The Association Between Influenza Immunization Coverage Rates and Hospitalization for Community-acquired Pneumonia in Alberta

Yan Jin, MA[1]
Keumhee C. Carriere, PhD[2]
Gerry Predy, MD[3]
David H. Johnson, MD[4]
Thomas J. Marrie, MD[5]

ABSTRACT

Background: We compared regional coverage rates of influenza vaccination (composition in 1999/00 was A/Sydney-like A/Beijing-like B/Yamanashi-like and in 2000/01 was A/Moscow A/New Caledonia B/Beijing) to the rates, cost, and mortality for community-acquired pneumonia.

Methods: We used the Pearson's correlation coefficient to establish linear associations between variables derived from Alberta administrative data during the period April 1, 1999 to March 31, 2001.

Results: The influenza vaccination coverage rate for the 17 health regions varied between 30% to 80% (mean 70%) in Alberta seniors (n=298,473). The annual hospitalization and ambulatory community-acquired pneumonia attack rates were 2% and 6.5% per year respectively. There were strongly negative correlations between vaccination coverage rates and pneumonia rates requiring hospitalization (r_{1999}=-0.59 and r_{2000}=-0.79 with both p<0.05), total per capita physician and hospital costs for pneumonia (r_{1999}=-0.57 and r_{2000}=-0.79 with both p<0.01), community-diagnosed pneumonia rate (r_{1999}=-0.39, p=0.12 and r_{2000}=-0.70, p<0.01) and per capita in-hospital mortality for pneumonia (r_{1999}=-0.30, p=0.24 and r_{2000}=-0.57, p<0.05) . Per capita costs, rates, and mortality were highest and influenza vaccinations rate lowest in the northern, remote health regions. The per capita vaccination cost (about $10) was small in relationship to the per capita cost of hospital care for pneumonia (about $100).

Conclusion: Regional under-utilization of preventive influenza vaccination in Alberta seniors is associated with increased utilization of health services for community-acquired pneumonia.

La traduction du résumé se trouve à la fin de l'article.

1. Information Analysis, Alberta Health and Wellness
2. Department of Mathematical and Statistical Sciences, University of Alberta
3. Medical Officer of Health, Capital Health Authority
4. Department of Critical Care Medicine, University of Alberta
5. Department of Medicine, University of Alberta

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Correspondence: David Johnson, 368 O'Connor Close, Edmonton, AB T6R 1L4, Tel: 780-435-0530, Fax: 780-435-9083, E-mail: cujecjohnson@shaw.ca

The Canadian National Advisory Committee on Immunization (NACI) recommends a yearly influenza vaccination for those 65 years and older.[1] Evidence from cohort studies and randomized trials demonstrates that influenza vaccination prevents pneumonia by 53%, hospitalization for pneumonia by 48%, and mortality in those with pneumonia by 68%.[2-4] These benefits in the United States and Britain were found in population studies with a vaccination rate of 40%[3] to 52%.[5] In high risk patients (seniors with chronic lung disease, long term care residents), vaccination rates were 60 to 70%.[4,6,7] The NACI recommends a vaccination rate of 90% for all those 65 years and older. In this study, we use administrative data and associate the regional rates of influenza vaccination coverage to the rates, cost, and mortality for community-acquired pneumonia in Alberta during the period April 1, 1999 to March 31, 2001.

METHODS

Four administrative health service databases were used and the analysis was done within the protected environment of Alberta Health and Wellness, governed by provincial legislative guidelines on the confidentiality of health information.

- Canadian Institute for Health Information's (CIHI) Inpatient Discharge Abstract Database (DAD) for the province of Alberta for 1999/00 to 2000/01,
- Alberta Physician Claims Assessment System Database for 1999/00 to 2000/01,
- Alberta Health Insurance Plan Registry File for 1999/00 to 2000/01,
- Alberta vaccination registry 1999/00 to 2000/01.

