A B S T R A C T

Objective: A retrospective study was conducted to compare age- and sex-specific rates of hospital admission of the elderly in Ontario for five influenza seasons from 1988-1993 for pneumonia, congestive heart failure and chronic respiratory disease.

Results: Significant increases in admissions were found for pneumonia in each influenza season for both sexes. Admissions were significantly increased for congestive heart failure for the oldest males in all years; and for four of five years for the youngest two age groups of males. For females significant increases in admissions occurred in the oldest two age groups in each influenza season; and for three of five seasons for the youngest age group. For chronic respiratory disease, significant increases in admissions were found for each influenza season for all years for the two youngest age groups of males and females.

Conclusion: The impact of influenza is substantial in terms of morbidity in the elderly.

A B R É G É

Objectif : On a mené une étude rétrospective pour comparer en Ontario, durant cinq saisons grippales (de 1988 à 1993), les taux d'hospitalisation par âge et par sexe des personnes âgées pour cause de pneumonie, d'insuffisance cardiaque globale et de maladie respiratoire chronique.

Résultats : On a constaté des augmentations importantes des pneumonies, chez les deux sexes, durant chaque saison grippale. Les hospitalisations pour insuffisance cardiaque globale ont augmenté de façon importante toutes les saisons chez les hommes les plus âgés et quatre saisons sur cinq chez les hommes des deux groupes les moins âgés. Chez les femmes, il y a eu augmentation importante des hospitalisations au cours de chaque saison grippale pour les deux groupes les plus âgés et trois saisons sur cinq pour le groupe le moins âgé. En ce qui concerne les maladies respiratoires chroniques, il y a eu d'importantes augmentations des hospitalisations en saison grippale chaque année pour les deux groupes les moins âgés, hommes et femmes confondus.

Conclusion : La grippe a un effet marqué sur la morbidité des personnes âgées.

Measuring the Impact of Influenza on the Hospital Admission Rates of the Elderly in Ontario: A Five-year Admission Rate Analysis, 1988-1993

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Influenza is a major cause of morbidity and mortality in Canada. The Laboratory Centre for Disease Control in Ottawa estimates that influenza causes 75,000 hospitalizations and 6,000 deaths on an annual basis.¹ Epidemiological studies consistently find relationships between the presence of influenza virus and increased mortality rates, rates of hospital admission and health services utilization.²⁻¹⁴ Increased pneumonia admission rates are consistently associated with influenza. Outcomes plausibly related to influenza infection such as congestive heart failure and chronic lung disease have received less analysis. The few studies have shown equivocal results.^{9,10,13}

The greatest burden of illness from influenza occurs in the elderly who are at increased risk for death and other serious complications related to influenza.^{2,4,5,7,15-17} Consequently, strategies for the control of influenza in Canada have emphasized universal immunization of those over the age of 65. Randomized studies, cohort and case control studies have all demonstrated the efficacy of influenza vaccine in reducing morbidity and mortality from influenza in the elderly population.^{9,12,16,18-26} One prominent influenza researcher has argued for the use of administrative data as a means to evaluate influenza morbidity.²

Most studies of influenza morbidity have treated the elderly as an aggregate class,

and have not sought to examine important differences between age groups and sexes. It is well recognized in the clinical literature that the elderly are not a homogenous population.¹⁵ Little descriptive data exist on the impact of influenza on the elderly accounting for the differential effects of age and sex. Many studies focus on arbitrarily defined "epidemic" influenza seasons, and miss increases in morbidity and mortality associated with influenza. "Non-epidemic" influenza seasons may be associated with different patterns of hospital admission in the elderly.

The objectives of this study are to employ administrative data to examine the age- and sex-specific rates of hospital admission for pneumonia, congestive heart failure and chronic respiratory disease in the elderly population of Ontario for five influenza seasons from 1988-1993. This study is retrospective, descriptive and ecological in nature. To our knowledge, no such studies using Canadian data have been published on this topic.

METHODS

Data sources

Hospital Discharge Abstracts

The Canadian Institute for Health Information collects and analyzes health information derived from a standardized discharge separation abstract. On discharge each chart has administrative and clinical variables abstracted by a medical records clerk, including demographic variables such as age and sex, residence, admission date, discharge date, length of stay, up to 15 diagnosis codes and procedures. Discharge diagnoses are classified according to the International Classification of Diseases (ICD-9) classification.

