Community EM

A population-based study of emergency department presentations for asthma in regions of Alberta

Rhonda J. Rosychuk, PhD;[*] Donald C. Voaklander, PhD;[†] Terry P. Klassen, MD, MSc;[*] Ambikaipakan Senthilselvan, PhD;[†] Thomas J. Marrie, MD;[‡] Brian H. Rowe, MD, MSc[†§]

ABSTRACT

Objective: We describe the epidemiology of asthma presentations to emergency departments (EDs) for 3 main regions in the province of Alberta.

Methods: We used a comprehensive ED database to identify ED visits in Alberta from April 1999 to March 2005. We linked the visits to other provincial administrative databases to obtain all data on follow-up encounters for asthma during that period. Information extracted included demographics, regions of residence (Edmonton, Calgary or non–major urban [NMU]), timing of ED visits, and subsequent visits to non-ED settings. Data analysis included descriptive summaries and directly standardized visit rates.

Results: During the 6-year study period, 93 146 patients made 199 991 ED visits for asthma. Crude rates in 2004/05 were 7.9/1000, 6.5/1000 and 15.4/1000 in the Edmonton, Calgary and NMU regions, respectively. The Edmonton and Calgary regions had consistently lower visit rates than the NMU regions. The ED visits were followed by low rates of follow-up visits in a variety of non-ED settings, at different intervals.

Conclusion: Asthma is a relatively common presenting problem in Alberta EDs. This study identified relatively stable rates of presentation during the study period, and variation among regions in terms of age and sex. This study provides further understanding of the variation associated with ED presentation and indicates possible targets for specific interventions to reduce asthma-related ED visits.

Keywords: asthma, databases, emergency medicine, epidemiology, respiratory tract diseases

RÉSUMÉ

Objectif : Nous décrivons les caractéristiques épidémiologiques des cas d'asthme dans les services d'urgence de 3 grandes régions de l'Alberta.

Méthodes : Nous avons recensé les consultations à l'urgence en Alberta d'avril 1999 à mars 2005 à partir d'une base de données détaillées des services d'urgence. Nous avons relié ces consultations à d'autres bases de données administratives provinciales afin de comptabiliser toutes les visites de suivi pour asthme pendant cette période. Les données extraites portaient entre autres sur les caractéristiques démographiques, la région de résidence (Edmonton, Calgary ou région hors des grands centres urbains [HGCU]), le moment des visites à l'urgence et les visites subséquentes auprès d'autres services de santé. L'analyse des données incluait des sommaires descriptifs et les taux de visite directement standardisés.

Résultats : Durant les six années de l'étude, 93 146 personnes ont effectué 199 991 visites à l'urgence pour asthme. Les taux bruts en 2004–2005 étaient de 7,9/1000, 6,5/1000 et 15,4/1000 pour les régions d'Edmonton, de Calgary et HGCU respectivement. Les taux de visites sont demeurés plus faibles dans les régions d'Edmonton et de Calgary que dans les régions HGCU. Les visites à l'urgence étaient suivies de visites de contrôle auprès de divers autres services de santé à différents intervalles.

Conclusion : L'asthme est un motif relativement courant de consultation dans les urgences de l'Alberta. Cette étude fait état de taux relativement stables de consultation au cours de la période de l'étude et d'une variation entre les régions sur les plans de l'âge et du sexe des patients. Elle apporte des éclaircissements sur la variation associée aux consultations à l'urgence et indique des cibles possibles d'interventions précises pour réduire le nombre de consultations liées à l'asthme dans les urgences.

INTRODUCTION

Asthma is a common disease with a prevalence of approximately 7%–10% in adults and 15% in children.[1] The prevalence of this disease is thought to be on the increase, perhaps because of gene–environmental factors, obesity and the hygiene hypothesis.[2,3]

From the *Department of Pediatrics, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, Alta., the †Department of Public Health Sciences, School of Public Health, University of Alberta, Edmonton, Alta., the ‡Faculty of Medicine, Dalhousie University, Halifax, NS, and the §Department of Emergency Medicine, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, Alta.

Submitted Oct. 1, 2008; Revised Jun. 5, 2009; Accepted Oct. 4, 2009

This article has been peer reviewed.

