Pediatric Pulmonology 32:101–108 (2001)

Original Articles

Prospective Study of the Patient-Level Cost of Asthma Care in Children

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Summary. Our objective was to assess the cost of asthma care at the patient level in children from the perspectives of society, the Ontario Ministry of Health, and the patient. In this longitudinal evaluation, health service use data and costs were collected during telephone interviews at 1, 3, and 6 months with parents of 339 Ontario children with asthma. Direct costs were respiratory-related visits to healthcare providers, emergency rooms, hospital admissions, pulmonary function tests, prescription medications, devices, and out-of-pocket expenses. Indirect costs were parents' absences from work/usual activities and travel and waiting time.

Hospital admissions accounted for 43%, medications for 31%, and parent productivity losses for 12% of total costs from a societal perspective. Statistically significant predictors of higher total costs were worse symptoms, younger age group, and season of participation. Adjusted annual societal costs per patient in 1995 Canadian dollars varied from $1,122 in children aged 4–14 years to $1,386 in children under 4 years of age. From the Ministry of Health perspective, adjusted annual costs per patient were $663 in children over 4 years and $904 in younger children. Adjusted annual costs from the patient perspective were $132 in children over 4 years and $129 in children under 4 years.

The rising incidence of pediatric asthma demands that greater attention be paid to the delivery of optimal care to this segment of the population. Appropriate methods must be used to analyze healthcare costs and the use of services in the midst of widespread healthcare reform. The quality of clinical and health policy decision-making may be enhanced by cost-of-illness estimates that are comprehensive, precise, and expressed from multiple perspectives. **Pediatr Pulmonol. 2001; 32:101–108.** © 2001 Wiley-Liss, Inc.

Key words: asthma; cost-of-illness; children; health services utilization; health care policy.

INTRODUCTION

The prevalence of asthma in children appears to be increasing in several countries.[1–3] In Canada, the 1990 Ontario Health Survey reported a prevalence of 5.6% in 12–14 year-olds.[4] More recently, the 1995–1996 Canadian Student Lung Health Survey reported a prevalence rate in 5–19 year-olds that varied from 10% in Sherbrooke, Quebec to 18% in Prince Edward Island.[5] The prevalence of pediatric asthma worldwide raises concerns regarding the availability of appropriate care and the consequences of health policy decisions that result in reductions to health services. Decision-making would be aided by studies that examine the utilization of healthcare services and the economic burden of illness. The cost of asthma has been investigated internationally,[6] and in Canada has been estimated at Canadian (Cdn) $504 million.[7] However, these studies were limited by retrospective designs and did not focus on childhood asthma. Given the changing epidemiology of asthma,

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Grant sponsor: Medical Research Council of Canada; Grant sponsor: Ciba Canada, Inc.; Grant sponsor: Hospital for Sick Children Research Institute; Grant sponsor: Ontario Ministry of Health; Grant sponsor: Glaxo Wellcome Canada, Inc.

This work was presented at the American Lung Association/American Thoracic Society Annual Meeting, Toronto, May 2000.

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Received 6 December 2000; Accepted 9 May 2001.

high-quality prospective assessments are required to assess the economic impact of this disease on the pediatric population.

The purpose of this study was to estimate the cost of asthma in children using a prospective approach. Prospective studies may be costly, take several years to complete, and require a sampling strategy that ensures generalizability of the results. They nevertheless retain important advantages over retrospective studies that rely on aggregate data from claims databases. These include the ability to collect data pertaining to medication use, time losses, and out-of-pocket expenses; the ability to assess the impact of demographic and disease-related factors on total cost; and the ability to quantify the precision of the point estimate with confidence intervals. Analyses were undertaken from the perspectives of society, the Ontario Ministry of Health, and the patient.

