

Can a universal influenza immunization program reduce emergency department volume?

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ABSTRACT

Objectives: In 2000 the Ontario Minister of Health and Long-Term Care announced a universal influenza immunization program for Ontario, Canada. The 2 objectives of this \$38-million program were to decrease seasonal impact of influenza on emergency department (ED) visits and to decrease the number and severity of influenza cases. This paper examines the correlation between population influenza rates and ED visits in 5 tertiary care hospitals in Ontario over a 5-year period (1996–2001).

Methods: In this retrospective, observational study, we determined the total number of ED visits during the study period, by month, at 5 tertiary care hospitals in 3 Ontario cities (Kingston, London and Ottawa). Detailed ED diagnoses were captured for Kingston, and provincial and national population-based influenza rates were obtained from Health Canada for the 5-year study period. Correlation and regression analyses were used to determine the relationship of influenza rates and ED volumes. "Influenza season" is defined in this study as November 1st to March 31st of each year.

Results: There was no significant correlation between influenza rates and ED volumes, with Pearson correlation coefficients (r) of 0.22 ($p = 0.72$), 0.33 ($p = 0.59$) and 0.27 ($p = 0.66$) at the Kingston, London and Ottawa study sites, respectively. Data from the Kingston hospitals showed that, during influenza season, acute respiratory diagnoses accounted for only 4.4% of ED visits and influenza for only 0.34% of visits. Multiple linear regression analysis showed that the ED diagnosis of influenza was not significantly related to ED volume. During the influenza season after the universal immunization campaign, ED visits increased at all sites.

Conclusion: Based on this study, a universal influenza immunization campaign is unlikely to affect ED volume.

Key words: influenza; vaccination; emergency department, volume

RÉSUMÉ

Objectifs : En 2000, le Ministre de la Santé et des soins de longue durée de l'Ontario a annoncé un programme de vaccination anti-grippale à la grandeur de l'Ontario au Canada. Les deux objectifs de ce programme de 38 millions de dollars étaient de réduire l'impact saisonnier de la grippe sur les visites au département d'urgence (DU) et de réduire le nombre et la gravité des cas de grippe. Le présent article examine la corrélation entre le nombre de cas de grippe au sein de la population et les visites au DU dans cinq hôpitaux de soins tertiaires de l'Ontario sur une période de cinq ans (1996–2001).

Méthodes : Lors de cette étude rétrospective observationnelle, nous avons déterminé le nombre

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total de visites au DU au cours de la période d'étude, par mois, dans les cinq hôpitaux de soins tertiaires de trois villes en Ontario (Kingston, London et Ottawa). Les diagnostics détaillés du DU furent obtenus pour Kingston et les taux national et provincial de cas de grippe au sein de la population furent obtenus de Santé Canada pour la période d'étude de cinq ans. Des analyses de corrélation et de régression furent utilisées pour déterminer la relation entre le nombre de cas de grippe et les visites au DU. Cette étude établit la saison de la grippe du 1er novembre au 31 mars de chaque année.

Résultats : Il n'y avait aucune corrélation significative entre le nombre de cas de grippe et les visites au DU, les coefficients de corrélation de Pearson (r) étant de 0,22 ($p = 0,72$) à Kingston, de 0,33 ($p = 0,59$) à London, et de 0,27 ($p = 0,66$) à Ottawa. Les données des hôpitaux de Kingston indiquaient que, pendant la saison de la grippe, les diagnostics de détresses respiratoire aiguë représentaient seulement 4,4 % des visites au DU et les cas de grippe, seulement 0,34 % des visites. Une analyse de régression linéaire multiple indiquait que le diagnostic de la grippe n'était pas en corrélation significative avec le nombre de visites au DU. Pendant la période de la grippe après la campagne universelle de vaccination, les visites au DU augmentèrent à tous les sites d'étude.

Conclusion : À partir des résultats de cette étude, une campagne universelle de vaccination antigrippale est peu susceptible d'avoir un impact sur le nombre de visites au DU.

Introduction

In the winter of 1999/2000 the province of Ontario suffered a severe outbreak of influenza, and news reports linked this outbreak to concurrent emergency department (ED) overcrowding.¹ In July 2000 the Ontario Ministry of Health and Long-Term Care announced a universal influenza immunization program for all Ontario residents.² Through this program all 11.5 million Ontarians were eligible to receive publicly funded influenza vaccine annually, starting in October of 2000. In October 2001, the MOHLTC announced a second year of the universal campaign, at a cost of \$44 million.³ The program's 2 stated objectives are to decrease the impact of influenza on ED visits, and to decrease the number and severity of influenza cases in Ontario.

