

DIRECT AND INDIRECT COSTS OF ASTHMA IN CANADA, 1990

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Abstract • Résumé

Objective: To calculate the direct and indirect costs of asthma in Canada.

Design: Cost-of-illness study.

Setting: Canada.

Patients: All Canadians receiving inpatient or outpatient care for asthma in 1990.

Outcome measures: Direct costs incurred by inpatient care, emergency services, physician and nursing services, ambulance use, drugs and devices, outpatient diagnostic tests, research and education. Indirect costs from productivity loss due to absence from work, inability to perform housekeeping activities, need to care for children with asthma who were absent from school, time spent travelling and waiting for medical care, and premature death from asthma. All costs are in 1990 Canadian dollars.

Results: Depending on assumptions, the total cost of asthma was estimated to be between \$504 million and \$648 million. Direct costs were \$306 million. The single largest component of direct costs was the cost of drugs (\$124 million). The largest component of indirect costs was illness-related disability (\$76 million).

Conclusions: Annual costs of treating asthma are comparable to the individual cost of infectious diseases, hematologic diseases, congenital defects, perinatal illnesses, home care and ambulance services. Asthma costs may increase in the future, given current morbidity and mortality trends. Further evaluation of the effectiveness and cost-effectiveness of available asthma interventions in addition to aggregate cost data are required to determine whether resource allocation for the treatment of asthma can be improved.

Objectif : Calculer les coûts directs et indirects de l'asthme au Canada.

Conception : Étude sur le coût de la maladie.

Contexte : Canada.

Patients : Tous les Canadiens qui ont reçu des soins contre l'asthme en service externe et interne en 1990.

Mesures des résultats : Coûts directs entraînés par les soins hospitaliers, les services d'urgence, les services médicaux et infirmiers, l'utilisation d'ambulances, les médicaments et les instruments, les tests de diagnostic chez les patients externes, la recherche et l'éducation. Coûts indirects causés par la perte de productivité découlant de l'absentéisme, l'incapacité d'exécuter des tâches ménagères, l'obligation de s'occuper d'enfants asthmatiques absents de l'école, le temps consacré aux déplacements et à l'attente de soins médicaux et les décès prématurés causés par l'asthme. Tous les coûts sont en dollars canadiens de 1990.

Résultats : Selon les hypothèses, le coût total de l'asthme est estimé entre 504 et 648 millions de dollars. Les coûts directs se sont établis à 306 millions de dollars. L'élément le plus important des coûts directs était le coût des médicaments (124 millions de dollars). Celui des coûts indirects était l'incapacité liée à la maladie (76 millions de dollars).

Conclusions : Les coûts annuels du traitement de l'asthme sont comparables au coût individuel des maladies transmissibles, des maladies hématologiques, des malformations congénitales, des maladies périnatales, des soins à domicile et des services ambulanciers. Les coûts de l'asthme pourraient augmenter à l'avenir compte tenu des tendances actuelles de la morbidité et de la mortalité. Une évaluation plus poussée de l'efficacité et du rapport coût-efficacité des interventions anti-asthmatiques disponibles, outre les données globales sur le coût, s'impose pour déterminer s'il est possible d'améliorer l'affectation des ressources consacrées au traitement de l'asthme.

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Asthma is a major and increasing cause of morbidity and mortality worldwide.¹⁻⁸ In Canada researchers have reported that the incidence and prevalence rates of asthma,⁹ asthma-related deaths^{10,11} and rates of hospital admissions because of asthma¹⁰ have all been increasing.

Asthma affects not only the health but also the wealth of Canadians. Cost-of-illness studies attempt to characterize the economic burden of disease by quantifying the resources applied to research, diagnosis and treatment, as well as estimating productivity losses caused by illness-related work absence and premature death.¹²⁻¹⁹ Previous studies have measured the economic burden of asthma in the United States,²⁰⁻²⁶ Australia,²⁷ Sweden²⁸ and the United Kingdom,²⁹ but no such study has been carried out in Canada.

We performed a cost-of-illness study of asthma in Canada. In so doing, we have identified Canadian stakeholders in asthma decision making, characterized areas of particularly heavy resource utilization and supplemented economic appraisals of asthma interventions by providing an aggregate estimate of achievable cost savings.

METHODS

FUNDING

Funding for this project was provided in part by Glaxo Canada Inc., the manufacturer of a number of anti-asthma drugs. The terms of the contract were determined after we proposed the initial study design, and we retained the right to control entirely the methods, conclusions and means of publication of the study.

DATA SOURCES

Three surveys provided valuable information on asthma-related disability and resource utilization. The Canada Health Survey³⁰ covered the noninstitutionalized Canadian population, excluding people in the Northwest and Yukon territories, remote areas and reserves (who accounted for 3% of the population). Data from the Canada Health Survey were adjusted for unsampled areas and estimated population growth between 1979 and 1990.

The Ontario Health Survey, performed in 1990 (unpublished), sampled households throughout Ontario. More comprehensive than the Canada Health Survey, the Ontario Health Survey also gathered information on demographic characteristics, risk factors, health status and health resource utilization.

The Canadian Disease and Therapeutic Index complementary audit³¹ gathered data on the practice patterns of 652 of Canada's 43 000 office-based physicians. Selected physicians from all specialties and geographic re-

gions kept a log of visit location, diagnosis, and drug or device mention (prescription, hospital order, dispensing recommendation or administration) for 2 days in each of four consecutive quarters.