CJEM 2010;12(4):339-46

Asthma control can be achieved by limiting exposure to triggering stimuli, by education and by employing anti-inflammatory agents alone or in combination with bronchodilators.[4–6] Despite these interventions, asthma control can be elusive and exacerbations can frequently occur. Moderate to severe exacerbations are a common reason for presentation to the emergency department (ED), and some people with asthma return frequently. In Canada, the treatment of acute asthma accounts for close to one-quarter of the nearly $500 million spent annually on asthma.[7,8]

Rowe and colleagues[9] and Rosychuk and coauthors[10] have previously described the epidemiology of presentations to EDs made by adults[9] and children[10] in the province of Alberta, using large population-based administrative health databases. The objective of this study was to explore interregional differences in greater detail. Specifically, we wanted to compare the presentation rates, outcomes, ED visit durations and follow-up visits based on the hypothesis that the major urban regions of Edmonton and Calgary differ from the rest of the province.

METHODS

Setting

As in other provinces, all residents of Alberta can access free health care, assuming they are eligible for and maintain health insurance through the Alberta Health Care Insurance Plan (AHCIP). In Alberta, some citizens still pay for their health care if they are self-employed, and subsidies exist for those with limited financial means.

Data sources

The Ambulatory Care Classification System (ACCS)[11] was developed as a flexible and integrated system for tracking ambulatory care visits within government-funded facilities in Alberta. The only other ED database in Canada is the National Ambulatory Care Reporting System, which includes all ED data from Ontario and data from some EDs in British Columbia, Nova Scotia and the Yukon.[12] All ED encounters at more than 100 provincial emergency care facilities are entered into computerized abstracts that constitute the majority of records within the ACCS system. Using a uniform protocol, trained medical records nosologists code each chart using ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) diagnostic codes (before Apr. 1, 2002) or ICD-10-CA (International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canadian Enhancement) (Apr. 1, 2002, onward) at each ED in the province.

Each ACCS record represents a service and contains a personal health number (unique to each Albertan), start and end dates and times of the visit, diagnoses, disposition status and region of the ED facility where the service occurred. We obtained demographic data by linking the individuals in the ACCS to the annual AHCIP cumulative registry file based on the personal health number (true linkage). This file includes all people (99% of the population) registered under the AHCIP at any time in a given year. The demographic information obtained included age, sex and region of residence.

We also obtained data on subsequent visits to physicians in non-ED settings (follow-up visits) by linking the individuals in the ACCS to the individuals in the physician claims database. This database provides dates of follow-up visits, diagnoses, physician specialties and facility types.

Variable description

Diagnostic information in the ACCS consisted of a main ambulatory diagnosis field, and 5 and 9 additional diagnostic fields, for ICD-9-CM and ICD-10-CA codes, respectively. To be considered an asthma-related visit, the first or second diagnosis fields in the ACCS had to have diagnostic codes 493.x "Asthma all forms" or J45.x "Asthma all forms." Previous studies using ACCS data indicate that the accuracy of the diagnosis is approximately 97%.[13–15]

The difference between the start and end dates and times provided the duration of an ED service in hours for each visit. Disposition from the ED is based on the manner in which patients are separated/released from the ambulatory service facility, and includes "discharged" (returning to previous place of residence) and "admitted" (admitted to hospital in a critical care or inpatient area in a health facility).

Ages were grouped into approximate 5-year categories and 2 subgroups were created: children (age < 18 yr) and adults (age ≥ 18 yr). Until 2008, Alberta had 9 regional health authorities (RHAs) responsible for the delivery of health care services. Patients were assigned codes according to which RHA they lived in at the end of the fiscal year, and the RHA of the ED facility was also provided. The 2 most urban RHAs are Edmonton and Calgary (including surrounding areas). The remaining 7 RHAs are grouped together (non–major urban [NMU] regions) to divide the province into

3 regions with approximately similar populations.

The follow-up visit data include the date of visit, 3 ICD-9 diagnosis fields, physician specialty codes and facility types. The follow-up visits within 365 days of an ED visit were extracted and classified as asthma-related if the first or second diagnosis field was ICD-9 coded as 493.x. We used 11 physician specialty codes (e.g., general practice, respiratory medicine) and 3 facility types (active treatment hospital, and clinic and ambulatory care centre; practitioner's office; other).