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All discharges for Ontario residents 65 years of age and older were abstracted from fiscal years April 1 to March 31, 1988-1993. The following ICD-9 codes were included: Pneumonia and Influenza: 480.0-487.0; Chronic Respiratory Disease: 490.0-492.0; and Congestive Heart Failure: 428.0-428.9. ICD-9 codes were then aggregated into three groups: pneumonia and influenza, chronic respiratory disease, and congestive heart failure. Each diagnostic group consisted of the ICD-9 codes when they appeared as the first or second diagnosis code. Age groupings for both sexes were created as follows: 65-74, 75-84 and 85+. Five influenza seasons were analyzed: 1988-89, 1989-90, 1990-91, 1991-92, 1992-93.

Ontario Influenza Surveillance Data

Influenza surveillance is conducted annually, from October to April, by the Public Health Branch of the Ministry of Health in Ontario. The data include laboratory surveillance, reports of influenza through the reportable disease information system, reports of institutional outbreaks, and absenteeism and illness surveillance at selected schools.

Laboratory confirmation consists of either isolation of virus from nasal or pharyngeal secretions, direct antigen detection from nasal or pharyngeal secretions, or a demonstrated four-fold rise in hemagglutination titres to influenza virus from serological specimens collected at the onset of illness and four weeks later. The majority of laboratory-confirmed influenza infections are either virus isolation or antigen detection. For the purposes of this study, influenza seasons were defined on the basis of reported laboratory-confirmed cases from Ontario. An influenza season was defined as commencing with the isolation of influenza virus on consecutive weeks and ending when no further isolations were made. Weekly totals for the influenza seasons were obtained from the Laboratory Centre for Disease Control in Ottawa.

Population Data

Denominators were constructed from data for the years 1988-1991 on the basis of intercensal estimates published by Statistics Canada. For 1991, census data

TABLE I
Annualized Admission Rates per 100,000: Pneumonia

	Males			Females		
	Influenza Season	Interim Period	Difference and 95% Confidence Interval	Influenza Season	Interim Period	Difference and 95% Confidence Interval
Age 85+						
1988-89	4635	3651	984 (446-1522)	2937	2003	934 (663-1205)
1989-90	5549	3904	1594 (1033-2155)	3087	1863	1224 (965-1483)
1990-91	5381	3904	1510 (961-2059)	2818	1895	923 (672-1174)
1991-92	6977	5325	1652 (914-2390)	3707	2344	1363 (1036-1690)
1992-93	5171	3529	1642 (1143-2141)	2855	1705	1150 (918-1382)
Age 75-84						
1988-89	2316	1700	616 (443-789)	1389	934	455 (363-547)
1989-90	2729	1758	971 (794-1148)	1695	950	745 (647-843)
1990-91	2400	1797	603 (433-773)	1576	960	616 (522-710)
1991-92	3759	2630	1129 (879-1379)	2170	1215	955 (826-1084)
1992-93	2650	1855	795 (626-964)	1650	978	672 (582-762)
Age 65-74						
1988-89	745	566	179 (114-244)	537	434	103 (59-147)
1989-90	850	703	147 (76-218)	571	374	197 (152-242)
1990-91	816	600	216 (153-279)	529	382	147 (103-191)
1991-92	863	653	210 (135-285)	793	467	326 (269-383)
1992-93	830	625	205 (141-269)	560	363	197 (158-236)

TABLE II
Annualized Admission Rates per 100,000: Congestive Heart Failure

	Males			Females		
	Influenza Season	Interim Period	Difference and 95% Confidence Interval	Influenza Season	Interim Period	Difference and 95% Confidence Interval
Age 85+						
1988-89	3980	3515	465 (47-883)	3603	2771	832 (569-1095)
1989-90	4139	3381	758 (340-1176)	3384	3034	350 (111-589)
1990-91	4502	3381	1121 (692-1550)	3634	3081	553 (311-795)
1991-92	5302	4969	333 (210-876)	5037	4430	607 (270-944)
1992-93	4324	3284	1040 (833-1247)	3968	3078	890 (649-1131)
Age 75-84						
1988-89	2774	2439	335 (173-497)	2171	1876	295 (179-411)
1989-90	2729	2450	279 (123-435)	2053	1937	116 (7-225)
1990-91	2903	2518	385 (223-547)	2276	1966	310 (198-422)
1991-92	3759	3915	-156 (-373-61)	3081	2863	218 (60-376)
1992-93	3253	2873	380 (221-539)	2428	2210	218 (106-330)
Age 65-74						
1988-89	1050	845	205 (138-272)	655	558	97 (57-137)
1989-90	939	910	29 (-31-88)	621	574	47 (2-92)
1990-91	1029	921	108 (43-173)	692	584	108 (61-155)
1991-92	1441	1474	-33 (-124-58)	911	896	15 (-48-78)
1992-93	1173	1003	170 (106-234)	663	685	-22 (-67-23)

were used. 1992-1993 data were based on extrapolations from Statistics Canada.