ECONOMIC ASSUMPTIONS

We estimated costs incurred by all patients in Canada with asthma in 1990. Our analysis is therefore a prevalence-based rather than an incidence-based study.^{17,32} We calculated costs in 1990 Canadian dollars. When 1990 data were not available we adjusted for inflation using the consumer price index for medical care or all items.

Indirect costs, or lost productivity associated with morbidity and premature death, were valued using the human capital method.^{12,14,18,33,34}

We used a range of data sources and assumptions to quantitatively estimate the degree of uncertainty associated with each component of costs. For each cost category, we used the lowest cost estimate as our baseline value and the highest estimate as our high value.

DIRECT COSTS

Inpatient care

We estimated expenditures on inpatient care for asthma by multiplying the number of days of hospital care provided to all Canadian patients with asthma³⁵ by the adjusted average cost per inpatient day. The average cost per inpatient day was calculated using service volume and aggregate cost data from Statistics Canada for all public hospitals.³⁶ We adjusted inpatient costs to correct for the contribution of outpatient and emergency services using the method of MacLean and Mix,³⁷ inflated to 1990 dollars using the consumer price index for medical care and then adjusted for drug costs by subtracting the average drug cost per inpatient day for public hospitals.³⁶

Emergency visits

The number of emergency visits during 1988-89 in general and pediatric hospitals³⁸ was multiplied by the estimated proportion of all emergency visits due to asthma.^{39,40} We also calculated emergency use by multiplying the proportion of respondents in the Ontario Health Survey with probable asthma (i.e., those who almost certainly had asthma) who had emergency visits within the previous 12 months by the mean number of visits per respondent with asthma.

Statistics Canada's estimate of the average cost per visit to the emergency department (\$23) was judged to be a gross underestimate of true costs.³⁸ Instead, we used the average cost for all emergency visits at the Che-

doke-McMaster Hospitals (\$120) (Ron Goeree, Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, Ont.: personal communication, 1994). This value includes all overhead and ancillary costs but excludes drug costs.

Physician services

The number of physician services and their aggregate cost were estimated from asthma-related medical claims data for 1990 in Manitoba (Manitoba Health, Winnipeg: unpublished data). We generated estimates for Canada by adjusting for differences in provincial reimbursement schedules (payment schedule comparison, all Canada and Ontario statistics, Health Information Branch, Department of National Health and Welfare, Ottawa: unpublished data, July 1990). Additional estimates, including our upper-limit estimate, were obtained from the Ontario Health Survey and the Canadian Disease and Therapeutics Index complementary audit.⁴¹

Nursing services

We used data from section A of the Ontario Health Survey to calculate the frequency of outpatient nursing services provided to patients with asthma. The hourly cost of nursing services (\$20.48) was estimated from the median of the salary range of registered, general-duty nurses in Canadian hospitals and adjusted for benefits and interprovincial wage differentials (Canadian Nurses Association, Ottawa: unpublished data from collective agreements).

Ambulance use

From discussions with asthma specialists we assumed that 5% of asthma-related emergency visits would require use of an ambulance. The 1993 cost of ground ambulance transportation for emergent illness in Ontario (Ontario Ministry of Health, Toronto: unpublished data) was deflated to 1990 dollars (\$276).

Drugs

The wholesale cost of drugs used by patients with obstructive-airways disease (β_2 -adrenergic agonists, ipratropium bromide, theophylline preparations, sodium cromoglycate and inhaled corticosteroids) was determined from validated⁴² market data.⁴³ The average dispensing fee for Canadian prescriptions was added to the cost of outpatient pharmacy sales⁴⁴ to determine aggregate drug costs.

The proportion of pharmaceutical sales by category attributable to asthma was calculated by determining the proportion of overall drug appearances (prescription or mention of a drug) associated with a diagnosis of asthma in

the Canadian Disease and Therapeutic Index complementary audit.⁴¹ Since drug appearances do not correlate precisely with prescriptions, and since the number of individual prescriptions may vary according to the diagnosis, there is some uncertainty associated with these estimates.

Devices

An estimate of the overall market size of \$11 million for devices used in the treatment of obstructive-airways disease (spacers, nebulizers, peak-flow meters, compressors, masks, hand-held ultrasonic devices) was derived from private-sector marketing data (Devilbiss Corporation, Barrie, Ont.: unpublished data). From discussions with private-sector experts, we assumed that 40% of overall sales were to patients with asthma.

Outpatient diagnostic tests

We retrieved Ontario Health Insurance Plan (OHIP) billing data to estimate the total number of pulmonary function and allergy tests performed in Ontario in 1990. We asked asthma specialists to provide an estimate of the proportion of each type of service provided to asthma outpatients. OHIP reimbursement rates, adjusted for interprovincial reimbursement differentials, were used to calculate aggregate Canadian costs.

Research and education

We estimated the cost of asthma-related research, including peer-reviewed research, support for students and research fellows, and pulmonary units, from the Medical Research Council of Canada's Reference List of Health Science Research.⁴⁵ We also surveyed the manufacturers of asthma drugs to estimate separately the cost of industry-supported research, although such costs are captured in the "drug cost" category.

Most asthma education is provided by nurses, physicians and respiratory technologists and is therefore also accounted for in other cost categories. The Canadian Lung Association provided an estimate of the cost of paid public lectures, brochures and other public education activities not accounted for elsewhere (A. Les McDonald, Canadian Lung Association, Ottawa: personal communication, 1994).

