, but also by how long these patients required ICU services. Outside of Quebec, H1N1 and influenza patients spent a median of 93 hours (3.9 days) in ICU. Median ICU stays were longest among those age 20 to 64 (103 hours/4.3 days) and shortest among those age 4 and younger (median 56 hours/2.3 days) and 5 to 19 (median 58 hours/2.4 days). Quebec captures ICU stays in days rather than hours. Within Quebec, the median ICU length of stay was 3 days.

Because many patients had protracted ICU stays, the average ICU stay, at 170 hours (7.1 days), was longer than the median (3.9). The average ICU stay for H1N1/influenza patients was somewhat lower than the 10-day figure used in some hospital pandemic planning models.\textsuperscript{15}

Equipment and staffing needs within the ICU are also affected by a patient’s age. Patients age 4 and younger had the highest rates of hospitalization for H1N1/influenza, but once admitted they were least likely to require ICU care or ventilation. Conversely, patients age 20 to 64 were least likely to be admitted to hospital, but once there they were more likely to need ICU care or ventilation.
Did Antiviral Medication or Vaccination Programs Have an Impact on the Use of Hospital Services?

Antiviral medication was an important part of treatment in the second wave and occurred at the same time as the proportion of patients needing ICU and ventilators declined.

The vaccination campaign began as the second wave of H1N1 was ramping up. More study is required to understand its impact on hospitalizations and ICU use.

The duration and severity of the pandemic peak has a major impact on how extensively hospitals are affected. Many factors play a role. For instance, the peak of H1N1 activity was affected by the transmission and spread of influenza, influenced by the level of immunity acquired in communities during the first wave, weather/humidity conditions and the prevalence of competing viruses. Other factors were more within the control of the health system, including the effectiveness of public education campaigns to mitigate transmission, such as staying home from school or work if sick, coughing etiquette and hand-washing campaigns. While this report does not address these issues, it does provide some information on two other health system activities which may have influenced the spread and severity of H1N1: delivery of vaccinations and administration of antivirals.

Antivirals

Antiviral drugs, such as Tamiflu, can be used to treat people who are identified early in their illness. There is evidence that antivirals are effective in reducing the duration and severity of illness from influenza when administered within an appropriate time frame of the onset of symptoms. Antivirals can also be used to prevent influenza in an individual before or after he or she is exposed to an infected person, although prophylactic use during the pandemic was not recommended. Information on antiviral medication is available for nine provinces: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador. Across these nine provinces, more than 362,000 prescriptions were filled between April and December 2009. This is likely an underestimate, as data from some provinces does not provide information on antivirals prescribed in hospital or to certain populations (see the appendix for more information).

There was very little use of antiviral medication before September 2009. Lessons learned from early H1N1 experience may have contributed to increased use of antivirals to reduce morbidity and mortality in later cases. Before the second wave, significant awareness campaigns were directed at primary care providers regarding guidelines for treating patients (particularly those at high risk of complication, including pregnant women) with antiviral medication at an early stage of respiratory infection. During the week of November 1, 2009, alone, more than 96,000 prescriptions were filled across nine provinces.
High antiviral use in October and November was observed at the same time as lower proportions of hospitalized patients requiring ICU care and invasive mechanical ventilation. We don’t know whether this situation is due specifically to the antiviral medication or whether there was a change in the hospitalized patient profile (such as a greater number of less acutely ill patients being admitted) during this period. However, there was no observed relationship between increased use of antivirals and an increase in the proportion of short-stay (one or two days) H1N1/influenza cases.

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**Sources**


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iv. Because antivirals for hospitalized patients would typically be administered at the beginning of a stay, the hospitalization information in this section focuses on admission date. Analysis elsewhere in this report outlines hospital data according to discharge date.
Vaccinations

Since pandemic H1N1 was a new virus, few had previous immunity against it, except for the elderly. The H1N1 vaccine triggers the immune system to produce antibodies against the virus and to fight pandemic infection within 10 to 14 days of vaccination. Health Canada approved a vaccine for H1N1 in mid-October 2010, and shortly afterwards provinces and territories rolled out mass vaccination campaigns.

Vaccination information by week is available for six provinces: Newfoundland and Labrador, P.E.I., Quebec, Manitoba, Saskatchewan and Alberta. More than 7 million vaccinations were delivered across these six jurisdictions between late October and December 2009. Another 7.2 million vaccinations were delivered in New Brunswick, Ontario and British Columbia, where data was reported differently.