Data analysis

All ED visits including our asthma diagnostic codes between Apr. 1, 1999, and Mar. 31, 2005, were extracted. Numerical summaries (e.g., frequencies, medians, interquartile ranges [IQRs]) were calculated by region. Age group–specific ED visits per 1000 population were calculated for each sex. Directly standardized visit rates for ED visits and associated standard deviations[16] were calculated and tested using the 1999/2000 Alberta population as the reference. Proportions and continuous values were compared using χ^2 and Kruskal–Wallis tests, respectively. Region refers to region of residence, except for duration and outcome summaries, for which the region is the region of the ED facility. The latter 2 variables represent ED-specific information and hence the region is specified as the ED facility.

For analyses with both ED and follow-up visits, a discharged data subset of "index" ED visits was created for the period from Nov. 1, 2003, to Oct. 31, 2004. If an individual patient had multiple ED visits during this time frame, one visit was randomly selected. This subset allowed summaries at 7 and 30 days after the index ED visit to be at the individual level, permitted a follow-up time of at least 6 months and avoided variability associated with different fiscal years. The times to the next ED visit and the first follow-up visit were calculated, with observations censored at Mar. 31, 2005, or the date of the next ED visit, respectively. SAS (version 9.1, SAS Institute Inc.) and S-PLUS (version 7.0, TIBCO Software Inc.) were used for analysis.

Ethics

The study was approved by the health research ethics board of the University of Alberta.

RESULTS

General trends

During the 6-year period, there were 199 991 ED visits for asthma (Tables 1 and 2) from Alberta residents for

Table 1. Asthma-related visits to Alberta emergency departments from Apr. 1, 1999, to Mar. 31, 2005, by fiscal year and region of residence

	Year					
Variable	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05
Population						
Edmonton	929 328	943 329	961 950	978 160	990 931	1 000 862
Calgary	1 042 066	1 067 058	1 098 149	1 122 521	1 143 368	1 164 535
NMU region	985 403	996 922	1 012 072	1 023 567	1 030 606	1 044 461
Total no. of ED visits						
Edmonton	385 040	410 186	421 161	443 636	448 734	410 487
Calgary	303 540	314 970	303 745	330 109	344 170	346 414
NMU region	896 342	911 932	910 378	943 000	985 132	991 114
No. of asthma-related ED visits (% of total ED visits)						
Edmonton	8 395 (2.2)	8 810 (2.1)	8 118 (1.9)	7 619 (1.7)	8 179 (1.8)	7 925 (1.9)
Calgary	8 010 (2.6)	8 346 (2.6)	7 415 (2.4)	7 490 (2.3)	8 316 (2.4)	7 534 (2.2)
NMU region	21 038 (2.3)	18 162 (2.0)	17 141 (1.9)	15 329 (1.6)	16 067 (1.6)	16 097 (1.6)
No. of patients with ED visits for asthma (% of population)						
Edmonton	5 679 (0.6)	5 943 (0.6)	5 742 (0.6)	5 466 (0.6)	5 857 (0.6)	5 634 (0.6)
Calgary	5 685 (0.5)	5 924 (0.6)	5 475 (0.5)	5 457 (0.5)	6 049 (0.5)	5 558 (0.5)
NMU region	11 304 (1.1)	10 902 (1.1)	10 446 (1.0)	9 760 (1.0)	10 379 (1.0)	10 508 (1.0)

ED = emergency department; NMU = non–major urban.

whom regional information was available (region of residence was missing for 9 ED visits). These ED visits for asthma accounted for approximately 2% of the total number of ED visits for any reason. The number of ED visits for asthma in each region was relatively stable over the years, although the population increased to approximately one million residents in each of the 3 study regions by 2004/05. Crude visit rates were lower in the Calgary and Edmonton regions, compared with the NMU regions. By 2004/05, the crude visit rates per 1000 population for the Calgary, Edmonton and NMU regions were 6.5, 7.9 and 15.4, respectively.

Overall, the 199 991 ED visits were made by 93 146 patients during the 6-year study period. Most patients had only 1 visit during the study period: 65.2% for Edmonton, 65.7% for Calgary and 60.9% for the NMU regions. The mean number of visits per patient for the Edmonton, Calgary and NMU regions was 2.0, 1.9 and 2.3, respectively. The vast majority of visits (93.2%) were made to ED facilities within the same region as patients' region of residence.