INDIRECT COSTS

Morbidity costs

The number of days lost to both short-term and long-term asthma-related disability were abstracted from the Canada Health Survey, which described activity loss in

the 2 weeks before the survey. The number of bed-days, days of major activity loss (MAL) (i.e., days that were not bed-days but during which the patient was unable to perform major activities, including work, housekeeping or school) and "cut-down" days (days during which activities were restricted) were assigned weights of 1, 1 and 0.5 respectively. All data from the Canada Health Survey were adjusted for unsampled areas and estimated population growth between 1979 and 1990.

We obtained another estimate of the cost of disability using questions 10 through 15 of the Ontario Health Survey. Both the Canada and the Ontario health surveys provided information about the proportion of patients with disability who were employed, keeping house and attending school.

Disability among patients residing in health care institutions was estimated from the Health and Activity Limitation Survey.⁴⁶ We tabulated the number of disability days but conservatively assumed that there was no productivity loss for these patients (i.e., indirect cost = 0) because few of these people would be working or keeping house.

The 1990 industrial aggregate of average weekly earnings,⁴⁷ adjusted for labour-force participation,⁴⁸ was used to value productivity loss due to absence from work (\$508 per week). Average weekly earnings for those employed in full-time domestic work,⁴⁸ adjusted for the differential in number of hours worked between domestic workers in and out of the labour force,⁴⁹ were used as an estimate of the productivity value of housekeeping services (\$278 per week).

Workers' compensation and disability payments

Compensation payments made to people with disability do not represent costs, direct or indirect, but rather transfer payments. Nevertheless, we tabulated data on workers' compensation payments (obtained from the Workers' Compensation Board of Ontario, Toronto, the Workers' Compensation Board of British Columbia, Vancouver, and the Commission de la Santé et de la Sécurité de travail du Québec, Quebec City), on unemployment insurance claims (obtained from CEIC Yardstick System, Employment and Immigration Canada, Ottawa) and on Canada and Quebec pension plan disability payments for asthma (obtained from the master benefit file, Department of National Health and Welfare, Ottawa, December 1991, and the Régis des rentes du Québec, Quebec City) for the purposes of comparing this information with that from previously published studies.

School days

We conservatively assumed that the caretakers of asthmatic children were women and that each bed-day

or MAL day and half of all cut-down days of a child in school were associated with a day of lost productivity for the caretaker. Productivity loss for caretakers was valued according to their primary occupation. The proportion of women between the ages of 25 and 49 who were employed (78%) was provided by labour force data.⁴⁸

Travelling and waiting time

We conservatively assumed that each outpatient visit consumed 1 hour of travelling and waiting time, that each emergency visit consumed 3 hours and that one third of all visits occurred during working hours. Ontario Health Survey data were used to predict the occupation of those receiving outpatient services. We also calculated productivity loss under more generous estimates of time loss (2 hours per outpatient visit and 5 hours per emergency visit) to arrive at an upper-limit estimate.

Asthma-related death

Canadian asthma mortality rates and age at time of death were used to predict the number of life-years lost because of asthma-related death.⁵⁰ We calculated productivity loss by multiplying life-years lost by the productivity value of each life-year. Productivity values for employed people were predicted from the industrial aggregate of average weekly earnings and from the proportion of people in each age and sex group who were employed. The proportion of men and women who reported their main activity as "managing the home" or "caring for children" in a Statistics Canada Labour Force Survey⁴⁸ and the value of housekeeping services (described earlier) were used to calculate lost housekeeping productivity. The net present value of the stream of lifetime earnings was calculated, after adjustment for lost life-years, sex, an annual 2% productivity gain and a discount rate of 5%.⁵¹

UNMEASURED COSTS

We were unable to measure the full cost of outpatient diagnostic services (x-rays and blood tests) and the costs of some drugs (e.g., orally administered corticosteroids, over-the-counter drugs and immunosuppressive drugs). The cost of lost productivity for caregivers of adults with asthma was not tabulated, nor could we value future productivity losses due to school absence because of asthma-related childhood morbidity.^{6,52,53} In addition, we could not measure the contribution of asthma as a comorbidity factor to other cardiorespiratory diseases, or the cost of complications from long-term asthma treatment (e.g., corticosteroid-induced cataracts, hip fractures and osteoporosis).