METHODS

Patient Sample

This research study focused on use of health resources reported by consecutive patients or caregivers filling prescriptions for bronchial inhalers in pharmacies in south central Ontario during the study period. The geographic sampling was designed to include urban and rural communities of various population densities. The project received ethics approval, and participants provided written consent. The methods used to recruit pharmacies and enroll subjects have been published elsewhere.[8] Pharmacists approached 3,074 eligible study candidates, of whom 2,078 consented, resulting in a 68% response rate. Of the consenting subjects recruited between May and October 1995, 1,588 persons successfully completed their 6-month interview by March 31, 1996. The 11-month recruitment plus follow-up period enabled data collection to capture seasonal variation in health service use. Among the 1,588 registrants who completed the study, 1,279 were classified as probable asthma patients: 940 were aged 15 years or more, and 339 were children under 15 years. This study focuses on the 339 pediatric enrollees. Probable asthma patients were those who had a prescription for a bronchial inhaler medication in the last month (bronchodilator or corticosteroid) and who reported experiencing shortness of breath (SOB), wheeze, or recurrent cough in the past.

ABBREVIATIONS

Cdn	Canadian
CI	Confidence interval
ED	Emergency Department
GP	General practitioner
LOS	Length of stay
MOH	Ministry of Health
N/A	Not applicable
SOB	Shortness of breath
US	United States

Data Collection

Parents of pediatric patients provided informed consent and underwent telephone interviews at 1, 3, and 6 months after registration. They reported on demographics, medication consumption, health services use, and symptom type and frequency related to the child's condition, using a proxy questionnaire. In rare circumstances, some of the older children (fewer than 10% of the sample) completed their own interviews, using the regular patient questionnaire. The telephone interview questions were worded and framed to concentrate specifically on respiratory-related resource use. Health services reporting consisted of respiratory-related visits to general/family practitioners (GP), pulmonologists, and pediatricians; emergency department (ED) visits not resulting in admissions; and hospital admissions. At the 1-month (baseline) interview, respondents recalled the child's use of health services for the prior 6 months (GP visits) or the prior 12 months (specialist visits, ED visits, and admissions). At subsequent interviews, the use of services that occurred since the previous interview (an interval of 2–3 months) was reported. The reliability of these recall intervals was demonstrated in previous studies.[9–11] The interviews included questions regarding complementary respiratory healthcare (care provided by naturopaths, chiropractors, and physiotherapists), respiratory health products and services requiring out-of-pocket payments, copayments for respiratory drugs and devices, transportation costs, parent productivity losses, and travel and waiting time to provide or get access to respiratory care for their child.[12]

Cost Measurement

Respiratory-related *direct* and *indirect costs* were assessed from the perspectives of society, the Ontario Ministry of Health, and the patient. The Ministry of Health represents the public healthcare system and does not include private sector health costs, such as medications, devices, and complementary health services. Summing the Ministry of Health and patient total costs is less than the societal total, since societal costs include all items, in both the public and private healthcare sectors, as well as indirect and out-of-pocket expenses. Costs were calculated by multiplying asthma-related utilization by the unit cost. Since the true value of resources consumed (opportunity costs) is not available for most services and products, prices and fees (excluding taxes) were used. Thus costs reflect charges, rather than opportunity costs. Measurements of heath resource utilization spanned periods that varied from 18 months to 6 months, depending on the type of healthcare

resource. All costs incurred by the parent were assigned to the patient and were adjusted to an annual rate per patient to facilitate interpretation.

In the societal perspective, *direct medical costs* consisted of asthma-related health services including publicly insured health services, privately insured complementary care, prescription medications and dispensing fees charged for pharmacy services, while *direct patient costs* were out-of-pocket expenses related to asthma care. *Indirect costs* consisted of parents' productivity losses resulting from disease-related child care, and travel and waiting time to access respiratory care. The Ministry of Health perspective included direct asthma-related medical costs paid for by the provincially administered health insurance program: physician services, ED visits, pulmonary function tests, hospital admissions, and the publicly insured portions of complementary medicine (chiropractice and physical therapy). The patient perspective comprised the parents' contributions to medication and device costs, noninsured health services, parents' out-of-pocket expenses, and personally incurred indirect costs (lost income). All costs were expressed in 1995 Canadian dollars.