A MEDLINE search using the terms "influenza" and "ED volume," "ED overcrowding," "emergency room (ER) volume," "ER overcrowding" and the related articles, revealed no published research on the direct impact of influenza cases on ED volume, although research on other causes of ED overcrowding were found. Because reducing ED volume was one of the universal campaign's 2 objectives, we conducted a study to determine the relationship between population influenza rates and ED patient visits.

Our primary objective was to determine whether population influenza rates are associated with increasing ED volumes. Secondary objectives were to describe temporal patterns of ED utilization at the 3 study sites (5 hospitals), to estimate the number of cases of influenza and acute upper respiratory (AUR) disease that are diagnosed in the Kingston EDs and to determine the likely impact of influenza and AUR diseases on ED volume based on their numbers relative to all ED visits.

Methods

In this retrospective observational study, we obtained the total number of ED admissions from 5 hospitals in 3 Ontario cities between Nov. 1, 1996, and Mar. 31, 2001. ED visits were converted to age-standardized rates per 100 000 population and correlated with provincial influenza cases reported by Health Canada.

Data collection

ED data were obtained from the medical records departments of the Ottawa Hospital's Civic Campus in Ottawa, the London Health Sciences Centre's South St. and University campuses in London, and the Kingston General (KGH) and Hotel Dieu hospitals in Kingston, which are large, tertiary care centres representing eastern, western and southern Ontario. All sites provided the total number of ED visits, by month, between Nov. 1, 1996, and Mar. 31, 2001. The 2 Kingston hospitals also provided the number of influenza cases as a percentage of all respiratory diagnoses in adults (over age 18) seen in the ED. This site was chosen because it had the highest volume and was a convenient sample to obtain.

ED respiratory diagnoses

All patient visits were coded by ED discharge diagnoses (ICD-9 codes) and entered into a central database. Medical records staff provided the researchers with the ED diagnoses for all influenza season patient visits for the years 1996/97 to 2000/01. Visits within that time frame with the discharge diagnosis of AUR disease, pneumonia and influenza-like illness (ILI) or influenza (ICD-9 codes 460–466, 480–487) were identified by ICD-9 code, age and gender. We did not

limit our focus to ICD-9 codes 487–487.8 (influenza and ILI) because this would have underestimated influenza rates. Many upper respiratory conditions have similar symptoms to influenza and ILI, and in the absence of confirmatory testing, emergency physicians may apply nonspecific respiratory diagnoses to patients with influenza. Consequently, this study and others^{4,5} have used AUR illnesses and pneumonia, (ICD-9 codes 460–466,480–486) as a proxy measure for influenza and ILI.

Population influenza data

Provincial and national influenza data were obtained from Health Canada's *Canada Communicable Disease Reports (CCDR)*,⁵⁻⁹ which are based on 3 types of data collection. First, laboratories participating in the Canadian case-by-case surveillance program are required to report confirmed influenza cases to the Division of Disease Surveillance at the Centre for Infectious Diseases Prevention and Control (CIDPC). Second, ILI is reported by sentinel physicians on a weekly basis, and third, influenza activity levels are assessed by the provincial and territorial epidemiologists. These data are compiled and published in the *CCDR*.

Confirmed influenza is a reportable disease in Ontario, and the reporting definition is the presence of 3 symptoms — fever greater than 39°C; cough or sore throat; and myalgia, malaise or prostration — as well as at least 1 of the following: laboratory confirmation by detection or isolation of influenza virus in pharyngeal or nasal secretion OR a 4-fold increase in hemagglutination antibody titers to influenza between acute and convalescent sera. This study used *laboratory-confirmed cases of influenza* reported to the CIDPC and published in *CCDR* because these data were consistently available for the entire 5-year study period.

In the United States, all laboratory-confirmed cases of influenza are collated by the Centers for Disease Control and Prevention and reported in the *Morbidity and Mortality Weekly Reports*.¹⁰⁻¹⁵ These data were collected for comparison purposes in this study.

Analysis

ED volumes were aggregated by city. The ED patient visits were then transformed into age-standardized rates per 100 000 population (using 1996 Statistics Canada census data) in order to compare them to provincial influenza rates and to each other. Descriptive statistics, including counts, percentages, means and frequencies, were used to describe ED diagnoses.