Children from 6 months to 4 years were a priority for vaccination across the country, including the five provinces for which we have detailed information. The data suggests that this strategy was implemented successfully, with children age 4 and younger being vaccinated before other age groups. However, one limitation of the data is it identified vaccines administered as opposed to the number of unique recipients. Initial guidelines were for children younger than age 9 to receive two half doses 21 days apart. On November 20, 2009, the guideline was revised to a single dose only for healthy children age 3 to 9. Guidelines for children age 6 months to 2 years, or those with chronic health conditions, remained unchanged.
Did vaccination have an impact on reducing hospitalizations from H1N1? Several factors make this difficult to address. The timing of the vaccine distribution coincided with the ramp-up of the second wave. Given that the vaccine required about 10 to 14 days to confer immunity, it is unlikely that the vaccine had a significant impact on the height of the second wave’s peak. However, H1N1 was a novel virus and different from traditional flu, so the vaccine may have been important in preventing or reducing the impact of a potential third wave.

Research studies related to the H1N1 vaccine are just now being completed. Statistics Canada reported that 41% of Canadians got the vaccination, which translates to about 11.6 million people, exceeding the coverage typically seen for seasonal flu. Other important studies examining vaccine program implementation and evaluation have been coordinated by the PHAC–CIHR Influenza Research Network. The results of these research studies may shed more light on the impact of the vaccination campaign on the number of H1N1/influenza patients who required hospital care.
Summary

More than 15,000 patients across Canada were hospitalized with H1N1/influenza, two-thirds of whom needed care within a few-week period in fall 2009. Overall, the hospital system was able to manage these patients and the specialized services they needed. While few anticipate that H1N1 will be a major factor in the 2010–2011 flu season, there will undoubtedly be new strains of influenza (or other viruses) to test our health care system. Good understanding of the H1N1 pandemic in acute care hospitals will be critical as health systems review and revise their pandemic plans. H1N1 occurred at a different time of year and affected a different demographic than seasonal flu, and a higher proportion of inpatients required specialized and scarce hospital services such as ICU and ventilation. Hospital pandemic plans are designed to develop and match surge capacity to needs and rely on multiple assumptions about the nature of a pandemic. Good information from the 2009 pandemic should provide strong inputs to the models used and help hospitals improve their preparedness.

For More Information

Copies of this report are available free of charge in both official languages on the CIHI website at www.cihi.ca. You can also find

- Presentation slides with highlights from this analysis that you can use to share the results with others; and
- Information on other CIHI activities related to H1N1, including guidance regarding the collection of H1N1 data for health information professionals.

Acknowledgements

CIHI would like to acknowledge and thank the many individuals who contributed to the development of this analysis. Foremost, we would like to recognize provincial officials who provided information on testing directives, antiviral use and vaccine delivery. We know that this data could not be available without the dedication and commitment of public health partners across the country. Several public health officials made time to assist with the conceptualization of this paper and review of selected findings:

- Dr. Gaston De Serres, Institut national de santé publique du Québec
- Dr. Cordell Neudorf, Saskatoon Health Region
- Dr. Louise Pelletier, Public Health Agency of Canada
- Dr. Brian Schwartz, Ontario Agency for Health Protection and Promotion

Finally, appreciation goes to the CIHI staff involved, including Jennifer Frood, Tracy Johnson, Jenny Lineker, Janet Manuel, Kathleen Morris, Jessica Ramirez-Mendoza and Simon Tavasoli.
Appendix: Technical Notes

H1N1 Laboratory Testing

Across the country provincial public health organizations provided formal guidance on testing for H1N1. Nasal swabs were the preferred specimens for laboratory testing. Provincial directives recommended testing all hospitalized patients with influenza-like illnesses or specific respiratory conditions such as asthma and chronic obstructive pulmonary disease. The timing of these directives played out slightly differently across the country, with some jurisdictions providing guidance as early as April and May, while others started as late as September. As well, the specificity of the directives differed across jurisdictions. For more detailed information see Testing Directive Summary at www.cihi.ca.

Inpatients With H1N1/Influenza and Baseline Influenza

Data Sources

CIHI maintains the Discharge Abstract Database (DAD), which contains demographic, administrative and clinical data on all acute hospital discharges across Canada, excluding Quebec. For this analysis, hospitalization information for all provinces and territories (except Quebec) came from the DAD. Data is abstracted from the patient chart in each hospital using a standardized coding system. Information about specific medications or processes of care is not part of the data set.