The unit costs (prices) for each item were derived from fee schedules, the provincial drug formulary, case costing databases, and self-reports. The sources for each cost item are listed in Table 1. All prices used were those in effect at the time the health service was used. Average respiratory admission costs and average lengths of stay (LOS) were obtained for ICD9-CM code 493.00 (extrinsic asthma) from the Ontario Case Cost Project, a joint initiative of the Ontario Hospital Association and the Ontario Ministry of Health.[13] Admission costs included respiratory ward costs, in-patient medications, nursing services, laboratory and diagnostic tests, social work, and overhead (e.g., administration, housekeeping). The latter was allocated using the simultaneous equation allocation method. The fee for an inpatient specialist consultation was added.[14] Self-reported LOS were used for admissions reported at baseline, and case cost LOS values for subsequent admissions. The average total cost of an Emergency Department visit was previously estimated by the Chedoke-McMaster case-costing model.[7] Laboratory costs consisted of pulmonary function testing. Dispensing fees were assessed separately from the drug cost component from the societal and Ministry of Health perspectives. The customary dispensing fees of pharmacies where medications were purchased were obtained from the Ontario College of Pharmacists. Respiratory prescription drug prices were the best available price listed in the 1995 Ontario drug benefits formulary.[15] For prescription drugs not listed in the formulary, prices were obtained from a drug wholesaler. The annual cost of each medication was calculated by multiplying the estimated annual number of prescriptions by the cost per prescription. Information on changes to drug regimens and dosages was incorporated. The costs of each medication were summed to yield the total medication cost per patient. A 10% upcharge was added to reflect retail prices.[15] The costs for respiratory-related complementary health services (chiropractors, physiotherapists, homeopaths, naturopaths, and acupuncturists) were calculated by multiplying the reported number of sessions by the reported out-of-pocket expense per session. Fees for chiropractors and physiotherapists reimbursed by the provincial health plan were included in the Ministry of Health analysis.

Indirect costs (productivity loss) were measured as days lost from productive activity to care for a child with asthma, and to obtain treatment for the child's asthma, and travel and waiting time to access care. Indirect costs were measured by multiplying the total time loss by the

TABLE 1—Prices of Cost-of-Illness Items[1]

Item	Price/fee per service (1995 Cdn dollars)	Cost data source
General/family practitioner visit	1st visit, $51.40; additional visits, $16.25	Ontario Schedule of Benefits
Respiratory specialist visit	1st visit, $105.40; additional visits, $23.10	Ontario Schedule of Benefits
Emergency room visit	$120.00	Chedoke-McMaster Hospital
Hospital admission	$629 per diem	Ontario Case Cost Project
Spirometry	$31.90	Ontario Schedule of Benefits
Dispensing fee per prescription	$6.11–$11.49	ODB[1] formulary, Ontario College of Pharmacists
Prescription for medications	$0.30–$95.52	ODB formulary, drug/device wholesaler
Spacer[2]	$23.13 or $37.00	Drug/device wholesaler
Peak flow meter	$38.32	Drug/device wholesaler
Complementary services		
Out-of-pocket	$3.00–$100.00	Patient self-report
Insured	$9.65–$12.20	Ontario Schedule of Benefits
Travel to physician's office	$0.25–$32.00	Patient self-report
Exercise	Annual fee $12.00–$1,200.00	Patient self-report
Parent work/activity time loss (daily wage)	$17.66–$254.17	Patient self-report

[1]ODB, Ontario Drug Benefits Program.
[2]Spacer price was $23.13 for those aged 4–14 years and $37.00 for ages 3 and under.

parent's reported salary. The occupation classification dictated the weight of the productivity loss.[16] In the societal analysis, productivity losses of employed persons were valued at 1.0. Since no salaries are reported for unpaid labor categories, gender- and age-specific mean salaries of the study sample were used to impute values for nonlabor categories such as homemakers and the 15% of employed persons not reporting a salary. To recognize the value of unpaid labor and leisure time, the time losses of homemakers, the unemployed, students, retirees, and disability pensioners were valued at 0.4 rather than zero. The same approach was used for the patient perspective analysis; however, the productivity loss of employed persons who did not incur a loss in pay during a work absence was valued at zero.

