Direct health care costs associated with asthma in British Columbia

Mohsen Sadatsafavi MD MHSc¹, Larry Lynd PhD^{1,2}, Carlo Marra PharmD PhD^{1,2},
Bruce Carleton PhD², Wan C Tan MB³, Sean Sullivan PhD^{5,6}, J Mark FitzGerald MD^{3,4}

M Sadatsafavi, L Lynd, C Marra, et al. Direct health care costs associated with asthma in British Columbia. *Can Respir J* 2010;17(2):74-80.

BACKGROUND: A better understanding of health care costs associated with asthma would enable the estimation of the economic burden of this increasingly common disease.

OBJECTIVE: To determine the direct medical costs of asthma-related health care in British Columbia (BC).

METHODS: Administrative health care data from the BC Linked Health Database and PharmaNet database from 1996 to 2000 were analyzed for BC residents five to 55 years of age, including the billing information for physician visits, drug dispensations and hospital discharge records. A unit cost was assigned to physician/emergency department visits, and government reimbursement fees for prescribed medications were applied. The case mix method was used to calculate hospitalization costs. All costs were reported in inflation-adjusted 2006 Canadian dollars.

RESULTS: Asthma resulted in \$41,858,610 in annual health care-related costs during the study period (\$331 per patient-year). The major cost component was medications, which accounted for 63.9% of total costs, followed by physician visits (18.3%) and hospitalization (17.8%). When broader definitions of asthma-related hospitalizations and physician visits were used, total costs increased to \$56,114,574 annually (\$444 per patient-year). There was a statistically significant decrease in the annual per patient cost of hospitalizations ($P < 0.01$) over the study period. Asthma was poorly controlled in 63.5% of patients, with this group being responsible for 94% of asthma-related resource use.

CONCLUSION: The economic burden of asthma is significant in BC, with the majority of the cost attributed to poor asthma control. Policy makers should investigate the reason for lack of proper asthma control and adjust their policies accordingly to improve asthma management.

Key Words: Asthma; Cost of illness; Health care costs; Retrospective studies

Asthma is one of the most common chronic diseases in the world (1). Using relatively stringent criteria, it has been estimated that more than 300 million people suffer from asthma globally (2). The prevalence of the disease, along with atopic disease in general, has risen significantly in recent years (2). It is estimated that the prevalence of asthma may increase by another 25% in the next 20 years (1). In the 2007 Global Burden of Asthma report (1), 14.1% of Canadians were estimated to have been diagnosed with asthma at some point in their lives, placing Canada 10th in asthma prevalence among more than 100 countries (1). In a separate nationwide analysis, an estimated 10% of children and 5% of adults were determined to have current asthma (ie, used an asthma medication

Les coûts directs liés aux soins de santé associés à l'asthme en Colombie-Britannique

HISTORIQUE : Si on comprenait mieux les coûts liés aux soins de santé associés à l'asthme, on pourrait évaluer le fardeau économique de cette maladie de plus en plus courante.

OBJECTIF : Déterminer les coûts médicaux directs des soins de santé liés à l'asthme en Colombie-Britannique (C.-B.).

MÉTHODOLOGIE : Les auteurs ont analysé les données administratives liées aux soins de santé tirées de la *Linked Health Database* de la C.-B. et de la base de données PharmaNet entre 1996 et 2000 à l'égard des habitants de cinq à 55 ans, y compris les renseignements sur la facturation des visites des médecins, la dispensation de médicaments et les dossiers de congé de l'hôpital. Ils ont attribué un coût unitaire aux visites aux médecins et à l'urgence et appliqué un coût de remboursement gouvernemental aux médicaments prescrits. Ils ont utilisé la méthode de la charge de cas pour calculer les frais d'hospitalisation. Tous ces coûts étaient déclarés en dollars canadiens de 2006 rajustés en fonction de l'inflation.