Age and sex

In all 3 regions, the overall sex split was similar (female sex 51.0% for Edmonton, 47.5% for Calgary and 51.8% for NMU regions). Until age 14, more male patients than female patients presented for asthma in each region (Fig. 1). Visit rates were highest among male patients in the 1- to 4-year age group (37.9/1000 for Edmonton, 45.5/1000 for Calgary, 57.9/1000 for NMU regions) compared with visit rates among female patients of 24.7/1000 for Edmonton, 26.5/1000 for Calgary and 29.2/1000 for the NMU regions. After age 14, the pattern reversed so that older female patients present more often than males. These patterns were similar for each year.

Over time, the sex and age group directly standardized visit rates (DSVRs) remained relatively stable (Fig. 2) for Edmonton and Calgary with 8.3/1000 (95% confidence interval [CI] 8.0–8.6) and 6.9/1000 (95% CI 6.6–7.0), respectively, in 2004/05. For the NMU regions, the rates were much higher than in the other 2 regions and declined from 21.0/1000 in 1999/2000 until around 2002/03, and remained relatively stable thereafter with 15.5/1000 (95% CI 15.1–15.9) in 2004/05. All regions had statistically different DSVRs ($p < 0.001$ for each year).

Outcomes

The vast majority of patients with asthma in each

Table 2. Disposition from the emergency department for patients with asthma from Apr. 1, 1999, to Mar. 31, 2005, by fiscal year and region of facility

	Year					
Variable	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05
No. of asthma-related ED visits with complete information on region of ED facility						
Edmonton	7 982	8 536	7 765	7 412	8 020	7 731
Calgary	7 770	8 054	7 088	7 113	7 898	7 189
NMU region	21 691	18 728	17 804	15 910	16 644	16 636
No. discharged from ED (%)						
Edmonton	6 936 (86.9)	7 745 (90.7)	6 952 (89.5)	6 702 (90.4)	7 155 (89.2)	6 819 (88.2)
Calgary	6 510 (83.8)	7 023 (87.2)	6 217 (87.7)	6 213 (87.3)	6 945 (87.9)	6 232 (86.7)
NMU region	19 604 (90.4)	16 986 (90.7)	16 186 (90.9)	14 592 (91.7)	15 333 (92.1)	15 409 (92.6)
No. admitted to critical care or inpatient care (%)						
Edmonton	945 (11.8)	746 (8.7)	770 (9.9)	658 (8.9)	795 (9.9)	739 (9.6)
Calgary	1 173 (15.1)	1 008 (12.5)	853 (12.0)	880 (12.4)	936 (11.9)	840 (11.7)
NMU region	1 900 (8.8)	1 499 (8.0)	1 354 (7.6)	1 243 (7.8)	1 208 (7.3)	1 096 (6.6)
No. left ED without completion of care (%)						
Edmonton	45 (0.6)	44 (0.5)	42 (0.5)	49 (0.7)	68 (0.8)	171 (2.2)
Calgary	86 (1.1)	23 (0.3)	18 (0.3)	20 (0.3)	17 (0.2)	114 (1.6)
NMU region	37 (0.2)	34 (0.2)	37 (0.2)	31 (0.2)	45 (0.3)	105 (0.6)

ED = emergency department; NMU = non–major urban.

region were discharged from the ED (86.7%–92.6% in 2004/05, Table 1). In 2004/05, the Calgary region had the lowest proportion of discharges (86.7%; $\chi^2_2 = 12.7$, $p = 0.002$). The proportion of patients who left without completion of care was small in all 3 regions, with Edmonton experiencing the highest proportion for 2004/05 ($\chi^2_2 = 114.2$, $p < 0.001$).

Visit duration

The median length of stay was higher ($p < 0.001$) in Edmonton ($n = 47\,597$; 2 h 32 min, IQR 1 h 27 min to 4 h 20 min) and Calgary ($n = 35\,732$; 2 h 46 min, IQR 1 h 26 min to 4 h 49 min) than in the NMU regions ($n = 95\,036$; 1 h, IQR 33 min to 2 h).

Admitted patients had longer median ED lengths of stay in Edmonton (6 h 33 min) and Calgary (6 h 48 min) compared with the NMU regions (1 h 55 min). Discharged patients had the following median lengths of stay: Edmonton (2 h 21 min), Calgary (2 h 31 min) and the NMU regions (1 h). For each region, admitted children had shorter median ED lengths of stay than admitted adults ($p < 0.001$ for each region, Fig. 3).