Table 1: Utilization and unit costs for asthma in Canada in 1990*

Category	Unit	Utilization		Cost, \$	
		No. of units (1000s)	Source of data	Per unit†	Source of data
Hospital inpatient care	Bed-days	281	Statistics Canada ³⁵	300	Statistics Canada ³⁶
Emergency visits	Visits	182	Emergency department data ³⁸⁻⁴⁰	120	CHEPA
		697	OHS		
Physician services	Services	2 024	MH	NA	
		2 122	OHS		
		3 625	IMS Canada ³¹		
Nursing services	Hours	16	OHS	20	CNA
Ambulance services	Ground transportation services	9		276	MOH
Drugs	Drug mentions in audit data		Market reports ⁴²⁻⁴⁴		
	β ₂ -adrenergic agonists	2 778		NA	
	Ipratropium bromide	185		NA	
	Theophylline preparations	834		NA	
	Sodium cromoglycate	257		NA	
	Inhaled corticosteroids	1 068		NA	
Outpatient diagnostic tests	PFT	190	OHIP	NA	
	Allergy tests	17 041	OHIP	NA	
Disability (noninstitutionalized)	MAL days‡	1 348	CHS	102§	Statistics Canada ⁴⁷
		1 281	OHS	56§	
	Cut-down days‡	2 859	CHS	51§	
		5 802	OHS	28	
Disability (institutionalized)	Disability days	302	Statistics Canada ⁴⁶	0¶	
School days	MAL days	805	CHS	102§	Statistics Canada ⁴⁷
		791	OHS	56	
Travelling and waiting	Hours	3 770	OHS	13§	Statistics Canada ⁴⁷
				7	
Death	Asthma-related deaths	505**	Statistics Canada ⁵⁰	109 000	Statistics Canada ⁴⁷
Workers' compensation and disability payments	Compensation claims				
	WCB	222**	WCB	7 243	
	CPP	1 707**††	CPP	573††	
	RRQ	1 006**††	RRQ	494††	
	EIC	618**	EIC	1 990	

*WCP = Workers' Compensation Board, CPP = Canada Pension Plan, RRQ = Régis des rentes du Québec, EIC = Employment and Immigration Canada, OHS = Ontario Health Survey, CHEPA = Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, Ont., MH = Manitoba Health, CNA = Canadian Nurses Association, MOH = Ontario Ministry of Health, PFT = pulmonary function tests, OHIP Ontario Health Insurance Plan, MAL = major activity loss, CHS = Canada Health Survey.

†Costs are in 1990 Canadian dollars. NA = not applicable (no standardized unit cost applies to this item because multiple unit costs were used to calculate total category cost).

‡See Methods section for explanation.

§Unit cost related to absence from work.

||Unit cost related to inability to perform housekeeping.

¶See the Methods section (Morbidity costs) for an explanation.

**Values in this category represent actual number of deaths or compensation claims.

††Average number of claims per month, or average monthly reimbursement.

RESULTS

A detailed description of utilization and unit cost vectors is provided in Table 1. Utilization estimates varied widely for some categories, including emergency visits, physician services and cut-down days associated with asthma disability. Data from the Canada Health Survey and the Ontario Health Survey tended to yield similar national utilization projections, but those from other sources often differed significantly from the survey data.

Our conservative estimate of the total cost of asthma in Canada in 1990 was \$504 million (Table 2), with an

Table 2: Direct and indirect costs of asthma in Canada in 1990

Category	Cost estimate, \$ million*	
	Baseline	High
Direct costs		
Inpatient care	84.4	84.4
Emergency visits	21.8	83.7
Physician services	46.6	83.4
Nursing services	0.3	0.3
Ambulance services	2.5	2.5
Drugs	124.0	124.0
Devices	4.4	4.4
Research		
Peer reviewed	1.2	1.2
Industry funded†	7.5	7.5
Community health education	1.8	1.8
Outpatient diagnostic tests	19.4	19.4
Subtotal	306.3	405.1
Indirect costs		
Disability (noninstitutionalized)	75.8	97.6
Disability (institutionalized)	0‡	0‡
Absence from school	55.1	69.6
Travelling and waiting time	12.0	20.6
Death	54.8	54.8
Subtotal	197.7	242.6
Workers' compensation and disability payments	20.6	20.6
Total	504.0	647.7

*Costs are in 1990 Canadian dollars. Baseline estimates are derived from the lowest available value for each utilization and unit cost vector; high estimates are from the highest available value.

†Estimates are incomplete because some pharmaceutical manufacturers did not provide cost estimates for research. Industry-funded research does not appear in total costs, since these costs are represented in other categories.

‡See the Methods section (Morbidity costs) for an explanation.

||Workers' compensation and disability payments represent transfer payments rather than costs (resource consumption) and therefore are not included in the column totals.

upper-limit estimate of \$648 million. We estimated that 61% of all asthma costs (\$306 million) were direct costs. Drug costs were by far the single largest component of direct costs, followed by hospital inpatient care and physician services. Costs for outpatient services provided by nurses, for ambulance and emergency services, and for research accounted for relatively small proportions of the aggregate cost.

Illness-related disability was the largest contributor to indirect costs, almost 38% higher than the next greatest component, productivity loss related to school absence. The cost of all morbidity-related productivity loss (absence from work, inability to do housekeeping, need to care for children absent from school, and waiting and travelling time) was \$143 million, nearly three times higher than the cost of productivity loss due to premature death.

Using the adjusted estimates of Wigle and associates³⁴ as a standard for comparison, we calculated that the total cost of asthma (\$504 million) represented 0.4% of the total economic burden of illness in Canada and 7.1% of the burden of respiratory illness. The cost of asthma was similar to the cost of all infectious diseases (\$772 million), hematologic diseases (\$486 million), congenital defects (\$673 million) and perinatal illness (\$532 million), but it was much lower than the cost of cardiovascular disease (\$7742 million) and cancer (\$11 189 million). The cost of asthma was also approximately equal to the annual budget of a large downtown teaching hospital in Toronto (Toronto Hospital: unpublished data) and roughly equal to annual national expenditures on home care (\$640 million), ambulance services (\$660 million) and chiropractic services (\$528 million) (*Health Expenditures in Canada: Fact Sheets, Policy, Planning and Information Branch, Health Canada, February 1993*).