Hospital-diagnosed community-acquired pneumonia was defined as the diagnosis deemed the most responsible for hospital admission or any of the other 15 diagnosis codes defined to be Type 1 (pre-admit comorbidity). These diagnoses were coded by ICD-9CM values of 480.x to 487.x (pneumonia) or 507.x (aspiration pneumonia) excluding 484.x (pneumonia of infectious diseases classified elsewhere)[8,9] found in the Canadian Institute for Health Information's (CIHI) Inpatient Discharge Abstract Database (DAD) for 1999/00 and 2000/01. Exclusion criteria were:

1) Not an Alberta resident or not treated in an Alberta acute care facility,
2) Adjacent diagnosis related group (ADRG) defining hospitalization for a surgical procedure,
3) Any previous hospitalization within 10 days of incident pneumonia case.

Ambulatory-diagnosed community-acquired pneumonia was defined using the Alberta Physician Claims Assessment System Database. All physician consultation claims (CPX 03.x)[10] with the most responsible diagnosis of community-acquired pneumonia (as defined above) were extracted. In-hospital claims and claims within 10 days before or after a hospital-diagnosed community-acquired pneumonia were linked using anonymous personal identifiers and excluded as ambulatory-diagnosed community-acquired pneumonia. The maximum yearly incidence of community-acquired pneumonia per senior was limited to a maximum of seven distinct episodes of pneumonia by excluding all subsequent claims within 60 days of first claim found within the two-year study.

All pneumonia rates are age-specific using the population of seniors. All hospitals in Alberta are administered by an autonomous regional board in each of the 17 health regions. Nearly all 3 million residents of Alberta are enrolled in the public health care insurance plan and reside in one of the 17 health regions. Each region is responsible for an influenza vaccination program delivered by physicians in the community and public health nurses. The composition of the vaccines used in each year reflected the actual strains that circulated in the province. The costs of the vaccination and delivery program were obtained from the Capital Health Authority. Numbers of vaccinations and demographic characteristics of those vaccinated are anonymously recorded and reported to the provincial government.

Hospital costs per resource group number (RGN) were calculated using the provincially approved methodology as set forth by the Provincial Costing Project and in accordance with the Provincial & National Management Information Systems guidelines.[11,12] Total costs combine allocation and assignment of all direct and indirect costs associated with an inpatient encounter from the time a patient is admitted to the hospital to the time they are discharged. All costs were estimated in 1998/99 and assumed similar for all the study years. The quality of the data reporting of costs in Alberta has been highly ranked by the Canadian Institutes for Health Information.[13] As such, the methodological issues that arise around collection of cost data in the USA,[14] in part due to the use of prices rather than costs, and for centres in Canada which cost admissions on the basis of "diagnosis related case-mix groupings", do not arise with the majority of the cost data considered in this analysis. Physician costs were calculated from all physician claims for consultation services in seniors with pneumonia (hospital or community diagnosed). Claims were reimbursed expenses in the year of the claim.

TABLE I

Yearly Distribution of Community-acquired Pneumonia in Alberta Health Regions Averaged for April 1, 1999 through March 31, 2001

Alberta Health Regions	Number of Seniors (>65 years)	Number of Cases of Ambulatory Community-acquired Pneumonia	Number of Cases of Pneumonia Requiring Hospitalization	Average Hospital Costs per Pneumonia Case	In-hospital Mortality Rate per Pneumonia Hospitalization
Chinook	19,642	1167	429	$4,406	12.37%
Palliser	11,844	708	250	$4,379	12.50%
Headwaters	7644	576	203	$4,535	9.49%
Calgary	83,348	5459	1309	$4,891	14.61%
Health Authority 5	6939	402	167	$3,979	9.66%
David Thompson	20,745	1481	500	$4,094	10.50%
East Central	15,015	931	361	$3,900	10.23%
Westview	7196	394	147	$4,634	8.16%
Crossroads	4556	370	127	$4,365	11.89%
Capital	88,081	5438	1539	$5,381	16.54%
Aspen	8679	649	224	$4,091	9.76%
Lakeland	12,629	962	349	$4,236	9.41%
Mistahia	7257	458	191	$4,133	14.52%
Peace	1921	161	90	$3,828	8.45%
Keeweetinok	1406	147	90	$3,953	6.30%
Northern Lights	845	74	28	$4,029	5.57%
Northwestern	726	71	38	$4,172	7.74%
Alberta	298,473	19,444	6038	$4,651	12.93%