Discharged subset

Between Nov. 1, 2003, and Oct. 31, 2004, 19 946 patients with region of residence information were discharged from the ED. In the 7 days after the index ED visits, Calgary (45.5%) and Edmonton (36.6%) had

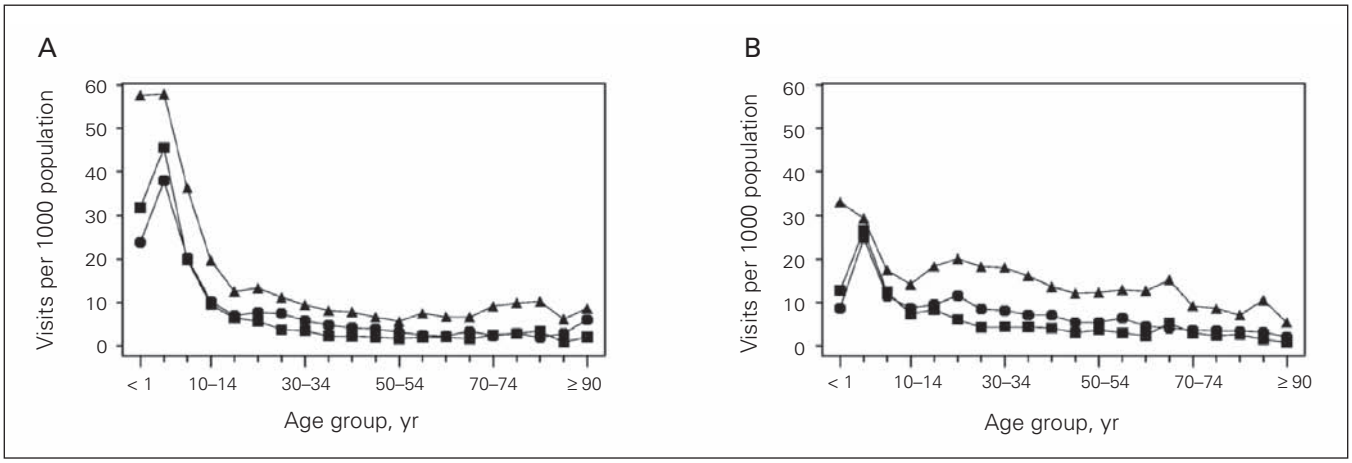

Fig. 1. Asthma-related visits to the emergency department, by age group, per 1000 population for the Edmonton (●), Calgary (■) and nonmajor urban (▲) regions for male **(A)** and female **(B)** patients, 2004/05.

Table 3. Characteristics of follow-up visits for 19 946 patients with asthma discharged from the emergency department, by region of residence (Edmonton, Calgary, non–major urban) and days since index emergency department visit (7, 30)

	Edmonton, *n* = 5 066		Calgary, *n* = 5 182		NMU, *n* = 9 698	
Variable; no. (%)	7	30	7	30	7	30
Subsequent ED visits	334	488	306	448	1 154	1 484
Follow-up visits	2 879	8 414	3 212	8 663	5 088	14 331
Sex						
Female	1 664 (57.8)	4 896 (58.2)	1 668 (51.9)	4 576 (53.0)	2 999 (58.9)	8 633 (60.2)
Male	1 215 (42.2)	3 518 (41.8)	1 544 (48.1)	4 057 (47.0)	2 089 (41.1)	5 698 (39.8)
Diagnosis						
Asthma	1 054 (36.6)	2 247 (26.7)	1 462 (45.5)	3 016 (34.9)	1 543 (30.3)	3 111 (21.7)
Other	1 825 (63.4)	6 167 (73.3)	1 752 (54.5)	5 617 (65.1)	3 545 (69.7)	11 220 (78.3)
Physician type						
General practitioner	1 571 (54.6)	4 340 (51.6)	1 796 (55.9)	4 640 (53.7)	4 012 (78.9)	10 585 (73.9)
Other	1 308 (45.4)	4 074 (48.4)	1 416 (44.1)	3 933 (46.3)	1 076 (21.1)	3 746 (26.1)
Facility type						
Active treatment hospital	827 (28.7)	2 267 (26.9)	1 098 (34.2)	2 559 (29.6)	2 402 (47.2)	5 766 (40.2)
Practitioner's office	1 896 (65.9)	5 594 (66.5)	1 992 (62.0)	5 728 (66.4)	2 575 (50.6)	8 034 (56.1)
Other	156 (5.4)	553 (6.6)	122 (3.8)	346 (4.0)	111 (2.2)	531 (3.7)