Fig. 1 shows how the cost of asthma compared with the cost of other respiratory diseases and of all diseases. The proportion of the total cost accounted for by hospital care (including emergency services) and physician services was approximately the same for asthma, other respiratory diseases and all diseases. The proportion accounted for by drugs, however, was strikingly higher for asthma.

Only 0.2% of all asthma costs, and 0.4% of direct costs, were accounted for by non-industry-funded research (Fig. 2). These figures were slightly higher than the proportion accounted for by all respiratory research but lower than that accounted for by research into many other diseases, including hematologic diseases and endocrine diseases.

DISCUSSION

Cost analysis is an inexact science. Both measurement

error and methodologic disagreement introduce uncertainty into the estimates. Recall bias may affect data obtained from survey estimates. Inadequate sampling from regional data may skew aggregate cost estimates. Imprecision or inconsistency in the definition of asthma may affect questionnaire data, medical claims data, mortality data and dispensing data.⁵⁴⁻⁶¹ Finally, disagreement about costing methods, particularly methods of determining

indirect costs, make it difficult to compare estimates from different cost-analysis studies.

We attempted to account for potential error by adopting conservative estimates of costs and, when possible, obtaining cost estimates from multiple sources. For many cost categories, a range of estimates was available that quantitatively characterized the uncertainty associated with individual cost estimates.

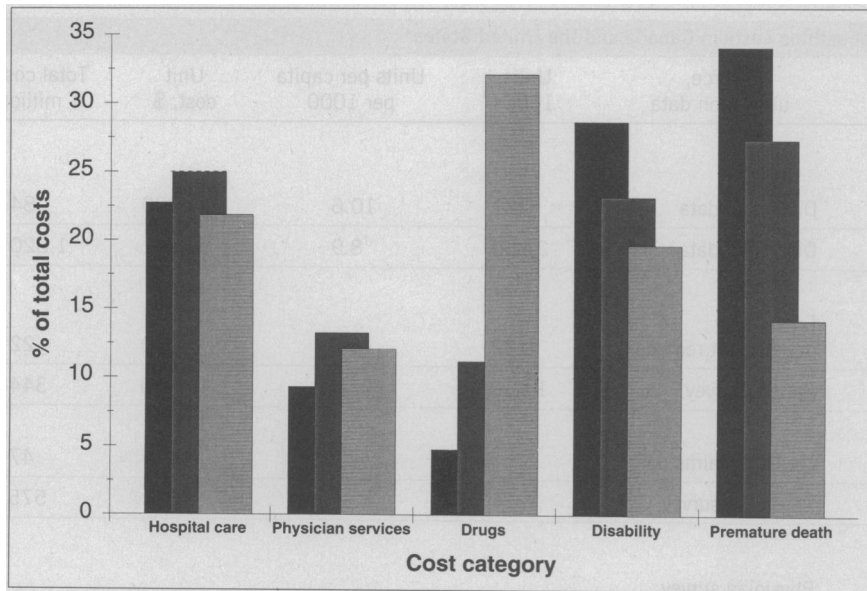


Fig. 1: Costs of asthma (lightly screened bars), other respiratory diseases (medium screened bars) and all diseases (black bars) in Canada in 1990, by cost category. Costs for other respiratory diseases and all diseases were obtained from the study by Wigle and associates.³⁴ Hospital care = inpatient, outpatient and emergency care; physician services = services by physicians for inpatient and outpatient care; disability = productivity loss due to absence from work and inability to perform housekeeping activities. Costs not included in the study by Wigle and associates are excluded here.

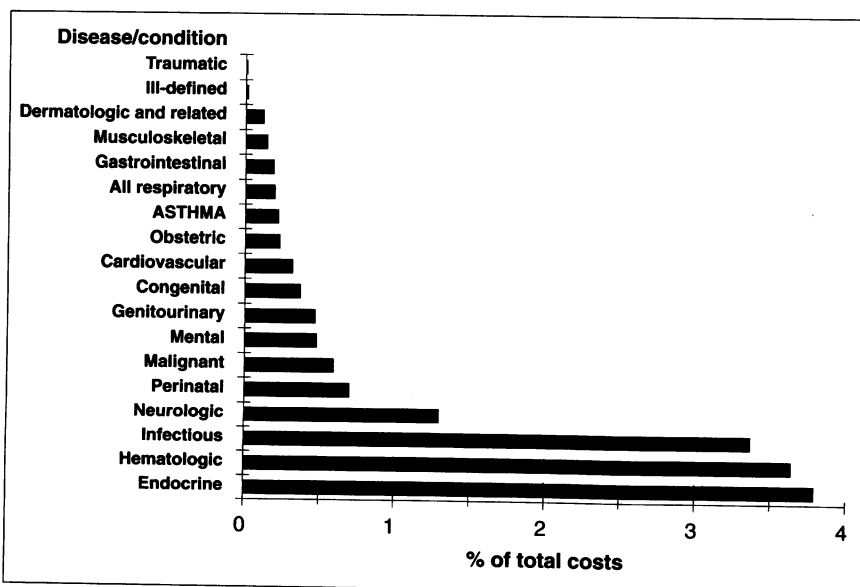


Fig. 2: Proportion of total costs of illnesses and conditions accounted for by research. Adapted, with permission, from Wigle and associates.³⁴

Our study differs from recently published studies of the cost of asthma^{20,62} in several important ways. First, our study was more complete. Weiss, Gergen and Hodgson²⁰ omitted costs associated with travel and waiting for medical care. Mellis and collaborators⁶² did not measure indirect costs associated with premature death or school absence. Neither study included costs associated with nursing services, ambulance services, outpatient diagnos-

tic services, research costs or transfer payments.