Analysis

Calculation of Rates

Age-specific rates per 100,000 were calculated for each age group and sex for five influenza seasons and interim periods. The definition of influenza seasons has already been described. Interim period rates were calculated by the same method on the basis of a comparable number of weeks when influenza was not reported to be circulating. Denominators for each season were constructed from the census estimate for the year in which the influenza season ended.

The denominator data for both the influenza season and the interim period were for the same year. The rates were annualized for comparability. Therefore, if the influenza season was 20 weeks in duration, the rates per 100,000 were then annualized by multiplying by 2.6. The confidence interval of the difference between the influenza season and the interim period was then calculated as the main outcome measure.

RESULTS

Pneumonia admissions

Table I shows the annualized age- and sex-specific admission rates for pneumonia,

TABLE III
Annualized Admission Rates per 100,000: Chronic Lung Disease

	Males			Females		
	Influenza Season	Interim Period	Difference and 95% Confidence Interval	Influenza Season	Interim Period	Difference and 95% Confidence Interval
Age 85+						
1988-89	2421	2221	200 (-128-528)	816	826	-10 (-133-113)
1989-90	2516	2124	392 (-26-810)	905	673	232 (111-353)
1990-91	2697	2124	334 (-21-689)	858	671	187 (69-305)
1991-92	3085	2811	274 (-143-691)	1093	1030	63 (-94-220)
1992-93	2280	1835	445 (159-731)	830	763	67 (-45-179)
Age 75-84						
1988-89	2026	1613	413 (274-552)	792	658	134 (63-205)
1989-90	2095	1676	419 (281-557)	942	684	258 (184-332)
1990-91	2224	1908	316 (169-463)	966	700	266 (192-340)
1991-92	2544	2122	422 (247-597)	1226	863	363 (268-458)
1992-93	1938	1465	473 (350-596)	1013	680	333 (260-406)
Age 65-74						
1988-89	929	705	224 (162-286)	512	431	81 (37-125)
1989-90	963	703	260 (195-325)	497	439	58 (16-100)
1990-91	910	732	178 (119-237)	516	445	71 (29-113)
1991-92	1115	663	452 (378-526)	674	519	155 (101-209)
1992-93	855	505	350 (296-404)	505	353	152 (115-189)

the difference between the influenza seasons and the interim period, and the upper and lower 95% confidence interval for the difference for the five years under study. Each influenza season is associated with significantly higher admission rates than the comparable interim season.

The annualized age-specific rates of admission for pneumonia were higher in each age group in each influenza season for males compared to females. In the oldest age group, the male admission rate ranged from 57 to 90% higher than the female rate. The range in percentage difference between males and females in the 75-84 age group and the 65-74 age group were 52 to 73% and 9 to 54%, respectively.

The annualized age-specific admission rates in males for pneumonia were 1.85 to 2.24 times higher in the 85+ category compared to the 75-84 age group for each comparable influenza season and 6.2 to 9.9 times higher compared to the 65-74 age group. The annualized admission rates for the oldest female age group were 1.7 to 2.1 times higher than the 75-84 age group for each comparable influenza season and 4.7 to 5.5 times higher than the 65-74 age group.

Congestive heart failure admissions

Table II shows the annualized age- and sex-specific admission rates for congestive heart failure, the difference between the influenza seasons and the interim period, and the upper and lower 95% confidence interval for the difference for the five years

under study. The annualized age-specific rates of admission for congestive heart failure were higher in each age group in each influenza season for males compared to females. In the oldest age group, the male admission rate ranged from 5 to 24% higher than the female rate. The range in percentage difference between males and females in the 75-84 age group was 22 to 34% higher; for the 65-74 age group, 41 to 88% higher.

For males, the annualized age-specific admission rates in the 85+ age group were 1.32 to 1.55 times higher than in the 75-84 age group and 3.68 to 4.40 times higher than in the 65-74 age group. For females, the annualized age-specific admission rates in the 85+ age group were 1.6 to 1.65 times higher than in the 75-84 age group and 5.45 to 5.98 times higher than in the 65-74 age group.

Chronic respiratory disease admissions

Table III shows the annualized age- and sex-specific admission rates for chronic respiratory disease, the difference between the influenza seasons and the interim period, and the upper and lower 95% confidence interval for the difference for the five years under study. For both males and females, all influenza seasons for the 65-74 and 75-84 age groups are associated with significantly increased admission rates in comparison with the interim period.