TABLE II

Averaged Costs and Mortality for Community- and Hospital-diagnosed Pneumonia in Alberta Health Regions Between April 1, 1999 through March 31, 2001

Region of Residence	Cost of All Physician Pneumonia Claims per Senior in the Population	Costs for Pneumonia Requiring Hospitalization per Senior in the Population	In-hospital Mortality Rate for Pneumonia Requiring Hospitalization per 1000 Seniors in the Population
Chinook	$7.5	$96.5	2.6
Palliser	$8.5	$93.0	2.6
Headwaters	$8.5	$120.0	2.5
Calgary	$7.5	$77.0	2.3
Health Authority 5	$8.0	$96.5	2.2
David Thompson	$9.5	$99.0	2.5
East Central	$8.0	$94.0	2.4
Westview	$7.5	$95.0	1.7
Crossroads	$12.0	$120.5	3.3
Capital	$8.5	$94.0	2.9
Aspen	$10.0	$101.0	2.4
Lakeland	$9.5	$119.5	2.6
Mistahia	$9.0	$110.5	3.8
Peace	$12.0	$165.0	3.8
Keeweetinok	$16.5	$251.0	3.9
Northern Lights	$12.5	$134.0	1.8
Northwestern	$13.5	$216.5	4.1
Alberta	$8.5	$94.5	2.6

Statistics

Age-specific rates for vaccination coverage and pneumonia rates were calculated using the average population in the two fiscal years. Lower age limit was 65 years at the end of each fiscal year and 95% confidence intervals were calculated.

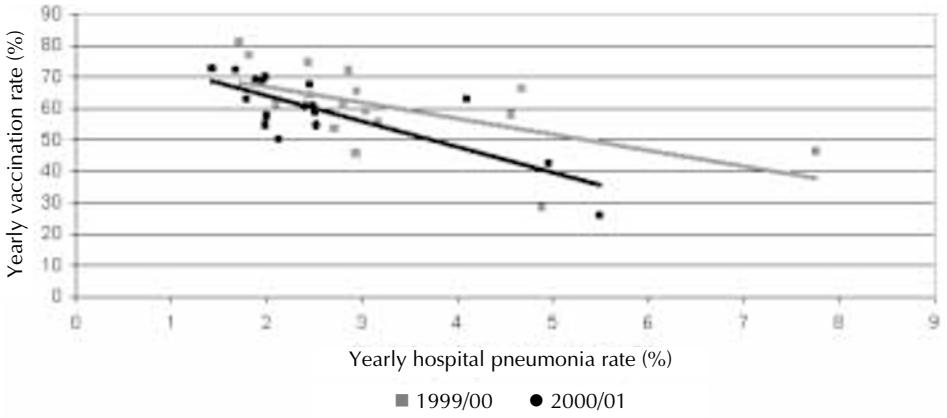

Figure 1. Hospitalization rate for community-acquired pneumonia according to the influenza vaccination rate of seniors in each of Alberta's 17 health care regions.

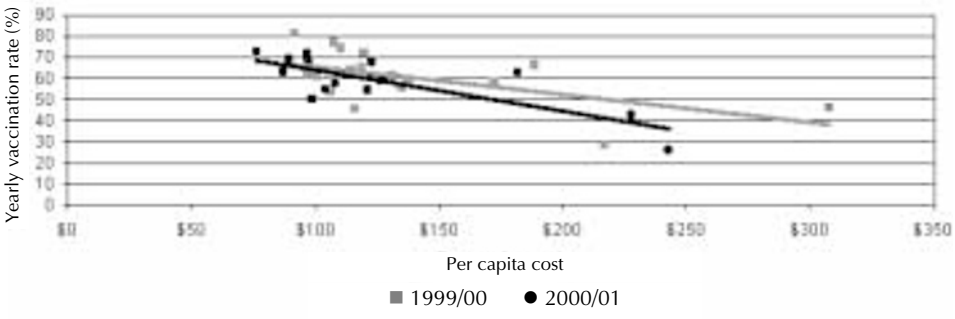

Figure 2. Per capita cost for treating community-acquired pneumonia according to vaccination rate for each of Alberta's 17 health care regions.