A special tabulation of Quebec data came from the Fichier des hospitalisations MED-ÉCHO (Maintenance et exploitation des données pour l’étude de la clientèle hospitalière). Quebec discharge data was provided to CIHI in July 2010 for data up to December 31, 2009. While the completeness of data from April to September 2009 is very good (at 97% of the previous year’s activity), information from October to December 2009 was less complete (at 80% of the previous year’s activity) and varied by region. A weight was created for each health region based on estimated missing records—the difference between the number of records in 2009 relative to the same time period in the previous year. This weight was then applied to actual case counts for October to December to compensate for missing data. Baseline data for 2006–2007 to 2007–2008 was obtained from MED-ÉCHO.

A special tabulation of H1N1 data was provided by PHAC. For case definitions refer to PHAC’s website at http://origin.phac-aspc.gc.ca/fluwatch/. National population estimates were produced by the Demography Division at Statistics Canada. Data was derived from the latest census and administrative sources on births, deaths and migration, adjusted for net under-coverage. Population growth for health regions in Alberta and British Columbia was supplied by Alberta Health and Wellness and BC Stats, respectively. H1N1/influenza rates used population estimates based on 2009–2010; baseline influenza rates were based on 2007–2008.

Unit of Analysis

The unit of analysis for this project was the episode of care. To account for patient transfers from one acute hospital to another, individual abstracts were combined to build episodes of care (or hospitalizations). A transfer was defined as a scenario when a patient was discharged from one acute facility and admitted to another within 24 hours. Linkage was done by combining the data elements Health Card Number, Gender and Province Issuing Health Card Number to create a unique identifier for each patient and identifying all relevant acute care admissions. Linking all admissions together into a single episode of care allows us to see the entire acute portion of the pathway of care.
H1N1 Case Selection and Baseline

Selection Definitions

**H1N1 cases:** Abstracts with an ICD-10-CA code of J09– in any diagnostic position. Note that code J09 was previously used for avian influenza, but the WHO re-purposed it to collect H1N1 information as of April 2009. Patients with a diagnosis of H1N1 may or may not have had lab confirmation of the diagnosis. In May 2009, CIHI advised hospitals to classify any lab-confirmed H1N1 cases to ICD-10-CA code J09 (given the time lag to have charts completed and abstracted, this directive would have included captured cases from the beginning of the pandemic period in April 2009). However, based on feedback from hospitals CIHI modified its guidance in November 2009 to also accept cases where a clinical diagnosis of H1N1 had been made in the patient’s chart, regardless of whether there was a supporting lab report.

**H1N1 and unspecified influenza cases:** Abstracts with an ICD-10-CA code of J09– Influenza due to identified Avian influenza virus, J10– Influenza due to other identified influenza virus or J11– Influenza, virus not identified in any diagnostic position.


While not the focus of our study, it is worth understanding that seasonal influenza (baseline) is typically under-captured in administrative databases. Few Canadians are hospitalized for influenza alone. Most are hospitalized only when a complication of influenza develops—usually from lung infections, such as pneumonia. Once hospitalized, treatment is focused on the pneumonia, and information on the organism that triggered the infection is not usually available. For this reason some caution should be used when comparing to baseline, as it is likely an underestimate of actual cases.

Other Health Conditions

PHAC identified that certain patients were at heightened risk of developing complications from H1N1. This study examined persons with the following health conditions:

<table>
<thead>
<tr>
<th>Health Condition</th>
<th>ICD-10-CA code (in any diagnostic position)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy</td>
<td>O^ (excluding those with a sixth digit of 4), Z32.1, Z33^, Z34^, Z35^, Z36^</td>
</tr>
<tr>
<td>Chronic Heart Disease</td>
<td>I11, I13, I20.8^, I27^, I31^, I34^, I38, I42^</td>
</tr>
<tr>
<td>Kidney Disease</td>
<td>N0^, N1^, N20^, N21^, N22^, N23^, N25^, N26^, N27^, N28^</td>
</tr>
<tr>
<td>Diabetes</td>
<td>E10^, E11^, E13^, E14^</td>
</tr>
<tr>
<td>Asthma</td>
<td>J45^</td>
</tr>
<tr>
<td>Chronic Lung Disease</td>
<td>J40^, J41^, J42^, J43^, J44^, J45^, J47^, J60^, J61^, J62^, J63^, J64^, J66^, J67^, J70.1, J70.3, J95.3, J96.1, J98.9</td>
</tr>
<tr>
<td>Immune Suppressed</td>
<td>B24, D80, T86, Z94</td>
</tr>
</tbody>
</table>