Regression Analysis

Ordinary least squares regression was used to explore the impact of explanatory variables on costs. These variables included patient age group, gender, child smoking status, parent education, parent occupation, parent annual wages, drug plan availability, and season of participation, the latter assessed through the month of registration. Disease severity was also considered an important explanatory variable. The most recent National Asthma Education and Prevention Program guidelines recommend that disease severity be determined from clinical data, including symptoms and pulmonary function.[17] However, the choice of disease severity measure that should be used in observational research remains controversial.[18,19] In observational studies, access to medical charts is not available for assessment of pulmonary function. Medication use has been recommended as an alternative method for indicating asthma severity in observational research, alone[20] or in combinations with symptoms.[21,22] Since medications are a key component of the dependent variable of total cost, it would not be appropriate to assign a severity rating based on medication use. Thus symptom frequency alone was used to control for severity. Patients reported the daily frequency of shortness of breath, wheeze, and cough for a 4-week period prior to each interview. A continuous symptom frequency variable was derived based on the cumulative occurrence of all three symptoms over the three 4-week periods. Parent occupation may also be considered an important socioeconomic predictor of costs. However, since weights for the value of time losses were assigned based on occupation category, occupation was not an independent predictor of total costs and was excluded from the societal and patient perspective analyses. The distribution of costs was positively skewed due to very high costs occurring in a few patients. Each patient's unadjusted total costs were logarithmically transformed to approximate a normal distribution.[23] Multiple regression modeling determined which variables were statistically significant predictors of costs, using a *P*-value of 0.05 or less. Where main effects were significant, the Duncan test was used to perform pairwise tests of significance. The regression equations were used to determine the adjusted mean costs and 95% confidence intervals (CI). Log transformed costs and CI were retransformed using a retransformation factor.[23]

RESULTS

Sample Characteristics

Table 2 reports the annual utilization rate in patients using the service/resource. A mean of 11 prescriptions was filled per patient, comprised of two different types of medications. The 84 parents (25% of the sample) who reported a work/usual activity time loss experienced a mean loss of 5 days per year. Travel and waiting time loss was less than 1 day per year. Table 3 reports the sample characteristics. Most patients were male and aged 4–14 years. Most children (70%) used a bronchodilator and an inhaled anti-inflammatory medication, consisting of an inhaled corticosteroid or a mast-cell stabilizer. One or more respiratory-related physician visits (GP or specialist) were reported for 89% of patients. Most respondents were employed or homemakers. A large majority of families had medication insurance, although 41% of these were required to make copayments.

Cost Components

The contributions of the direct and indirect cost components from the perspectives of society, the Ministry of Health, and the patient are displayed in Table 4. From the *societal* perspective, the *unadjusted annual cost* was $1,220 per patient. The largest single

TABLE 2—Volume of Health Resource Utilization

Item	Number of patients reporting use of health resource	(%)	Average annual use in subgroup reporting use of health resource
General/family practitioner visit	271	(80)	3.6
Respiratory specialist visit	141	(42)	2.1
Emergency room visit	42	(12)	0.8
Hospital admission	31	(9)	1.0
Spirometry	91	(27)	1.0
Prescription refills	339	(100)	11.2
Types of prescription medications	339	(100)	2.3
Spacer	155	(46)	1.0
Peak flow meter	38	(11)	1.0
Complementary services	15	(4)	11.2
Travel to physician's office	83	(24)	5.5
Exercise	4	(1)	Not available
Parent work/activity absence (days)	84	(25)	4.8
Travel + waiting time (days)	272	(80)	0.7

TABLE 3—Pediatric Asthma Study Sample Characteristics (n = 339)[1]