As our goal is to establish associations between variables and the scatter plots suggested linear relationships, we adopted the linear correlation measure. We computed the Pearson's correlation coefficients to study the associations between vaccination rate and the four outcomes of community-diagnosed pneumonia rate, hospital-diagnosed pneumonia rate, total per capita physician and hospital costs for pneumonia, and per capita in-hospital mortality for pneumonia. Graphical display further demonstrated their strong associations.

RESULTS

There were 6,038 yearly hospital admissions during the two-year study period among 298,473 seniors for community-acquired pneumonia, representing an attack rate of 2%. The average cost per hospital admission was $4,651 for a total annual cost of $28 million in Alberta. There were 19,444 episodes of ambulatory community pneumonia diagnosed annually during the two-year study period representing an attack rate of 6.5%. The average cost for physician consultations per pneumonia episode was $126 for a total annual cost of $2.45 million in Alberta. The number of unique patients with hospital-diagnosed pneumonia was 5,217 and unique patients diagnosed with ambulatory community-diagnosed pneumonia was 16,229. Table I demonstrates the population distribution in each of the 17 health regions and number of cases of pneumonia treated in hospital and on an ambulatory basis. The in-hospital mortality rate for each hospitalization is also shown.

The average influenza vaccination coverage rate was 70% and ranged among regions from a low of 27% (95% CI 24.8, 29.4) to a high of 77% (95% CI 76.6, 77.0). The average rate of pneumonia requiring hospitalization was 2.0% and ranged among regions from a low of 1.6% (95% CI 1.5,1.6) to a high of 6.4% (95% CI 5.4, 7.2). The average rate of ambulatory pneumonia was 6.5% and ranged among regions from a low of 5.5% (95% CI 5.1,5.9) to a high of 10.4% (95% CI 9.3,11.5). The vaccination coverage rate was less than the Alberta average (70%) in 13 of 17 health regions. The large population density and high vaccination rate in the two metropolitan regions (Calgary and Capital [Edmonton]) increased the Alberta average to a level greater than that found in most non-metropolitan regions. The rate of ambulatory pneumonia was higher than the Alberta average in 8 of the 13 health regions which had a lower than average vaccination rate. The rate for pneumonia requiring hospitalization was higher than the Alberta average in 12 of the 13 health regions which had a lower than average vaccination rate. The absolute magnitude of the increased pneumonia rate was greater in the more remote northern health regions.

Table II shows the per capita (seniors only) costs and mortality of ambulatory and pneumonia requiring hospitalization in each health region. Per capita physician claims for hospital and community consultations were 10% of hospital costs. Per capita hospital costs varied over threefold ($77 to $251) and reflected both the differences in average regional costs ($3900 to $5381 per hospitalization) and hospitalization rates (over four-fold variation). The costs of the vaccine, supplies (needles, syringes, etc.) and staffing to administer it in one metropolitan region (Capital Health in Edmonton]) were $8.23 per dose in 1999/2000 and Can $10.02 per dose in 2000/01.

Figures 1 to 4 show the association between vaccination rates and outcomes. All Pearson's correlations were negative; pneumonia rate requiring hospitalization (r_{1999}=-0.59 and r_{2000}=-0.79 with both $p<0.05$), total per capita physician and hospital costs for pneumonia (r_{1999}=-0.57 and r_{2000}=-0.79 with both $p<0.01$), community-diagnosed pneumonia rate (r_{1999}=-0.39, p=0.12 and r_{2000}=-0.70, $p<0.01$) and per capita in-hospital mortality for pneumonia (r_{1999}=-0.30, p=0.24 and r_{2000}=-0.57, $p<0.05$). Per capita costs and mortality were higher in the northern, remote health regions. Generally, the trend is downward, indicating that increase in immunization rate is associated with decrease in the outcome considered.