ED = emergency department; NMU = non–major urban.

higher asthma-related follow-up visits than the NMU regions (30.3%; $\chi^2_2 = 196.6$, $p < 0.001$) by 7 days (Table 3). The NMU regions had a higher proportion of visits to general practitioners (78.9%) than the Edmonton (54.6%) and Calgary (55.9%) regions ($\chi^2_2 = 687.9$, $p < 0.001$). The follow-up visits were more likely to occur in practitioners' offices in Edmonton (65.9%) and Calgary (62.0%) than in the NMU regions (50.6%; $\chi^2_4 = 330.5$, $p < 0.001$). The results at 30 days followed the same general patterns.

At 7 days after discharge from the ED, 4.4% of patients in Edmonton and 5.0% in Calgary had returned to the ED. In the NMU regions, 7.2% had returned. The estimated median time to the first follow-up visit was 21 days for Edmonton, 19 days for Calgary and 26 days for the NMU regions.

DISCUSSION

This study explored presentations to EDs for asthma in 3 main regions of the province of Alberta during a 6-year period, using large provincial databases. The study demonstrated markedly higher rates of presentation in NMU regions in the province. Overall, a patient visits an ED in Edmonton, Calgary and the NMU regions every 64, 67 and 30 minutes, respectively. Patients with asthma in Edmonton, Calgary and the NMU regions are admitted to hospital every 2.1, 2.6 and 3.8 days.

Although it is important to put these visit rates in perspective, comparative data are sparse. Using a 1-year stratified sample of 16 hospitals in Ontario, the estimated age- and sex-standardized ED visit rates ranged from 1.7 to 10.1 per 1000 population for adults, again with marked variation.[17] Our results demonstrate higher visit rates, especially in the NMU regions. Using a representative sample of EDs in the United States, an overall rate of 6.7 visits per 1000 population was reported, which had appeared to plateau despite marked variability.[18] A higher proportion of patients with asthma are admitted to hospitals in the United States compared with Canada, a phenomenon which appears to be multifactorial.[19]

Our study identified new interregional differences and temporal trends. In each region studied, the number of asthma-related visits to EDs has remained relatively stable despite increasing populations. Explanations may include ED overcrowding that results in acute asthma being treated elsewhere, improved access to after-hours care in major centres and improved application of evidence-based management in primary care. Recent evidence has examined the association of air quality on asthma presentations.[20,21] Nonurban air quality in Alberta may be influenced by proximity to cities and industrial pollution and other environmental allergens. Moreover, options for rural patients to seek care may be more limited because of the lack of available alternatives. Consequently, the severity of asthma in patients presenting to these sites may be lower.

Finally, the most important barrier to asthma visits in urban Alberta is overcrowding in urban EDs. Emergency department overcrowding has been a growing concern across Alberta, especially in major centres.[22] As proof, patients with asthma who presented to Edmonton and Calgary region facilities experienced longer stays,

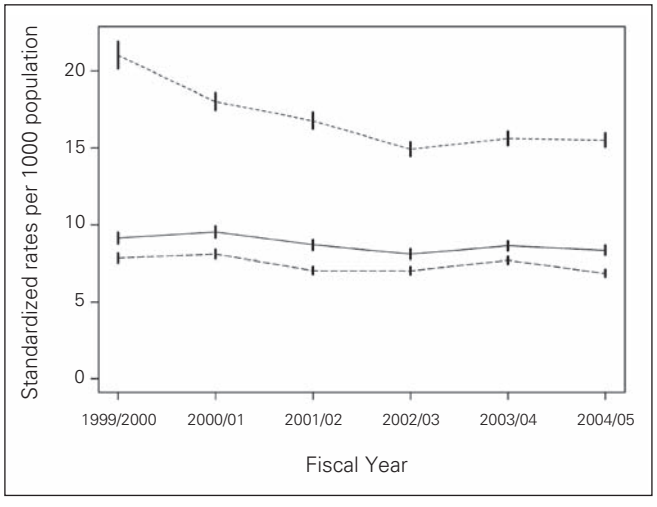

Fig. 2. Age group and sex directly standardized visit rates and 95% confidence intervals (vertical lines) for each fiscal year by region: Edmonton (solid line), Calgary (dashed line) and non–major urban regions (short dashed line).