Gender	M	213 (63)	General practitioner visits per year	None	67 (20)
	F	126 (37)		1–2	140 (41)
				3–5	95 (28)
Age (years)	<4	61 (18)		6+	37 (11)
	4–14	278 (82)			
			Respiratory specialist visits per year	None	198 (58)
Medications	BD alone	51 (15)		1–2	118 (35)
	IAI alnoe	49 (15)		3–5	15 (4)
	BD + IAI	224 (66)		6+	8 (2)
	BD + IAI + OC	15 (4)			
			Admissions in prior year and 6-month follow-up	None	308 (91)
Physician visit	Yes	301 (89)		1+	31 (9)
	No	38 (11)			
			ED visits in prior year and 6-month follow-up	None	297 (88)
Occupation of parent	Employed full-time	93 (27)		1+	42 (12)
	Employed part-time	89 (26)			
	Unemployed	11 (3)	Annual salary of (n = 182) employed parents	Less than $20,000	55 (30)
	Homemaker	98 (29)		$20,000–$30,000	34 (19)
	Student	43 (13)		$30,000–$40,000	25 (14)
	Disability pensioner	5 (2)		$40,000–$50,000	19 (10)
				$50,000–$60,000	12 (7)
Private drug plan	Yes	305 (90)		More than $60,000	10 (6)
	No	34 (10)		Unknown	28 (15)

[1]Percentage in parentheses (may not add to 100 due to rounding). BD, bronchodilator; IAI, inhaled anti-inflammatory (included inhaled corticosteroids and mast-cell stabilizers); OC, oral corticosteroid; ED, emergency department.

component was hospital admissions, accounting for 43% of the total. Taken together, medications and dispensing fees contributed 31% of total costs. Indirect (productivity) costs consisting of time losses from work, usual activities, and travel and waiting time accounted for 12% of the total cost of asthma from the societal perspective. The unadjusted *annual cost from the Ministry of Health* perspective was $676 per patient. The largest cost component was hospital admissions, accounting for 77% of the total. Physician services (GP, specialist, and ED) comprised 21% of Ministry of Health costs. From the patient perspective, medication costs, which consisted of the full price of drugs plus dispensing fees for the uninsured and copayments for persons with a drug plan, were the largest component, accounting for 49% of the unadjusted annual total of $135 per person. Indirect costs related to parent productivity losses constituted 44% of total costs from the patient perspective.

TABLE 4—Annual Cost per Child With Asthma by Component[1]

	Societal		MOH		Patient	
Component	Cost ($)	% of total	Cost ($)	% of total	Cost ($)	% of total
Direct						
Family physician	75	6	75	11	N/A	
Specialist	54	4	54	8	N/A	
Emergency room	12	1	12	2	N/A	
Admissions	522	43	522	77	N/A	
Pulmonary function tests	8	1	8	1	N/A	
Dispensing fees	110	9	N/A		N/A	
Medications	270	22	N/A		66	49
Devices	16	1	N/A		2	2
Complementary	6	<1	5	<1	1	1
Out-of-pocket	6	1	N/A		6	5
Total direct	1,079	88	676	100	76	56
Indirect	141	12	N/A		59	44
Total costs	1,220	100	676	100	135	100

[1]N/A not applicable; MOH, Ministry of Health. All costs are in 1995 Canadian dollars.

Cost-of-Illness Analysis

From the societal viewpoint, symptom frequency, age group, and season were significant explanatory variables in the multiple regression model. The patient's gender was not significant. As seen in Table 5, the annual cost per patient for children under 4 years was $1,386 (95% CI, $1,210–$1,588), and was statistically significantly higher than the cost per older child, i.e., $1,122 (95% CI, $1,041–$1,210). With respect to season, children enrolled in August and followed for 6 months were exposed to late summer allergens. These children experienced a mean cost of $1,647 (95% CI, $1,399–$1,938), which was significantly higher than the cost for children who were enrolled in November, i.e., $1,032, (95% CI, $828–$1,286).

Annual costs to the Ministry of Health were dependent on symptom frequency and age group. Gender, drug plan availability, season of participation, and parent's occupation were not significant explanatory variables. The effect of age group was the same as the societal analysis, with children under 4 years of age demonstrating significantly higher costs than older children.

Symptom frequency was the one significant explanatory variable from the patient perspective, as annual costs per patient were similar in the two age groups. As the patient perspective is chiefly comprised of out-of-pocket expenses, these costs do not capture age-related differences in healthcare system resource consumption.