RÉSULTATS : L'asthme entraîne des coûts annuels liés aux soins de santé de 41 858 610 \$ pendant la période de l'étude (331 \$ par patient-année). Le principal élément de coût provenait des médicaments, qui représentaient 63,9 % des coûts totaux, suivi des visites aux médecins (18,3 %) et des hospitalisations (17,8 %). Lorsqu'on utilisait les grandes définitions des hospitalisations et des visites aux médecins liées à l'asthme, les coûts annuels totaux passaient à 56 114 574 \$ (444 \$ par patient-année). On constatait une diminution statistiquement significative du coût annuel des hospitalisations par patient ($P < 0,01$) au cours de la période de l'étude. L'asthme était mal contrôlé chez 63,5 % des patients, ce groupe étant responsable de 94 % de l'utilisation des ressources liées à l'asthme.

CONCLUSION : Le fardeau économique de l'asthme est important en C.-B., la majorité des coûts étant attribuables à un mauvais contrôle de l'asthme. Les décideurs devraient explorer la raison de ce manque de contrôle convenable de l'asthme et rajuster leurs politiques en conséquence, afin d'en améliorer la prise en charge.

or experienced symptoms in the previous 12 months) (3). The majority of Canadians with asthma are inadequately controlled (4-6); suboptimal control of asthma is associated with increased morbidity and excessive health care use (7).

The total health care costs of asthma are likely substantial because it is so common. Surprisingly, there has been no systematic assessment of health care costs associated with asthma care in Canada since the early 1990s (8). The objective of the present study was to describe the direct health care resource use attributable to asthma from the payer's perspective in British Columbia (BC) from April 1996 to March 2000, and to evaluate the impact of asthma control on resource use.

¹Collaboration for Outcomes Research and Evaluation; ²Faculty of Pharmaceutical Sciences; ³Department of Medicine; ⁴Centre for Clinical Epidemiology and Evaluation, Vancouver Coastal Health Research Institute; ⁵University of British Columbia, Departments of Pharmacy, Health Services and Medicine, Vancouver, British Columbia; ⁶University of Washington, Seattle, Washington, USA

Correspondence: Dr Larry Lynd, Faculty of Pharmaceutical Sciences, University of British Columbia, 2146 East Mall, Vancouver, British Columbia V6T 1Z3. Telephone 604-806-9447, fax 604-827-4014, e-mail llynd@interchange.ubc.ca

METHODS

Data from the BC PharmaNet database and the BC Linked Health Database (BCLHD) were used to identify a cohort of asthma patients followed from April 1996 to March 2000. Throughout the current article, a 'year' is used to indicate the fiscal year starting April 1 and ending March 31 the following year (9). The BCLHD is a longitudinal administrative health care database containing person-specific, anonymized health data from 1985 onward on BC's four million residents with health insurance (9). Data extracted from the BCLHD included Medical Services Plan (MSP) data, which encompass fee-for-service physicians, the Discharge Abstracts Database (DAD) of hospital inpatient separation records, as well as records of death certificates. Prescription drug use was determined from the BC PharmaNet database – a population-based prescription drug database that captures essentially all dispensing episodes of outpatients residing in the province on a prescription-by-prescription basis (regardless of funding source). All pharmacies are required to enter drug and dosage information for each prescription into the Internet-based PharmaNet system.

Patients were diagnosed with asthma and, therefore, were eligible for inclusion in the cohort if during a 365-day rolling time window, they filled at least four prescriptions for an asthma-specific medication; had at least one acute inpatient hospital discharge with asthma as the primary diagnosis (*International Classification of Diseases – Ninth Revision* [ICD-9] code 493); or had at least two physician visits for asthma. Due to the possible overlap of patients diagnosed with asthma and other respiratory conditions such as bronchiolitis and wheezing in children, and chronic obstructive pulmonary disease in adults (10), the present analysis was restricted to subjects five to 55 years of age.