The annualized age-specific rates of admission for chronic respiratory disease

were higher in each age group in each influenza season for males compared to females. In the oldest age group, the male admission rate ranged from 175 to 240% higher than the female rate. The range in percentage difference between males and females in the 75-84 age group was 91 to 156% higher; for the 65-74 age group, 65 to 93% higher.

For males the annualized age-specific admission rates in the 85+ age group were 1.18 to 1.20 times higher than in the 75-84 age group and 2.6 to 2.9 times higher than in the 65-74 age group. For females the annualized age-specific admission rates ranged from 17% lower to 3% higher for the 85+ age group in comparison to the 75-84 age group and were 1.6 to 1.82 times higher in the 85+ age group compared to the 65-74 age group.

DISCUSSION

The results of this study indicate a strong and consistent relationship between the presence of circulating influenza virus and hospital admissions for the elderly for pneumonia, congestive heart failure, and chronic respiratory diseases in the elderly population of Ontario. This occurs on an annual basis and is not related to the presence of "epidemic" years. The results demonstrate the "mountain of morbidity beneath the snowcap of mortality" associated with influenza.¹¹ The results indicate that influenza is still a significant public health problem.

Each influenza season was associated with increased rates of pneumonia admission in comparison to the comparable interim period. The results were consistent from year to year, even though influenza circulation commenced at a different time each year. The relationship between age groups for each sex was also consistent from year to year. Consequently, the impact of influenza seasons on pneumonia admissions in the elderly can be regarded as substantial. This study is consistent with other morbidity studies and indicates that pneumonia is the most important complication of influenza.

A striking finding in the admission rate analysis for chronic respiratory disease was a lack in consistent elevation of admission

rates for the oldest age groups for both females and males. For the younger two age groups, consistent increases in admission rates were detected. This phenomenon has not been previously reported. The reasons for the lack of increase in admission rates in the oldest age group for chronic respiratory disease are unclear and deserve further study.

This study is subject to several limitations. Administrative data are not collected specifically for the purposes of research. Data quality issues have been addressed in a study sponsored jointly by the Ontario Ministry of Health, the Ontario Hospital Association and the Hospital Medical Records Institute.²⁷ The report indicated that of all the diagnosis codes, the most responsible diagnosis had the highest agreement. The fields used for this study are all mandatory fields and are reliably coded. Other limitations of administrative databases are multiple re-admissions, which would increase the numerator and therefore bias the rates differentially.^{28,29} The direction of the bias would be to overestimate the impact of influenza. As well, there is a possibility of misclassification of the diagnosis of interest to other diagnostic codes.

In this analysis there is no verification of the presence of influenza virus in those admitted to hospital. Environmental factors such as temperature, humidity and air quality are also implicated as having adverse health effects in the elderly.³⁰⁻³² However, summer is the season of poorest air quality in Ontario and influenza is usually absent in the summer. Adding strength to the association is the observation that admission rates tended to peak with the presence of influenza, which varies from season to season.³³ Although the time series study failed to find a consistent temporal relationship between CHF and influenza, the association may be present and warrants further study.

In the current climate of fiscal restraint and hospital and bed closings, health ser-

vices planners would be well advised to prepare for an annual increase in demand for hospital and health care services during influenza seasons. Planning for increased community care during influenza seasons could help to reduce the complications associated with influenza.