DISCUSSION

The societal analysis revealed that *admissions* were the highest component of total costs (43%), followed by *medications* (31%). Trends toward reduced lengths of stay and more aggressive therapy with inhaled corticosteroids and new therapies such as leukotriene antagonists may cause shifting of the cost distributions in the future. Regression analysis revealed significantly higher societal costs for children under 4 years compared to older children and for those with more symptomatic asthma. Higher costs were also associated with the late summer and fall compared to the winter months.

The unadjusted direct medical costs observed in children in this study ($1,079) were similar to those observed for adults participating in the same study ($1,280).[12] In contrast, annual societal indirect costs were much larger in the adult cohort ($1,270) than in the pediatric group, reflecting the higher value placed on the lost time of employed persons compared to homemakers, as well as the greater number of lost productivity days reported by adult patients compared to parents of children with asthma (23 vs. 5).[12,24] In this study, homemakers' time was conservatively valued at 0.4 of the gender- and age-specific mean wage of the sample. There is disagreement over the appropriate method for valuing productivity costs. Weighting the time losses of unpaid labor equivalent to 1.0 would increase the indirect cost contribution. The use of alternative methods, such as the market value or the opportunity cost approach, may also have resulted in higher indirect costs.[16,25] By presenting the indirect costs in a disaggregated manner, the reported time losses can be compared to other studies, regardless of the methods used to assign a monetary value to the time loss.

Few asthma cost-of-illness studies have been conducted in children.[26–29] Marion et al. examined pediatric costs in 25 families between 1977–1980.[27] From a societal perspective, direct costs were United States (US) $941 per family (approximately Cdn $1,344), and indirect costs were US $147 (approximately Cdn $210). As in this study, indirect costs were calculated from parental productivity losses, but assigned no value to time losses incurred by unpaid caregivers, such as homemakers. Using data from the 1987 U.S. National Medical Expenditures Survey, a U.S. study[28] estimated the direct medical cost per child, with asthma at US $171 (approximately Cdn $244). In a study in 177 Swiss children with asthma, total direct costs were 793 Swiss francs (approximately Cdn $704), but this excluded ED visits.[26] Indirect costs were 30 Swiss francs (approximately Cdn $27), but like the study by Marion et al.,[27] no values were assigned to time losses of unpaid homemakers. An Australian (A) study estimated out-of-pocket expenditures for asthma from the family perspective at A $212 (approximately Cdn $169), which was similar to the costs observed from the patient perspective in the present study.[29] Like the present study, the Australian study found an increase in costs with increasing disease

TABLE 5—Adjusted Annual Cost of Asthma per Child

	Society			MOH			Patient		
Age (years)	Cost ($)	95% CI		Cost ($)	95% CI		Cost ($)	95% CI	
<4	1,386	1,210	1,588	904	810	1,013	129	91	182
4–14	1,122	1,041	1,210	663	630	701	132	112	155

[1]MOH, Ministry of Health; CI, Confidence interval. Estimates from the societal perspective are adjusted for symptom frequency, age group, and season. Estimates from the Ministry of Health and patient perspectives are adjusted for symptom frequency and age group. All costs are in 1995 Canadian dollars.

severity. The positive correlation between cost of illness and severity was previously observed in adults.[12,19]