The DAD contains 16 discharge diagnoses for each hospitalization coded according to the ICD-9. One of these ICD-9 codes was designated as the 'most responsible' diagnosis. To determine costs associated with asthma, two different definitions of asthma-related hospitalizations were applied. In the primary analysis, only hospitalizations in which asthma was coded as the 'most responsible' diagnosis (ie, ICD-9 493.xx) were included. In the secondary analysis, all hospitalizations in which asthma was indicated among the discharge diagnoses were included. Similarly, in calculating the number and associated cost of physician visits entered in the MSP database, two definitions of an asthma-related physician visit were applied. The primary analysis included only physician visits that were coded as asthma (ie, ICD-9 493.xx). In a secondary analysis, a more liberal definition was used that included all physician visits for an asthma-related diagnosis (Table 1) (see Appendix 1 for a list of asthma-related ICD-9 codes).

Annual resource use was calculated both as the total costs and as the mean cost per patient. Per-patient costs were calculated based on the number of asthma patients in the cohort for each year. Because there may have been asthma patients who did not use health care resources in a particular year, the number of subjects present in the database in each year was likely an underestimation of the true number of asthma subjects. Therefore, if a subject was missing from a particular year but was in the cohort in a previous year and re-entered in a future year, the subject was included in the denominator in the intervening year (no middle censoring). On the other hand, for any

TABLE 1
Number of encounters, total annual costs and annual cost per patient

Component	Encounters, n		Annual costs*, \$	
	Total	Per patient-year	Total	Per patient
Physician/emergency department visits [†]				
Narrow definition	1,021,6692	1.86	7,583,921	60.00
Broad definition	2,115,912	3.85	13,955,806	110.41
Medication prescriptions	2,486,672	4.53	26,512,351	209.74
Hospitalizations [‡]				
Narrow definition	8,818	0.016	7,762,338	61.41
Broad definition	16,506	0.030	15,646,417	123.78
Total				
Narrow definition	3,517,159	6.42	41,858,610	331.15
Broad definition	4,619,090	8.41	56,114,574	443.93

*Inflation-adjusted 2006 Canadian dollars; [†]Narrow definition: Physician visits that were coded as asthma according to the *International Classification of Diseases – Ninth Revision* (ICD-9) code 493.xx. Broad definition: Includes all visits for an asthma-related diagnosis; [‡]Narrow definition: Hospitalizations in which asthma was coded as the 'most responsible' diagnosis (ie, ICD-9 493.xx); Broad definition: All hospitalizations in which asthma was indicated among the discharge diagnoses

particular year in which a subject was absent in the database, if the subject was absent in all previous years or in all subsequent years, the subject was considered to be absent in the database (left and right censoring, respectively) and, hence, was not counted in the calculation of per-patient costs.

Cost calculations

Total population cost and cost per patient were calculated for each year. For MSP billings, the type of service for each record was matched to the corresponding service codes for services from the MSP (11). Unit costs for each type of service were taken from the fee-for-service analysis of MSP billings for the year 2002 (12) by dividing the total expenditures over the total number of encounters for that service overall in the province, and adjusting for the inflation rate. Because emergency department (ED) visits are not captured in the BCLHD, costs attributable to ED visits were estimated based on an approximation of the ratios reported in the literature of hospital admissions to ED visits for patients with asthma. A recent analysis (13) reported that 11% of referrals to EDs due to asthma in Canada result in hospitalization, while a regional study in Ontario (14) reported an ED/hospitalization ratio of 14.5:1, or 6.9% of ED visits leading to hospitalizations. Therefore, it was assumed that 10% of asthma-related ED visits would lead to asthma-related hospitalizations. A unit cost of \$324 for each ED visit was taken from a previously published Canadian study (15).

Drug costs were determined based on the BC government's per dose reimbursement for each asthma-specific drug (drugs in the following categories were considered asthma related: anticholinergics, inhaled corticosteroids, short- and long-acting beta-2 agonists, leukotriene receptor antagonists, and xanthines, adrenaline and mast cell stabilizers (See Appendix 2 for the relative frequency of the prescriptions for each drug category during the study period). These were obtained by cross-referencing the unique drug identification numbers with the PharmaNet Drug Master database, which contains drug