Pearson correlation coefficients were used to identify significant relationships between ED volume and influenza cases, and (in Kingston) relationships between ED volume

and upper respiratory diagnoses. Multiple linear regression was used to determine how much of the variance in ED volume could be accounted for by influenza, pneumonia and other upper respiratory conditions, and to see whether influenza rates were significantly associated with ED volume, after controlling for other upper respiratory diseases. All analyses were completed using Excel spreadsheets and SPSS version 10.1 (Chicago, Ill.).

Ethical considerations

This protocol received expedited ethical approval by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board because the data collected from the hospitals (ED volume) were often publicly reported. At no time were the investigators aware of the identity of specific patients involved.

Results

Figure 1 shows reported rates of influenza cases per 100 000 population per year in Canada, the USA, and in Ontario, from the influenza seasons of 1996/97 to 2000/01. Annual fluctuations, as well as the decrease in influenza rates from the 1999/2000 season to the 2000/01 season are apparent.

Figure 2 illustrates total ED visits per 100 000 population for Kingston, Ottawa and London, between Nov. 1, 1996, and Mar. 31, 2001. Vertical lines indicate peak volume periods. This figure shows that ED volumes follow similar seasonal fluctuations in all of the study regions and that peak ED volumes occurred during summer.

Figure 3 shows mean ED volumes during influenza season only, with the rate of laboratory-confirmed influenza cases for the province of Ontario displayed on the Y-axis.

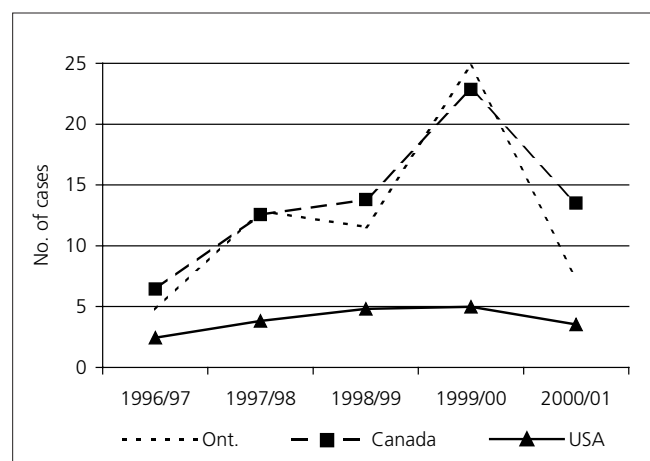


Fig. 1. Laboratory confirmed influenza cases in Ontario, Canada and the USA, rates per 100 000

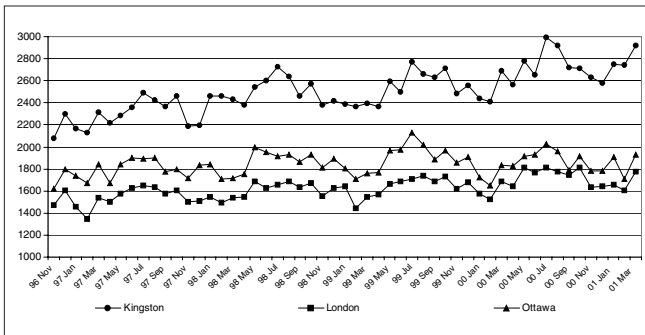


Fig. 2. Emergency department (ED) volume (per 100 000 population) from Nov. 1, 1996, to Mar. 31, 2001.

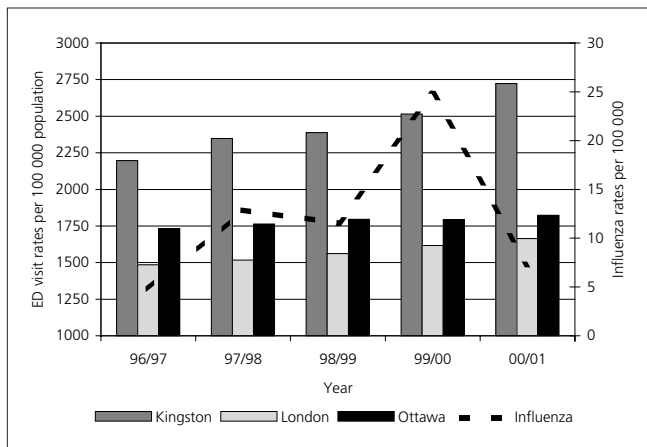


Fig. 3. Mean ED visit rates per 100 000 population during the influenza season (November 1st to March 31st)

There was no significant correlation between influenza rates and ED volumes, with Pearson correlation coefficients (*r*) of 0.22 (*p* = 0.72), 0.33 (*p* = 0.59), and 0.27 (*p* = 0.66) at the Kingston, London and Ottawa study sites, respectively.