The present study used actual time losses reported by parents to estimate indirect costs. Several population-based studies that included children assumed that a day of school absence was equivalent to a day of parental work loss.[7,30] Using school absences to represent parental productivity loss may overestimate indirect costs, since no more than 25% of the parent sample in this study reported a productivity loss associated with asthma-related child care. Comparisons between cost-of-illness estimates from different countries are greatly complicated by differences in the organization and financing of healthcare systems. A more transparent variable for determining the similarity of patient populations and hence the generalizability of findings is the volume of health service use. In this study, 89% of parents reported an asthma outpatient physician visit for their child over an 18-month reporting period, compared to a range of 65–81% reported over 12 months in the 1995–1996 Canadian Student Lung Health Survey (SLHS),[5] and rates of 87% for 0–4 years of age and 69% for 5–14 years of age reported over 12 months in the 1993–1995 U.S. National Center for Health Statistics (NCHS) asthma surveillance report.[1] The present study observed an ED visit rate of 12% over 18 months compared to rates of 10–35% in the SLHS[5] and rates of 21% and 11% for 0–4-year-olds and 5–14-year-olds, respectively, in the NCHS report.[1] Asthma hospital admissions were reported by 9% of parents over age 18 months in the present study, compared to annual rates of 2–6% in the SLHS,[5] 4% in the 1994–1995 Canadian National Longitudinal Survey,[31] and 9% and 3% for US 0–4-year-olds and 5–14-year-olds, respectively.[1]

Several limitations were present in this study. While the study did not draw a random sample of respiratory patients from the population, the sampling plan included pharmacies based in low-, medium-, and high-density population regions, and pharmacists enrolled consecutive patients as much as possible. Because of the diversity of the patient population enrolled, the community pharmacy-based approach used in this study is superior to a study limiting enrollment to physicians' practices or a single health plan. Generalizability of the findings to larger Canadian and US pediatric populations with asthma is supported by the similar rates of asthma-related outpatient physician visits, ED visits, and hospital admissions observed between the present study and Canadian and US surveys of children with asthma. While pharmacists were encouraged to enroll all eligible patients into the study, it is possible that patients with mild disease were not well-represented, since a prescription for an asthma medication was required at entry. The costs of children who have not been diagnosed were not reflected, and their economic burden remains unknown. Another challenge was establishing an asthma case definition in the absence of clinical information. The use of entry criteria based on symptoms and inhaler use to define probable asthma may have resulted in the inclusion of some cases of acute bronchitis and children with brief episodes of wheezing and upper respiratory tract infections. The inclusion of some cases representing transient respiratory conditions rather than chronic asthma would result in an underestimate of the actual cost of asthma. Analysis was limited to a 1-year period. Although not long enough to project long-term costs of this chronic disease, the study period enabled detection of seasonal variation. While the costs associated with premature mortality were omitted, fatal pediatric asthma remains rare in Canada.[32] All health service use data were derived from parent proxy reports. In a separate investigation, the reliability of self-reports from adults with asthma was found to depend on the type of health service, and was high for admissions and visits to specialists.[33] As parents are responsible for their child's access to healthcare, it is reasonable to speculate that proxy reports exhibit similar reliability. A number of items were missing from the cost-of-illness analysis, including ambulance services and home care. These contributed to less than 1% in the retrospective Canadian population study.[7] Finally, this study did not measure the psychosocial cost of asthma. Including a pediatric quality-of-life measure or an assessment of school absences might have provided insight into the intangible cost of this disease.

The rising incidence of pediatric asthma demands that greater attention be paid to the delivery of care to this population. At the same time, healthcare systems in North America are restructuring, moving away from fee-for-service to managed care and capitation models. It is imperative that appropriate methods be used to analyze healthcare costs and the use of services in the midst of widespread reform. This study used a comprehensive, prospective approach to measuring the patient-level cost of asthma in children. The prospective design enabled the identification of the significant determinants of cost and the extent of variation. The research also revealed the burden of indirect costs on the patient's family and on society, costs which may increase in the face of shifts from institutional to home care. By providing a detailed description of the cost-of-illness and the utilization of health services from various perspectives, this research may assist clinical and policy decision-makers to develop optimal disease management strategies and allocation of scarce healthcare funds.

ACKNOWLEDGMENTS

W.J.U. was supported by a Medical Research Council of Canada fellowship co-sponsored by Ciba Canada and

the Hospital for Sick Children Research Institute. P.C.C. was supported by grants from the Ontario Ministry of Health to the Institute for Clinical Evaluative Sciences, to the Hospital Management Research Unit, and to the Arthritis Community Research and Evaluation Unit. The study was supported by grants from Ciba Canada, Inc., and Glaxo Wellcome Canada, Inc.

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