PHAC also identified obesity and smoking status as risk factors for H1N1. These were not explored as the data elements are not routinely collected.
Other reasons for hospitalization: To put H1N1/influenza in perspective during the peak of the pandemic, we looked at other common inpatient groups in acute care hospitals for comparison, during the time period October 25 to November 28, 2009:

<table>
<thead>
<tr>
<th>Reasons for Hospitalization</th>
<th>Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Myocardial Infarction</td>
<td>ICD-10-CA: I21, I22 that was not coded as a post-admission (type 2) or service transfer (types W, X or Y)</td>
</tr>
<tr>
<td>Stroke</td>
<td>ICD-10-CA: I60, I61, I62, I63, I64 that was not coded as a post-admission (type 2) or service transfer (types W, X or Y)</td>
</tr>
<tr>
<td>Hip and/or Knee Replacement</td>
<td>CCI: 1.VG.53 ^ , 1.VA.53.LA.PN, 1.VA.53.PN.PN that was not abandoned or done out of hospital</td>
</tr>
<tr>
<td>Coronary Artery Bypass Graft Surgery</td>
<td>CCI: 1.IJ.76. PN that was not abandoned or done out of hospital</td>
</tr>
<tr>
<td>Newborns</td>
<td>Entry code indicating an infant born alive within the reporting facility (Entry code = N)</td>
</tr>
<tr>
<td>Normal Newborns</td>
<td>Case Mix Group: 576–577</td>
</tr>
<tr>
<td>Cardiology</td>
<td>Case Mix Group: 193–213</td>
</tr>
<tr>
<td>Cardiac Surgery</td>
<td>Case Mix Group: 160–185, 905</td>
</tr>
<tr>
<td>Pre-Booked Admissions</td>
<td>Admit Category = Elective, excluding major clinical categories (MCCs) related to pregnancy and childbirth (MCC 13) and newborns with conditions originating in the prenatal period (MCC 14)</td>
</tr>
</tbody>
</table>

Specialized Hospital Services

**In-hospital mortality:** In-hospital mortality is an indicator of severity of illness. It is defined as a patient having died while in acute care (includes both ICU and general beds).

Some patients who become severely ill may require the use of ICUs and mechanical ventilators. This section explains how these services were identified in the abstract.

**ICU:** Intensive care unit data is provided by hospitals as part of the discharge abstract and excludes step-down care. Within a hospitalization, some patients (21% of H1N1/influenza cases and 18% of baseline) had more than one admission to an ICU. In these cases, the first admission was selected for analysis. In most parts of the country, the length of stay in the ICU is measured in hours, while in Quebec the unit of measurement is days. For this reason Quebec ICU length of stay is reported separately.
**Ventilation:** CIHI has information on the date invasive mechanical ventilation was initiated and whether the duration of ventilation was more or less than 96 hours. Some hospitalizations (20% of H1N1/influenza cases and 18% of baseline) involved more than one ventilation episode. When a hospitalization involved multiple ventilations, the first ventilation was selected for analysis. Procedure codes used to identify ventilated patients were as follows:

1. **GZ.31.CA.ND** Ventilation, respiratory system NEC, positive pressure, invasive per orifice approach by endotracheal intubation

1. **GZ.31.CR.ND** Ventilation, respiratory system NEC, positive pressure, invasive per orifice with incision approach for intubation through tracheostomy

1. **GZ.31.GP.ND** Ventilation, respiratory system NEC, positive pressure, invasive percutaneous transluminal approach (e.g. transtracheal jet) through needle

**Emergency Department Visits**

For this analysis data on emergency department (ED) visits came from the National Ambulatory Care Reporting System (NACRS), which contains data on hospital-based and community-based ambulatory care, including day surgery, outpatient clinics and EDs. Only ED visits were included for this analysis (MIS functional centre starting with 71310, 72310 or 73310). CIHI has complete ED data for Ontario, but not yet for other provinces.