During the 5 influenza seasons studied in 2 Kingston EDs, AUR diagnoses accounted for only 4.4% of all ED visits, and influenza for only 0.34% of visits. Table 1 shows that, based on ED discharge diagnosis, influenza accounted for 7% to 10% of all acute respiratory conditions seen. In Table 2, Pearson correlation coefficients reveal that there are no statistically significant correlations between Kingston hospital ED volume and ED diagnosis of influenza, pneumonia or other upper respiratory disease. However, the diagnosis of influenza correlated significantly with diagnosis of “other AUR,” indicating that upper respiratory disease may be a good proxy for influenza.

Finally, multiple linear regression was used to determine how much of the variance in Kingston ED volumes could be accounted for by influenza, pneumonia and other AUR diagnoses. The regression model determined that all upper respiratory diagnoses combined accounted for 27% of the variance in ED visit volume (*r*² = 0.27), although this was not statistically significant (*p* = 0.53). Neither influenza, pneumonia, nor other AUR diseases were significant predictors of ED volume, with influenza showing an inverse (negative) relationship to total ED visit volume.

Table 1. Acute respiratory diagnoses in Kingston emergency departments (1996–2000)

Year	Colds, %	Other AUR* diseases, %	Pneumonia, %	Influenza, %	All respiratory, %
1996/97	13.0	53.0	27.0	7.0	100
1997/98	13.0	44.0	29.0	9.0	100
1998/99	12.7	44.6	32.9	9.8	100
1999/2000	12.1	52.5	27.3	9.1	100

AUR = acute upper respiratory

Table 2. Correlation* between Kingston ED volume and acute upper respiratory (AUR) illnesses

Variable	ED volume	Influenza	Pneumonia	Other AUR
ED volume	<i>r</i> = 1.0			
Influenza	<i>r</i> = -0.45; <i>p</i> = 0.45†	<i>r</i> = 1.0		
Pneumonia	<i>r</i> = 0.27; <i>p</i> = 0.66	<i>r</i> = 0.54; <i>p</i> = 0.35	<i>r</i> = 1.0	
Other AUR	<i>r</i> = -0.13; <i>p</i> = 0.83	<i>r</i> = 0.90; <i>p</i> = 0.04	<i>r</i> = 0.57; <i>p</i> = 0.32	<i>r</i> = 1.0

* Correlation (*r*) is based on Pearson’s product-moment correlation coefficient.
 † All tests of significance are 2-sided unless otherwise specified, and considered significant at the 0.05 level.
n = 5 for all comparisons, reflecting the 5 comparison periods (1996–2000).

Discussion

The findings from this study suggest that influenza rates do not correlate significantly with ED volumes and that, although influenza vaccination programs may have substantial public health benefit, they are unlikely to lead to meaningful improvement in ED overcrowding. Our findings also show that respiratory diagnoses in general and influenza in particular account for a small proportion of ED visits, and that the influence of these conditions on ED volume is not statistically significant. We recognize that because of the need for confirmatory testing, influenza may be underdiagnosed in the ED; therefore, we included pneumonia and other acute respiratory illnesses in our analysis. But even when all AUR diagnoses were examined, these accounted for only 4.4% of all ED visits during the influenza season, and influenza accounted for only 0.34%.

These findings echo results from the *Hospital Report 2001*,¹⁶ which states that in Ontario, injuries and symptoms account for 23% and 17% of ED visits respectively, and in adults over 18 years of age respiratory system diseases in their entirety account for approximately 10% of ED visits.¹⁶ Our regression analysis indicated that neither flu, pneumonia nor other AUR diagnoses were significant predictors of Kingston ED volumes.

Figure 3 illustrates the relationship between influenza rates and ED visit rates. Of note, the 2000/01 influenza season was the first season after Ontario's universal influenza vaccination program and the first since 1995/96 in which Influenza A (H3N2) viruses did not predominate.¹⁰ If population influenza rates are an important determinant of ED volumes, we would expect 2000/01 ED volumes to fall along with influenza rates. Figures 2 and 3 show that this did not occur.