REFERENCES

1. Canadian Consensus Conference on Influenza. *CCDR* 1993;19-17:136-46.
2. Glezen WP. Epidemic influenza. *Epidemiol Rev* 1996;18(1):64-76.
3. Wald TG, Miller BA, Shult P, et al. Can respiratory syncytial virus and influenza A be distinguished clinically in institutionalized older persons? *J Am Geriatr Soc* 1995;43:170-74.
4. Glezen WP. Serious morbidity and mortality associated with influenza epidemics. *Epidemiol Rev* 1982;4:25-44.
5. Cesario TC, Yousefi S. Viral infections. *Clin Geriatr Med* 1992;8(4):735-43.
6. Foy H, Cooney M, Allan I, Kenny G. Rates of pneumonia during influenza epidemics in Seattle, 1964-1975. *JAMA* 1979;241(3):253-58.
7. Strassberg MA, Greenland S, Sorvillo F, et al. Influenza in the elderly: Report of an outbreak and a review of vaccine effectiveness reports. *Vaccine* 1986;4(1):38-44.
8. Glezen WP, Decker M, Perrotta DM. Survey of underlying conditions of persons hospitalized with acute respiratory disease during influenza epidemics in Houston, 1978-1981. *Am Rev Respir Dis* 1987;136(3):550-55.
9. Nichol KL, Margolis KL, Wuorenma J, Von Sternberg T. The efficacy and cost effectiveness of vaccination against influenza among elderly persons living in the community. *N Engl J Med* 1994;331(12):778-84.
10. McBean AM, Babish JD, Warren JL. The impact and cost of influenza in the elderly. *Arch Intern Med* 1993;153(18):2105-11.
11. Perrotta DM, Decker M, Glezen WP. Acute respiratory disease hospitalization as a measure of impact of epidemic influenza. *Am J Epidemiol* 1985;122(3):468-76.
12. Carrat F, Valleron AJ. Influenza mortality among the elderly in France, 1980-1990: How many deaths may have been avoided through vaccination? *J Epidemiol Commun Health* 1995;49(4):419-25.
13. Barker W. Excess pneumonia and influenza associated hospitalization during influenza epidemics in the United States, 1970-1978. *Am J Public Health* 1986;76(7):761-64.
14. Monto A. Studies of the community and family: Acute upper respiratory illness and infection. *Epidemiol Rev* 1994;16(2):351-73.
15. Granton JT, Grossman RF. Community-acquired pneumonia in the elderly patient. *Clin Chest Med* 1993;14(3):537-53.
16. Gross PA, Quinnan G, Rodstein M, et al. Association of influenza immunization with reduction of mortality in an elderly population: A prospective study. *Arch Intern Med* 1988;148(3):562-65.
17. Wiselka M. Influenza: Diagnosis, management, and prophylaxis. *BMJ* 1994;308:1341-45.
18. Fedson DS, Wajda E, Nicol JP, et al. Clinical effectiveness of influenza vaccination in Manitoba. *JAMA* 1993;270(16):1956-61.
19. Barker WH, Mullooly J. Influenza vaccination for elderly persons: Reduction in pneumonia and influenza hospitalizations and deaths. *JAMA* 1980;244(22):2547-49.
20. Shann F. Modern vaccines: Pneumococcus and influenza. *Lancet* 1990;335:898-901.
21. Douglas RG. Prophylaxis and treatment of influenza. *N Engl J Med* 1990;322(7):443-50.
22. Bentley D. Vaccinations. *Clin Geriatr Med* 1992;8(4):745-60.
23. Saah AJ, Neufeld R, Rodstein M, La Montagne J. Influenza vaccine and pneumonia mortality in a nursing home population. *Arch Intern Med* 1986;146(12):2353-57.
24. Fedson D. Adult immunization: Summary of the National Vaccine Advisory Committee Report. *JAMA* 1994;272:1133-37.
25. Fedson DS, Wajda A, Nicol JP, Roos L. Disparity between influenza vaccination rates and risks for influenza associated hospital discharge and death in Manitoba in 1982-1983. *Ann Intern Med* 1992;116(7):550-55.
26. Foster D, Talsma A, Furomto-Dawson A, et al. Influenza vaccine effectiveness in preventing hospitalization for pneumonia in the elderly. *Am J Epidemiol* 1992;136(3):296-307.
27. Ontario Hospital Association, Ontario Ministry of Health, Hospital Medical Records Institute: Report of the Ontario data quality re-abstraction study. Ontario Hospital Association, 1991.
28. Naylor CD, Anderson GM, Goel V (Eds.). *Patterns of Health Care in Ontario: The ICES Practice Atlas* 1st ed. Ottawa: Canadian Medical Association, 1994.
29. Goel V, Williams J, Anderson GM, et al. (Eds.). *Patterns of Health Care in Ontario: The ICES Practice Atlas*. 2nd ed. Ottawa: Canadian Medical Association, 1996.
30. Schwartz J. Air pollution and hospital admissions for the elderly in Detroit, Michigan. *Am J Respir Crit Care Med* 1994;150(3):648-55.
31. Burnett RT, Dales RE, Brook JR, et al. Association between ambient carbon monoxide levels and hospitalizations for congestive heart failure in the elderly in 10 Canadian cities. *Epidemiology* 1997;8(2):162-67.
32. Burnett RT, Dales RE, Raizenne ME, et al. Effects of low ambient levels of ozone and sulfates on the frequency of respiratory admissions to Ontario hospitals. *Environ Res* 1994;65(2):172-94.
33. Upshur REG, Knight K, Goel V. Time series analysis of the relationship between influenza virus and hospital admissions of the elderly in Ontario for pneumonia, chronic lung disease and congestive heart failure. *Am J Epidemiol* 1999;149:85-92.

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