DISCUSSION

The influenza vaccination coverage rate varied between 30% to 80% in the 17

health regions for Alberta seniors in the time period April 1,1999 to March 31, 2001. A vaccination rate of about 70% is higher than that found in similar regions[4] and in other studies.[3,5] The vaccination rate varied with residence location: highest in the two metropolitan regions of Calgary and Edmonton, lower in non-metropolitan/rural regions, and lowest in more remote northern locations. The rates of pneumonia and costs for care followed the same general distribution – proportionally higher in those regions with lower vaccination coverage rates. The effectiveness of vaccination has been previously demonstrated and this study only compliments these previous clinical trials studies.[1-7] This study illustrates the variations in outcomes within one province as different health authorities utilize or under-utilize an effective preventive therapy.

The cost per vaccination of about $10 is small in relationship to the per capita cost of hospital care for pneumonia (about $100). Even if vaccine delivery costs are more expensive in non-metropolitan regions, increasing the vaccination rate to remote communities may still be cost effective. Despite Alberta's relatively high vaccination rate, the NACI target rate of 90% of seniors was not achieved but the provincial government target rate of 75% was achieved. It was not possible to state net savings comparing vaccinated and non-vaccinated areas as there was no randomized comparison group in which vaccinations were not given. However assuming the relationship of hospitalized pneumonia rate and immunization coverage rate was linear, for every increase in vaccination coverage rate of 10%, the rate of hospitalized community-acquired pneumonia decreased by 0.8 pneumonia cases per 100 seniors. The additional cost of vaccination (10 times $10 dollars = $100 dollars) would have potentially eliminated the hospitalization of 0.8 pneumonia cases (0.8 times $4,651 cost per case = $3700) for a potential cost savings of approximately $3600 dollars per additional 100 seniors vaccinated. This could also be conceptualized as: the cost of influenza vaccination coverage for an additional 100 seniors in Alberta would need to decrease the 2.0 cases per 100 seniors rate of pneumonia in Alberta by only 11% (i.e., $1000 cost of vaccination/$9302 cost of two pneumonia cases per 100 seniors), which would be less than the reported efficacy in clinical trials.

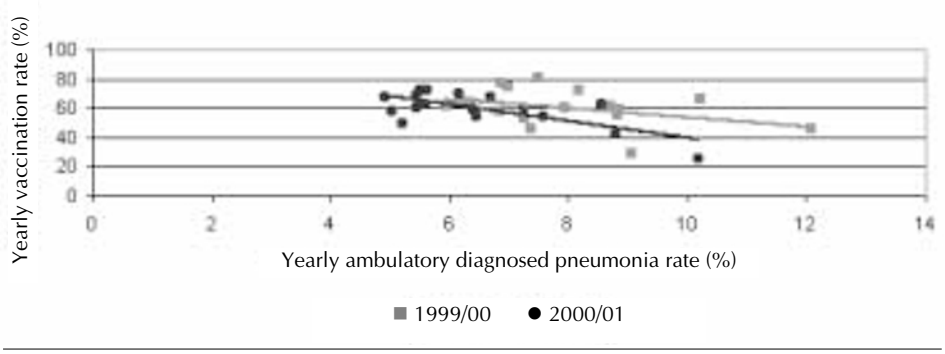

Figure 3. Ambulatory community-acquired pneumonia rate according to the influenza vaccination rate of seniors in each of Alberta's 17 health care regions.

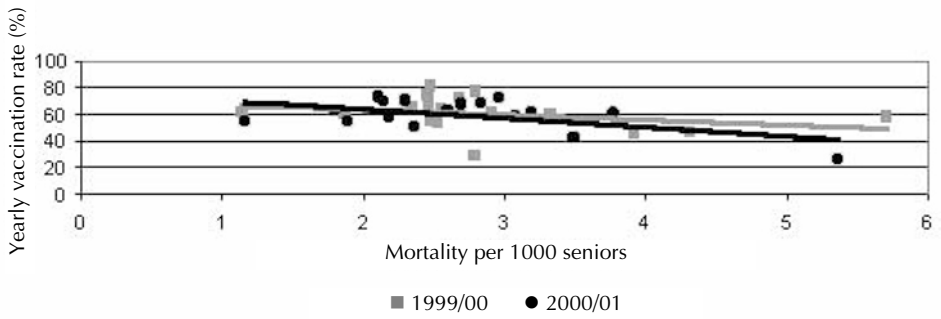

Figure 4. In-hospital mortality rate for patients with community-acquired pneumonia according to the vaccination rate of seniors in each of Alberta's 17 health care regions.