Second, our study used multiple, overlapping data sources to provide a range of estimates for many cost categories. We were therefore able to quantitatively estimate the degree of uncertainty associated with individual and aggregate cost estimates (sensitivity analysis).

Third, our estimates for important categories such as inpatient costs, physician services and drug costs are rel-

Table 3: Comparison of asthma costs in Canada and the United States*

Category	Source, utilization data	Units, 1000s	Units per capita per 1000	Unit cost, \$	Total cost, \$ million	Cost per capita, \$
DIRECT COSTS						
Inpatient care						
Canada	Discharge data	281	10.6	300	84	3.19
United States	Discharge data	2 300	8.9	791	1 820	7.01
Emergency visits						
Canada	Emergency department records‡	182	6.9	120	22	0.82
United States	Patient survey	1 810	7.0	190	344	1.33
Physician services						
Canada	Medical claims data	-	-	-	47	1.76
United States	Physician survey	-	-	-	575	2.22
Drugs						
Canada	Physician survey, dispensing data	-	-	-	124	4.69
United States	Physician survey	-	-	-	1 283	4.94
Subtotal†						
Canada		-	-	-	306	11.59
United States		-	-	-	4 245	16.35
INDIRECT COSTS						
Disability						
Canada	Patient survey	-	-	-	76	2.87
United States	Patient survey	-	-	-	991	3.82
Absence from school						
Canada	Patient survey	791	0.030	70	55	2.09
United States	Patient survey	10 000§	0.038	105	1 050	4.04
Death						
Canada	Vital statistics	505	0.019	109 000	55	2.07
United States	Vital statistics	3 880	0.016	246 000	956	3.68
Subtotal†						
Canada		-	-	-	198	7.47
United States		-	-	-	2 997	11.54
Total†						
Canada		-	-	-	504	19.06
United States		-	-	-	7 252	27.90

*US estimates are taken from the study by Weiss et al.²⁰ All costs are in 1990 Canadian dollars; a crude adjustment for purchasing power was performed using mean 1990 US/Canadian exchange rates (US\$1 = CAN\$1.167).

†Totals are not column sums. They include all costs (those included here for comparison and those excluded from this table).

‡Values for emergency use would be much higher in Canada if data comparable to US data (i.e., survey data) were used for Canadian estimates.

§Approximate value.

||Values in this category represent the actual number of deaths.

atively precise. Inpatient costs were based on all asthma-related admissions in Canada, and per-diem costs were carefully adjusted to exclude unrelated costs. Our estimate of physician services, although based on a limited sample, reflects both actual utilization and actual expenditure, rather than an estimate based on a patient survey. Similarly, our estimate of drug costs represents actual nation-wide drug expenditures. Survey estimates may incorrectly capture the cost of prescriptions that were never filled, or fail to capture the cost of filled prescriptions that were never taken.

Despite differences in methodology, however, our cost estimates support many of the conclusions reached in those two studies.^{20,62} All three studies suggest that the direct costs of asthma exceeded the indirect costs (accounting for 61% of all costs in Canada, 53% in the United States²⁰ and 68% in New South Wales, Australia⁶²). Drugs and inpatient care were the two largest contributors to direct costs in all three studies. Also, a detailed comparison of US and Canadian costs (Table 3) shows that utilization patterns were strikingly similar and that differences in overall costs and costs by category were largely accounted for by differences in unit costs.

What can we conclude from the descriptive information provided by our study? First, we cannot draw any direct inferences about the appropriateness of present asthma care or the desirability of future programs. The appropriateness of any intervention, past or present, must still be judged by the canon of efficacy, effectiveness and cost-effectiveness.⁶³⁻⁶⁵ Cost-of-illness studies do, however, allow us to identify categories of heavy resource utilization (e.g., drugs and inpatient care) and allow us to direct future research and therapy toward areas in which the potential gain would be the greatest. Also, they identify stakeholders in health policy decisions. Cost-of-illness studies alone, however, cannot tell us whether our resources have been or will be wisely spent.

Second, our study indicates the magnitude of potential savings from improvement in asthma care. The proportion of current asthma costs that can be eliminated is unknown.³² However, we do know that appropriate use of inhaled corticosteroids, asthma education, environmental control and written action plans help to decrease the number of emergency-department visits, admissions to hospital, and days absent from work and school.⁶⁶⁻⁷⁷ Further studies are needed to determine whether these clinically proven behavioural and pharmacologic interventions are a wise use of resources.