Although influenza rates did not influence ED volumes significantly, the season did. In all 5 tertiary care hospitals studied, ED volumes were highest in the summer months (May to August) and lower during influenza season. This finding is supported by research from the Institute for Clinical Evaluative Sciences (ICES),¹⁷ which reported that "there are highly predictable peaks periods in emergency volume on public holidays and weekends. The week between Christmas and New Year's is the busiest week of the year, with volumes rising as much as one-third above average. Summer is the most demanding season in the ED."

Our study also revealed that ED volume has been increasing every year for the past 5 years at all hospital sites. Other researchers have found that from 1993 to 2000 Ontario ED volumes have decreased; however they clarify that these findings may be due to strict inclusion criteria

whereby a portion of ED visits were not counted, resulting in numbers that are approximately 15% lower than those reported by hospitals.¹⁷ The same report states that ED volume in the USA rose 14% from 1992 to 1999, and that overcrowding and lower utilization are not necessarily mutually exclusive.¹⁷ The reasons for the difference in findings warrant further research.

In Canada, influenza and pneumonia (as a complication of influenza) are responsible for approximately 6700 deaths and 75 000 hospitalizations each year, with between 500 to 1500 deaths per year occurring in Ontario.¹⁸ Since 1989 Ontario has provided yearly influenza vaccinations for persons at high risk of influenza complications (i.e., people with chronic cardiac or pulmonary disorders, those over the age of 65, residents of long-term care facilities and health services workers). The cost-effectiveness of vaccinating low-risk people remains controversial,¹⁹⁻³⁰ and although numerous studies have looked at the causes of ED utilization and overcrowding there are no data suggesting influenza causes overcrowding.³¹⁻³⁶ However, although universal vaccination may have little influence on ED volumes, vaccinating individuals at high risk for complications arising from influenza provides an average direct cost savings of \$117 per person, in addition to reducing the number of hospitalizations and deaths.³⁷⁻⁴⁰

Limitations

The accuracy of ICD-9-coded ED discharge diagnoses and the validity of using administrative databases in health research are areas of debate.⁴¹ We acknowledge that these are potential limitations of the study but hope that the use of a single site and medical records system reduced variability and error. It is possible, however, that the number of ED visits for influenza and other respiratory diagnoses were underestimated.

The number of reported influenza and ILI cases underestimates the true number of cases in any given year. This is because many people with influenza do not seek medical attention and because, of those who do, many receive an alternate diagnosis (e.g., "viral illness"). Therefore, although the numbers presented in this study are not "actual" numbers of influenza cases in any given year, they represent a consistent proportion of the true number of cases because the method of data collection is constant from year to year. Furthermore, these are the official reporting numbers for the Canadian and US governments, and the numbers upon which health policy decisions are based.

This study does not discuss vaccination coverage rates, which are not systematically collected and thus unavailable. Prior studies have documented coverage rates of 13.8% for

low-risk Canadian adults and 44.8% for people over age 65.⁴² The target of the universal campaign was 90% for high-risk groups and 60% for low-risk groups. The Ontario Ministry of Health and Long-Term Care, the Public Health Research Education and Development programs of provincial health units, the Institute for Clinical Evaluative Sciences, and Aventis Pasteur recently completed a telephone survey to assess the success of the universal immunization campaign, but these results have not yet been released. If the campaign increased vaccine coverage rates, but ED volumes failed to decline, this would be direct evidence that influenza vaccination does not reduce ED utilization; however, if vaccine coverage rates did not increase, then the program itself needs to be re-examined.

Another limitation is that, at the time of this study, only 6 months of data were available after the universal immunization campaign, in contrast to 5 years of precampaign data. It is conceivable that, as vaccination coverage increases, future data will show a beneficial effect on ED utilization; however, this seems unlikely given the relatively small proportion of influenza- and respiratory-related ED visits during influenza season and the predictable peaks in the summer months.

Finally, this study was carried out at tertiary care centres only and therefore should not be generalized outside of this population. Furthermore, the actual admission diagnoses were collected from 1 centre only and should not be generalized beyond that centre. However, the primary finding that AUR diagnoses account for less than 10% of diagnoses is supported by other research.¹⁶

Conclusions

In this study, influenza accounted for only 0.34% of ED visits. ED volumes did not correlate with population influenza rates or ED influenza diagnosis rates. During the influenza season after a universal immunization campaign, ED visits increased. While universal influenza immunization may have health benefits for a population, it is unlikely to reduce ED volumes or overcrowding.

Competing interests: None declared.

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