Figure 1 Annual total cost of asthma (left panel) and per-patient cost (right panel) in British Columbia according to year and cost component (inflation-adjusted 2006 Canadian dollars). The number of subjects for each year of data was as follows: 1996: 109,236; 1997: 131,119; 1998: 137,593; 1999: 135,780; 2000: 118,291. ED Emergency department

costs per dose (16), then multiplying by the total dose dispensed. For hospital discharge records, the case-mix methodology was used (17). The DAD incorporates a resource intensity weight (RIW, calculated by the Canadian Institute for Health Information) for each hospitalization. The RIW estimates the relative resource use of each hospitalization event based on patient- and setting-specific covariates. An RIW of 1 corresponds to the average hospitalization cost in the province for that year. Therefore, to calculate an approximate cost for each asthma-related hospitalization, the RIW was multiplied by the average cost of hospitalization for that year obtained from the BC Ministry of Health.

All costs were adjusted to 2006 Canadian dollars using the medical component of the Canadian Consumer Price Index (18). Indirect and out-of-pocket costs were not included. Trends in the mean costs per patient over the study period were evaluated using a one-part model with a linear equation predicting the $\log(\text{cost}+1)$ with a random effect for each patient and a fixed effect for the cost year (19). In this way, a patient-specific mean $\log(\text{cost})$ was estimated and captured the between-patient variability in costs while enabling an estimation of the mean $\log(\text{cost})$ per patient for each year.

Analysis of resource use by level of asthma severity and control

The algorithm developed by Firoozi et al (20) was used to stratify patients by asthma severity and asthma control based on administrative data. This algorithm is based on factors such as the daily dose of inhaled corticosteroid (ICS), weekly dosage of short-acting beta-2 agonists, yearly dosage of other therapies (long-acting beta-2 agonists, theophylline or leukotriene receptor antagonists) and indicators of severe exacerbations (defined as a hospital admission or ED visit, or a filled prescription for an oral corticosteroid) over a 12-month period. The algorithm was validated against the pulmonary function

tests of 71 asthma patients in a Canadian setting and classified asthma status into three levels of severity (mild, moderate and severe) and two levels of control (controlled and uncontrolled). The algorithm was applied to each patient-year of data, allowing patients to move between levels of severity/control during the follow-up period. Total and mean per-patient costs were calculated within each stratum as described earlier.

Sensitivity analysis

The impact of alternative assumptions on the per-patient cost of asthma was explored in a series of sensitivity analyses. These included the impact of different methods for calculating total patient-years available (with respect to censoring) and incorporation of the broad definitions of an asthma-related hospitalization and physician visits.

RESULTS

There were 158,516 unique patients (mean age 29.1 years at the first encounter, 55% female) in the database who fulfilled the case definition of asthma. These patients had data available for a total of 549,389 patient-years of follow-up or, on average, 3.47 years of follow-up per subject. Based on the population of BC at the midpoint of the follow-up (21), the prevalence of asthma was estimated to be 5.3%.

Overall, the present cohort of patients was responsible for \$209,293,049 in direct health care costs during the five-year period, corresponding to \$41,858,610 annually or \$331 per patient per year. Hospitalizations/ED visits, physician visits and medication costs accounted for 17.8%, 18.3% and 63.9% of the total cost, respectively. Figure 1 presents the total costs stratified according to cost components and year. Per-patient hospitalization costs significantly decreased during the study period (on average, 4.4% per patient per year; $P < 0.01$). The number of hospitalizations also decreased from 1.7 in 1996 to 1.2 per

Figure 2) Share (%) of the total direct cost of asthma for different levels of severity and control

100 patients in 2000. On the other hand, there was a trend toward increasing cost of medications per patient (on average 1.5% per patient per year; $P=0.06$). There was no significant change in the average annual direct costs of asthma per patient over the study period ($P=0.14$).

Analysis by asthma severity and control

Overall, 67.1%, 25.5% and 7.4% of patient-years were categorized as being due to mild, moderate and severe disease, respectively. Only 36.5% of patient-years were deemed to be associated with adequately controlled asthma. The ratio of annual costs per patient for uncontrolled versus controlled asthma was 2.2 for mild, 1.0 for moderate and 2.8 for severe disease. Overall, 94% of all costs were incurred by patients with uncontrolled asthma (Figure 2). Figure 3 shows the cost breakdown of asthma per patient-year according to the level of severity (left panel) and control (right panel). All three components of costs increased in patient-years with higher severity and lower control levels. The increase in medication costs were most substantial in those with moderate to severe asthma versus those with mild disease, and in those with uncontrolled versus controlled asthma.