**Flu-Like Symptoms Case Selection**

**Flu-like symptoms:** Abstracts where patients indicated the reason for their visit to the ED was due to cough (R05), shortness of breath (R06.0), fever (R50.9), malaise and fatigue (R53) or sore throat (J02.9).


Most definitions of influenza-like illness are based on the presence of a combination of symptoms. In 2008, the WHO defined influenza-like illness as a fever and cough or sore throat in the absence of another diagnosis. PHAC defines influenza-like illness as “fever and cough with one or more of the following: sore throat, arthralgia, myalgia or prostration which is likely due to influenza.” Administrative data captures the primary reason for a visit as opposed to a comprehensive list of symptoms; therefore, we were not able to identify cases based on these symptom combinations. Our approach identified ED patients with an H1N1 diagnosis and looked at the symptoms reported as influenza-like: fever, cough, sore throat, shortness of breath or malaise and fatigue. If patients reported any of the five symptoms as the reason they came to the ED they were captured as having an influenza-like illness.
Antiviral Data

Data Sources

1. Special tabulations of antiviral data were provided directly from the provinces of British Columbia, Alberta, Ontario, Prince Edward Island, Nova Scotia and Newfoundland and Labrador. The unit of analysis is prescriptions filled.

2. The National Prescription Drug Utilization Information System (NPDUIS) Database, launched in 2006, contains information on the costs of prescribed drugs paid for by Canadian public drug programs, as well as supporting information for analyzing and informing on the patterns of drug use. Specifically, the NPDUIS Database includes claims data, formulary data, drug product data and federal, provincial and territorial public drug plan information. Claims data is available from six provinces, while all provinces have formulary information in the NPDUIS Database. For this analysis, full provincial antiviral claims data is available for Manitoba, Saskatchewan and New Brunswick. The NPDUIS Database does not contain information regarding diagnoses or conditions for which prescriptions were written. Therefore, we cannot ensure that the antiviral drugs were solely prescribed for patients with H1N1.

Antiviral drugs were identified by their WHO Anatomical Therapeutic Chemical (ATC) level 5 classifications as reported in the Health Canada Drug Product Database. In some cases, the drugs were dispensed with a pseudo–drug identification number (DIN) with no valid ATC code and were included in the analysis whenever possible. Antiviral claims that were accepted by the public drug programs in Manitoba, New Brunswick and Saskatchewan are included in this analysis. For the duration of the H1N1 pandemic all three provincial programs included any individuals who had a prescription filled for an antiviral medication. New Brunswick opened a program during the H1N1 flu season (Program C, Influenza). Claims made under this program are assumed to be one claim made per patient, within a reasonable margin of error because these claims cannot be linked to individual patients. While small, there may be some over-counting as some individuals may have had more than one prophylactic prescription. Prophylactic use of antivirals was not recommended for H1N1.

The first and last weeks of the analysis contain only claims from the requested time frame. The week starting March 29, 2009, contains only data starting on April 1, 2009. This is also the situation for the final week (starting December 27, 2009, and ending January 2, 2010), containing claims only up to December 31, 2009.

People covered by provincial workers' compensation boards or federal drug programs are not eligible for provincial public coverage. Federal drug programs include those delivered by the Canadian Forces; the Correctional Service of Canada; First Nations, Inuit and Aboriginal Health; the Royal Canadian Mounted Police; and Veterans Affairs Canada.

Claims dispensed through special programs, such as the Saskatchewan Cancer Agency, are not submitted.

Further information about public drug programs in Canada can be found in the NPDUIS plan information document at https://secure.cihi.ca/estore/productbrowse.htm?locale=en&Lang=en-US.

H1N1 Vaccines

Special provincial tabulations of weekly vaccinations were provided for specified age groups from April 1, 2009, to December 31, 2009, by Alberta, Saskatchewan, Manitoba, Quebec, New Brunswick, Prince Edward Island and Newfoundland and Labrador. British Columbia and Ontario were able to provide an estimate of total inoculations given. The unit of analysis is the number of people who had at least one dose of vaccine. There is likely over-counting of children due to changes in clinical guidelines, which initially recommended two doses of the vaccine for children younger than age 9.
References


6. Email from Julie Vachon, Epidemiologist, Public Health Agency of Canada, September 15, 2010, to Kathleen Morris, Head, Emerging Issues, Canadian Institute for Health Information.