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References

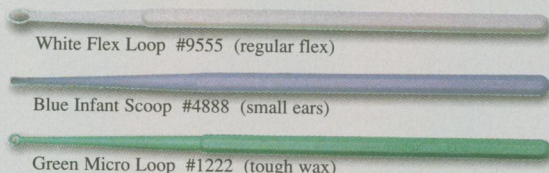
1. Burney PGJ: Asthma mortality in England and Wales: evidence for a further increase 1974-84. *Lancet* 1986; 2: 323-326
2. Sears MR, Rea HH, Beaglehole R et al: Asthma mortality in New Zealand: a two year national study. *N Z Med J* 1985; 98: 371-375
3. Bosquet J, Hatton F, Godard P et al: Asthma mortality in France. *J Allergy Clin Immunol* 1987; 80: 389-394
4. Evans R, Mullaly DI, Wilson RW et al: National trends in the morbidity and mortality of asthma in the US. *Chest* 1987; 91 (suppl): 65S-73S
5. Halfon N, Newacheck PW: Trends in the hospitalization for acute childhood asthma, 1970-84. *Am J Public Health* 1986; 76: 1308-1311
6. Taylor WR, Newacheck PW: Impact of childhood asthma on health. *Pediatrics* 1992; 90: 657-662
7. Mitchell EA: International trends in hospital admission rates for asthma. *Arch Dis Child* 1985; 60: 376-378
8. Gergen PJ, Weiss KB: Changing patterns of asthma hospitalization among children: 1979 to 1987. *JAMA* 1990; 264: 1688-1692
9. Johansson H, Dutta M, Mao Y et al: An investigation of the increase of preschool-age asthma in Manitoba, Canada. *Health Rep* 1992; 4: 379-402
10. Mao Y, Semenciw R, Morrison H et al: Increased rates of illness and death from asthma in Canada. *Can Med Assoc J* 1987; 137: 620-624
11. Wilkins K, Mao Y: Trends in rates of admission to hospital and death from asthma among children and young adults in Canada during the 1980's. *Can Med Assoc J* 1993; 148: 185-190
12. Hodgson TA: The state of the art of cost-of-illness estimates. *Adv Health Econ Health Serv Res* 1983; 4: 129-164
13. Max W, Rice D, Mackenzie R: The lifetime cost of injury. *Inquiry* 1990; 27: 332-343
14. Rice DP: *Estimating the Cost of Illness*. No 6 of Health Economics Series, US Department of Health, Education, and Welfare, Public Health Service, Washington, 1966
15. Shiell A, Gerard K, Donaldson C: Cost of illness studies: An aid to decision-making? *Health Policy* 1987; 8: 317-323
16. Hodgson TA: Cost of illness studies: No aid to decision making? [commentary] *Health Policy* 1989; 11: 57-60
17. Drummond MF: Cost-of-illness studies: A major headache? *PharmacoEconomics* 1992; 2: 1-4

18. Robinson JC: Philosophical origins of the economic valuation of life. *Milbank Q* 1986; 64: 133-155
19. Behrens C, Henke KD: Cost of illness studies: No aid to decision making? [commentary] *Health Policy* 1988; 10: 137-141
20. Weiss KB, Gergen PJ, Hodgson TA: An economic evaluation of asthma in the United States. *N Engl J Med* 1992; 862-866
21. Marion RJ, Creer TL, Reynolds RVC: Direct and indirect costs associated with the management of childhood asthma. *Ann Allergy* 1985; 54: 31-34
22. Patrick DL, Bergner M: Measurement of health status in the 1990's. *Annu Rev Public Health* 1990; 11: 165-183
23. Rice DP, Hodgson TA, Kopstein AN: The economic costs of illness: a replication and update. *Health Care Financ Rev* 1985; 7: 61-80
24. Ross RN: The costs of managing asthma. *J Respir Dis* 1988; 21 (suppl): S15-S20
25. Vance VJ, Taylor WF: The financial cost of chronic childhood asthma. *Ann Allergy* 1971; 29: 455-460
26. US National Heart and Lung Institute: *Respiratory Diseases: Task Force Report on Problems, Research Approaches, and Needs* (publ no [NIH] 76-432), US National Institutes of Health, Department of Health, Education, and Welfare, Washington, 1972
27. Mellis CM, Peat JK, Bauman AE et al: The cost of asthma in New South Wales. *Med J Aust* 1991; 155: 522-528
28. Thompson S: *Astmasjukdomens samhällsekonomiska kostnader*, Swedish Institute for Health Economics IHE Meddelande, Lund, Sweden, 1981
29. Action Asthma: *The Occurrence and Cost of Asthma*, Cambridge Medical Publications, West Sussex, England, 1990
30. *The Health of Canadians: Report of the Canada Health Survey* (cat no 82-538E), Supply and Services Canada, Ottawa, 1981
31. IMS Canada: *Canadian Disease and Therapeutic Index, Diagnosis*, IMS America, Plymouth Meeting, Penn, 1987
32. Weiss KB, Sullivan SD: The economic costs of asthma: a review and conceptual model. *Pharmacoeconomics* 1993; 4: 14-30
33. Cooper BS, Rice DP: The economic costs of illness revisited. *Soc Secur Bull* 1976; 39: 21-36
34. Wigle DT, Mao Y, Wong T et al: Economic burden of illness in Canada, 1986. *Chronic Dis Can* 1991; 12 (3 suppl): 1-40
35. *Hospital Morbidity, 1989-90*. Suppl 1 of *Health Reports* (cat no 82-003S), Statistics Canada, Ottawa, 1992
36. *The Annual Return of Health Care Facilities-Hospitals*. Suppl 5 of *Health Reports*, vol 3, no 2 (cat no 82-00355), Statistics Canada, Ottawa, 1991
37. MacLean MB, Mix P: Measuring hospital productivity and output: the omission of outpatient services. *Health Rep* 1991; 3: 229-244
38. *Diagnostic and Therapeutic*. Vol 2 of *Hospital Indicators 1988-89*, suppl 21 of *Health Reports*, vol 3, no 4 (cat no 82-003S), Statistics Canada, Ottawa, 1992
39. Rea HH, Garrett JE, Mulder J et al: Emergency room care of asthmatics: a comparison of Auckland and Toronto. *Ann Allergy* 1991; 66: 48-52
40. Bates DV, Baker-Anderson M, Sizto R: Asthma attack periodicity: a study of hospital emergency visits in Vancouver. *Environ Res* 1990; 51: 51-70
41. *Canadian Compuscript, December 1990*, IMS America, Plymouth Meeting, Penn, 1992
42. *Report on 1991 IPMRG Validation of Drugstore and Hospital Markets in Canada*, IMS Canada, Montreal, 1991
43. *Canadian Pharmaceutical Market: Drug Store and Hospital Purchases*, IMS America, Plymouth Meeting, Penn, 1990
44. A survey of drug store trends. *Drug Merchandising* [newsletter] 1994
45. Reference List of Health Science Research in Canada 1990-1991, Medical Research Council of Canada, Ottawa, 1992
46. *Profile of Persons with Disabilities Residing in Health Care Institutions in Canada: the Health and Activity Limitation Survey* (cat no 82-615), Statistics Canada, Ottawa, 1991
47. *Survey of Employment, Payrolls, and Hours 1990* (cat no A920502), Statistics Canada, Ottawa, 1991
48. *The Labour Force, June 1990* (cat no 71-001), Statistics Canada, Ottawa, 1991
49. Max W, Rice DP, MacKenzie EJ: The lifetime cost of injury. *Inquiry* 1990; 27 (winter): 332-343
50. *Mortality Summary List of Causes*. Suppl 12 of *Health Reports*, vol 4, no 1 (cat no 82-003S-12), Statistics Canada, Ottawa, 1992
51. Krahn M, Gafni A: Discounting in the evaluation of health care interventions. *Med Care* 1993; 31: 403-418
52. Hill RA, Standen PJ, Tattersfield AE: Asthma, wheezing, and school absence in primary schools. *Arch Dis Child* 1989; 64: 246-251
53. Bollinelli R, Tessier JF, Fournial F et al: Conséquences médico-sociales de la maladie asthmatique chez l'adulte. *Rev Fr Mal Respir* 1979; 7: 159-164
54. Speight AN: Is childhood asthma being underdiagnosed and undertreated? *BMJ* 1978; 2: 331-332
55. Hunt LW, Silverstein M, Reed CE et al: Accuracy of the death certificate in a population-based study of asthmatic patients. *JAMA* 1993; 269: 1947-1952
56. Sweet L, Fan JSK, O'Neill J: A validation study of asthma, Prince Edward Island, 1984-1988: I. Cause of death. *Chronic Dis Can* 1992; 13: 1-4
57. Sears MR, Rea H, DeBoer G et al: Accuracy of certification of deaths due to asthma, a national study. *Am J Epidemiol* 1986; 124: 1004-1011
58. Salome CM, Peat JK, Britton WJ et al: Bronchial hyperresponsiveness in two populations of Australian school children. 1. Relation to respiratory symptoms and diagnosed asthma. *Clin Allergy* 1987; 17: 271-281