Sensitivity analysis

Results of the sensitivity analysis are presented in Table 2. When the broader definitions of asthma-related hospitalization and physician visits were used, total costs increased by 33%,

TABLE 2
Results of the one-way sensitivity analysis

Scenario	Annual per-patient costs*, \$		
	Hospital/ ED	Physician visits	Medications
Baseline	61.4	60.0	209.7
Broad definition of hospitalization [†]	123.8	60.0	209.7
Broad definition of physician visits [‡]	61.4	110.4	209.7
ED costs not modelled	22.8	60.0	209.7
Right- and middle-censored cases included	55.6	54.3	189.9
All censored cases included	49.5	48.3	169.0
All censored cases excluded	66.5	65.0	227.3

*Inflation-adjusted 2006 Canadian dollars. [†]All hospitalizations in which asthma was indicated among the discharge diagnoses; [‡]Includes all visits for an asthma-related diagnosis. ED Emergency department

and hospitalization and physician visits accounted for 26.9% and 25.2% of total costs, respectively. Results were also sensitive to the criteria used to calculate the number of patients for each year. When all patients were assumed to have been in the database (ie, no left, middle or right censoring, and accounting for deaths), the total number of patient-years accrued to the end of the study period was 24% higher than the baseline. When all patient-years for which there was no resource use documented in the database were excluded (left, middle and right censoring), total patient-years in the study period decreased by 8% and affected per patient costs accordingly.

DISCUSSION

It was estimated that the direct health care costs of asthma in BC from 1996 to 2000 were \$41,858,610 annually or \$331 per patient per year. A statistically significant decrease in hospitalization and a statistically significant increase in medication costs over the study period was detected. The total costs for asthma in BC are likely much higher because we used a restricted age group and only considered direct costs. Disappointingly, based on their resource use, 63.5% of asthma patients in BC had poorly controlled asthma and this group was responsible for 94% of the overall cost of asthma care.

The burden of asthma has been studied in several countries and geographical regions using a variety of methods (2,8,10,22-34). Table 3 summarizes the results of a brief review of studies reporting on the per-patient and nationwide costs of

Figure 3) Breakdown of annual per-patient costs per level of asthma severity (left panel) and control (right panel)

TABLE 3
Published reports of the per-patient and nationwide estimates of asthma costs in North America*

Author (reference)	Year	Country	Perspective	Method	Cost*, \$	
					Direct	Indirect
Per-patient estimates of costs						
Armstrong et al (28)	1994–1996	United States	Third-party payer	Administrative database analysis	679	N/A
Cisternas et al (29)	1998–1999	United States	Societal	Cross-sectional survey data	3,180	1,732
Li et al (30)	1990–1991	United States	Third-party payer	Administrative database analysis	937	N/A
Piecoro et al (31)	1996	United States	Third-party payer	Administrative database analysis	616	N/A
Sapra et al (32)	1996–1998	United States	Third-party payer	Administrative database analysis	1,250	N/A
Smith et al (10)	1987	United States	Societal	National Medical Expenditure Survey	1,089	149
Stroupe et al (33)	1995	United States	Third-party payer + out of pocket	An inner-city public hospital-based care system	737	N/A
Ungar et al (26)	1995–1996	Canada	Societal	Prospective cohort (1 year)	1,275	1,275
Estimates of the national cost of asthma						
Krahn et al (8)	1990	Canada	Societal	Cross-sectional survey	355.5 million [†]	220.15 million [†]
Smith et al (10)	1987	United States	Societal	National Medical Expenditure Survey	5.1 billion	673 million
Weiss et al (34)	1985	United States	Societal	Data available from the National Center for Health Statistics	6.1 billion [‡]	6.1 billion [‡]
Weiss et al (27)	1994	United States	Societal	Data available from the National Center for Health Statistics	6.1 billion	4.64 billion