The statistically significant association between immunization coverage rates and pneumonia rates/costs does not necessarily imply a cause and effect relationship. For example, a lower influenza vaccination coverage rate has been associated with a higher hospitalization rate for pneumonia in Aboriginals.[15,16] However, remoteness of communities may be the associated factor in explaining both low vaccine rate and higher rate of hospitalizations rather than a direct association between vaccination coverage and hospitalization rates. The relative higher proportion of Aboriginals in more remote northern regions may have contributed to the high rate of pneumonia in our study. Targeting Aboriginal seniors in remote locations may be a successful strategy in reducing the burden of pneumonia in remote northern regions.

Limitations

Individual data about the use of any influenza and pneumococcal vaccination coverage rates were unavailable. The absence of such information for wider public awareness programs may explain under-utilization of these effective preventive therapies. In this study, only in-hospital mortality for community-acquired pneumonia was analyzed. The cause of an in-hospital death as related to pneumonia had a high degree of certainty.[17] Deaths from community-acquired pneumonia may have also occurred out of hospital. Out-of-hospital death data were not available. The absence of these data was unlikely to be significant as over 75% of all deaths in Canada occur while in hospital.[18]

CONCLUSION

This study reveals an inverse relationship between utilization of influenza vaccination and community-acquired pneumonia in Alberta although causality cannot be established. Under-utilization of influenza vaccination in Alberta seniors residing in some Alberta regions is associated with a subsequent increased utilization of health services for community-acquired pneumonia.

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RÉSUMÉ

Contexte : Nous avons comparé les taux de couverture régionale du vaccin antigrippal (composé en 1999-2000 de souches apparentées à A/Sydney, A/Beijing et B/Yamanashi et en 2000-2001 à A/Moscou, A/Nouvelle-Calédonie et B/Beijing) aux taux, au coût et à la mortalité de la pneumonie acquise dans la communauté.

Méthode : À partir des données administratives de l'Alberta (1er avril 1999 au 31 mars 2001), nous avons utilisé le coefficient de corrélation de Pearson pour établir des associations linéaires entre les variables.

Résultats : Le taux de couverture du vaccin antigrippal chez les aînés des 17 régions sanitaires de l'Alberta (n=298 473) variait de 30 % à 80 % (moyenne 70 %). Les taux annuels de pneumonie communautaire chez les patients hospitalisés et ambulatoires étaient de 2 % et de 6,5 %, respectivement. Nous avons constaté de fortes corrélations négatives entre les taux de couverture vaccinale et les taux de pneumonie nécessitant une hospitalisation (r_{1999}=-0,59 et r_{2000}=-0,79, p<0,05 dans les deux cas), les coûts totaux par habitant en services médicaux et hospitaliers de traitement de la pneumonie (r_{1999}=-0,57 et r_{2000}=-0,79, p<0,01 dans les deux cas), les taux de pneumonie diagnostiquée dans la communauté (r_{1999}=-0,39, p=0,12, et r_{2000}=-0,70, p<0,01) et la mortalité à l'hôpital, par habitant, due à la pneumonie (r_{1999}=-0,30, p=0,24, et r_{2000}=-0,57, p<0,05). Les coûts, les taux et la mortalité par habitant étaient les plus élevés, et les taux de vaccination antigrippale les plus faibles, dans les régions sanitaires éloignées (celles du nord de la province). Le coût de vaccination par habitant (environ 10 $) était faible par rapport au coût par habitant des soins hospitaliers aux malades atteints de pneumonie (environ 100 $).

Conclusion : La sous-utilisation régionale du vaccin antigrippal à titre préventif chez les aînés albertains est associée à une utilisation accrue des services de santé pour traiter la pneumonie communautaire.