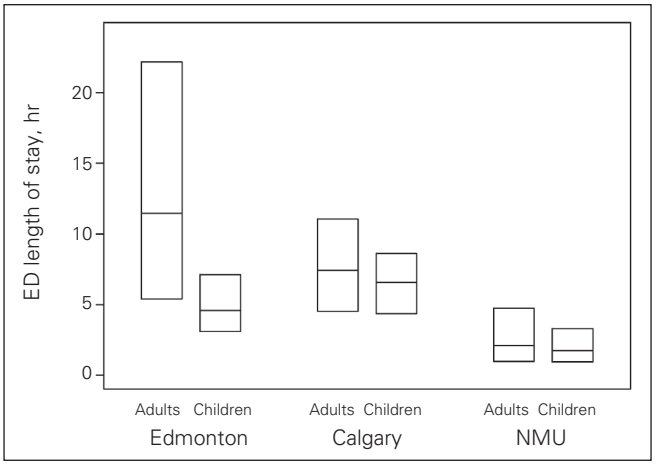

Fig. 3. Durations of asthma-related emergency department (ED) visits for admitted adults and children, by region of facility (25th percentile, median and 75th percentile). NMU = non–major urban.

whether they were discharged or admitted to hospital. In keeping with national trends, adults waited longer than children. The use of inhaled corticosteroids and combination agents has been increasing in Canada,[23] and status Aboriginals and welfare recipients within the urban centres have higher rates of asthma-related ED visits.[24] Further research is required to determine the relative contribution of each of these factors.

After an acute exacerbation requiring ED care, follow-up reassessment by the primary care provider is recommended in both pediatric and adult asthma guidelines;[24,25] however, the timing of this follow-up is unclear. Most asthma follow-up rates from clinical trials are spuriously high. Approximately 30% of discharged asthmatics had a non-ED follow-up within 7 days and approximately 50% by 3 weeks. This interval suggests that clinical reassessment, reinforcement of asthma education messaging and medication adjustment are too infrequent for optimal asthma control. "Asthma centres" where patients receives education, reassessment and overall management have been proposed as an alternative model for chronic disease management, but there is limited evidence regarding their cost-effectiveness.

This study has several limitations. The employed databases are unable to capture all cases of acute asthma visits to the health care system and do not provide a "true" incidence of disease. Many individuals may present to non-ED settings such as walk-in clinics for acute asthma, so these data underrepresent rates of acute asthma visits. We are not able to ascertain why individuals presented at EDs outside their region of residence. The observed patterns may also be indicative of differences in emergency service delivery and not systematic differences in the distribution of the disease. Higher rates of ED visits may reflect a preference for emergency services over other medical services in some regions. Moreover, the clinical treatment received in the EDs across Alberta is likely to vary considerably, affecting admission and relapse rates. Despite these limitations, the ACCS data have been shown to be valid and reliable.[13–15]

Asthma is a common presenting problem in Alberta EDs, and the interregional variation requires further study to understand the factors associated with these patterns. The most impressive findings of this study are the rates of presentation and the disparities in presentations based on age and sex, and the low proportions of post-ED follow-up.

Acknowledgements: The authors thank Sylvia Wilson and Yan Jin at Alberta Health and Wellness for facilitating access to the data. This work was made possible by an operating grant from the Canadian Institutes of Health Research and funding from The Lung Association, Alberta & NWT.

Competing interests: Dr. Rosychuk is supported by the Alberta Heritage Foundation for Medical Research as a health scholar. Dr. Rowe is supported by the Government of Canada as a 21st Century Canada research chair in emergency airway diseases, and has received speaking fees and research study funding from the following companies who produce asthma medications: GlaxoSmithKline, AstraZeneca and Abbott. None declared for the other authors.

Disclaimer: This study is based in part on data provided by Alberta Health and Wellness. The interpretation and conclusions contained herein are those of the researchers and do not necessarily represent the views of the Government of Alberta. Neither the government nor Alberta Health and Wellness express any opinion in relation to this study.

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Correspondence to: Dr. Rhonda Rosychuk, Department of Pediatrics, University of Alberta, 9423 Aberhart Centre, 11402 University Ave. N.W., Edmonton AB T6G 2J3; rhonda.rosychuk@ualberta.ca

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