*In the currency of the country of publication; [†]Average of the low and high estimates; [‡]Projected to 1990 \$US. N/A Not available

asthma in North American adults. The results of these analyses were remarkably heterogeneous, mainly reflecting the different data sources and the different methods used to analyze them. However, the estimates determined in the present study were close to Krahn et al's (8) 1990 calculation of \$306 million (equal to \$428 million in 2006) for the direct cost of asthma care in Canada – 40.5% of which was due to asthma medications. Our estimates of annual costs were within 10% of the adjusted costs reported by Krahn et al. The BC population at the midpoint of our study period was approximately 10% of the Canadian population in 1990. However, the proportion of costs due to medications is higher in our analysis. Increased use of more expensive combination inhalers have likely contributed to the rising costs of asthma medications in recent years, and differences in methods also likely contributed to the disparity in results.

The heterogeneity in the previous estimates was more evident when per-patient costs and the contribution of different cost components were evaluated. An American study (10) reported direct costs of \$1,096 per patient in 1994, with hospitalizations accounting for 54.4% of the costs, while another American study (27) in the same year estimated the hospitalization costs to account for less than 30% of the total direct costs. Furthermore, direct medical costs in a survey study conducted in Ontario (26) and in a Spanish study (24) were more than \$1,000 per patient-year, while total direct and indirect annual costs of asthma were estimated to be as low as US\$326 per patient in 1991 in Australia (35). Generally, survey-based studies seem to report significantly higher asthma-related costs. This is likely due to their more comprehensive design, although the possibility of overestimation should be considered due to recall bias in such studies. Perhaps even more importantly, there are differences in the health care systems among countries and in the pattern of asthma management.

The trend toward decreased hospitalization costs is worthy of further scrutiny. Such a trend has also been observed in the

United States (27,36). This may reflect a tendency toward shorter length of stay and greater use of outpatient facilities in the management of asthma, a higher clinical threshold for hospitalization, the implementation of several interventional programs including patient education, better outpatient case management (eg, use of ICS [37]) and better self-management plans. Nevertheless, the high costs associated with asthma medication are also of some concern. A study using similar data for BC (6) revealed that despite the widespread dissemination of guidelines focusing on asthma pharmacotherapy, inappropriate use of asthma medications has persisted, particularly the excessive use of inhaled short-acting beta-2 agonists combined with the underuse of ICS; such inappropriate medication use is associated with higher health care resource use (6,38). It should be noted that while ICS are more expensive than rescue medications such as short-acting beta-2 agonists, they are proven to be a cost-effective therapy for asthma, and their appropriate use will likely decrease the cost of asthma by lowering hospitalizations and physician visits. The proper use of ICS may, in fact, result in reduced costs of medication through lower prescription of rescue medication or other therapies, which seems to have been the case in our study population. Despite increased asthma drug costs, it is disappointing that the majority of asthma patients remained poorly controlled.

The present study had several limitations. First, we did not measure indirect costs of asthma in the analysis and, therefore, were not able to report the societal burden of asthma. Unlike other common respiratory diseases such as chronic obstructive pulmonary disease, asthma affects a younger, more active population and, hence, potentially results in much more lost productivity. For example, occupational asthma is reported to be the most common respiratory cause of workers' compensation claims (23).

Second, a challenge in the present analysis was quantifying the number of asthma subjects in a particular year because some patients with mild asthma may not have used health care

resources in a given year. Because such patients fall into the category of controlled asthma, lack of such data may have led to inaccuracies in the estimation of the proportion of uncontrolled patients. While this does not affect the total cost of asthma, it does result in inaccuracies when average per-patient costs are calculated. Our analysis demonstrated the sensitivity of per-patient costs to the various methods used to calculate total patient-years of data. In addition, the algorithm used for the stratification of asthma is based on the intensity of resource use. Therefore, its use naturally results in patients with higher resource use falling into higher levels of severity and lower levels of control. An unbiased analysis of resource use according to the level of severity/control would require independent verification of the severity of each asthma case based on symptoms, quality of life measures, history of exacerbations as well as objective measurements of airflow obstruction.

Third, several factors that might have resulted in inaccuracies in the estimation of total costs in our analysis include the absence of ED visits in the BCLHD, necessitating that ED costs be estimated indirectly. Previous reports (14) have demonstrated large variations in the ED visits/hospitalization ratios across geographical regions, even within a province. Hence, the estimated number of ED visits may not be completely accurate; however, it is likely a very good approximation. ED visits are also a marker of uncontrolled asthma in the algorithm we used to define levels of control; hence, lack of ED visits may have resulted in the underestimation of uncontrolled asthma. In addition, it has been demonstrated that the case definitions of asthma based on administrative claims have suboptimal sensitivity (39). Thus, it is likely that some asthma patients were excluded from the analysis. Furthermore, restriction of the cohort to patients between five and 55 years of age led to a conservative underestimation of the overall costs. Finally, the 'narrow' definition of asthma-related hospitalization and physician visit leads to an underestimation of resource use attributable to these two

components. Thus, given these methodological challenges and data limitations, the results likely represent a conservative estimate of the overall direct cost of asthma in BC.

In recent years, the importance of asthma control has been emphasized and the ability to achieve such control has been recognized. The present analysis suggests that despite improvement in asthma inpatient care – suggested by the decreased cost of hospitalization over the study period – a significant care gap in BC remains and, by extension, likely in the rest of Canada. In particular, it shows that while the bulk of costs are associated with poorly controlled asthma in patients with severe disease, poorly controlled asthma in patients with mild and moderate disease also makes a significant contribution to the costs.

The high cost of asthma medications is of concern. It suggests that optimal asthma control will not be achieved with increased prescription of asthma therapy alone. There needs to be a broader paradigm of asthma management, including provisions for greater access to asthma education. Previous studies (6) have documented the inappropriate use of asthma medications and, especially, the lack of anti-inflammatory therapy. Future efforts should focus on strategies for the elimination of the observed care gap in asthma management and on an ongoing economic evaluation of subsequent levels of asthma control.

ACKNOWLEDGEMENTS: This study was funded by the Michael Smith Foundation for Health Research (MSFHR). Additional funding was provided by the National Sanitarium Association. Drs Lynd and FitzGerald are an MSFHR Scholar and a Distinguished Scholar respectively. Dr FitzGerald is also a recipient of a BC Lung/Canadian Institutes of Health Research Scientist Award.

COMPETING INTERESTS: None declared.

APPENDIX 1

International Classification of Diseases – Ninth Revision (ICD-9) codes for asthma and asthma-related diagnoses

ICD-9 code	Name
32	Allergy injection
460	Acute nasopharyngitis
465	Acute upper respiratory tract infection
466	Acute bronchitis or bronchiolitis
472	Chronic pharyngitis/nasopharyngitis
477	Allergic rhinitis
480	Viral pneumonia
481	Pneumococcal pneumonia
482	Other bacterial pneumonia
485	Bronchopneumonia
487	Influenza
490	Bronchitis – other
491	Chronic bronchitis
492	Emphysema
493	Asthma
494	Bronchiectasias
496	Chronic airway obstruction

APPENDIX 2

The classes of drugs used for the analysis and their share among the asthma-specific drugs prescribed in the study population during the study period

Drug	Proportion of prescribed medications, %
Epinephrines*	<0.1
Mast cell stabilizers†	1.6
Anticholinergic, inhaled	2.7
Beta-adrenergics, nonselective	0.5
Corticosteroid, inhaled	27.3
Corticosteroids, other	6.2
Long-acting beta-2 agonists	2.3
Leukotriene receptor antagonist	1.7
Short-acting beta agonists	56.0
Xanthines	1.8

*Includes the following drug identification numbers (DINs): 282286, 1928465, 2017555, 1927582; †Includes the following DINs: 2231431, 2221330, 2219468, 555649, 534609, 261238, 638641, 500895, 2049082, 2176084, 2230730, 2231671, 2218305, 2231679, 2231680, 2046113, 600784, 577308

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