59. Woolcock AJ, Peat JK, Salome CM: Prevalence of bronchial hyperresponsiveness and asthma in a rural adult population. *Thorax* 1987; 42: 361-368
60. Bauman A, Hunt J, Young L et al: Asthma under-recognition and under-treatment in an Australian community. *Aust N Z J Med* 1992; 22: 36-40
61. Fincker F, Sauvan R, Pasquier J: Systematic association of PAP and PSA determinations to bone scintigraphy in prostatic cancer. *Am J Clin Oncol* 1988; 11: S68-S70
62. Mellis CM, Peat JK, Bauman AE et al: The cost of asthma in New South Wales. *Med J Aust* 1991; 155: 523-527
63. Laupacis A, Feeny D, Detsky AS et al: How attractive does a new technology have to be to warrant adoption and utilization? Tentative guidelines for using clinical and economic evaluations. *Can Med Assoc J* 1992; 146: 473-481
64. Detsky AS, Naglie IG: A clinician's guide to cost-effectiveness analysis. *Ann Intern Med* 1990; 113: 147-154
65. Eisenberg JM: Clinical economics: a guide to the economic analysis of clinical practices. *JAMA* 1989; 262: 2879-2886
66. Clark NM, Feldman CH, Evans D et al: The impact of health education on frequency and cost of health care use by low income children with asthma. *J Allergy Clin Immunol* 1986; 78: 108-115
67. Wilson S, Scamagas P, German DF et al: A controlled trial of two forms of self-management education for adults with asthma. *Am J Med* 1993; 94: 564-576
68. Mayo PH, Richman J, Harris HW: Results of a program to reduce admissions for adult asthma. *Ann Intern Med* 1990; 112: 864-871
69. Feldman CH: Asthma education: general aspects of childhood programs. *J Allergy Clin Immunol* 1987; 80: 494-497
70. Windsor RA, Bailey WC, Richards JM et al: Evaluation of the efficacy and cost effectiveness of health education methods to increase medication adherence among adults with asthma. *Am J Public Health* 1990; 80: 1519-1521
71. Bolton MB, Tilley BC, Kuder J et al: The cost and effectiveness of an education program for adults who have asthma. *J Gen Intern Med* 1991; 6: 401-407
72. Wilson-Pessano S, McNabb W: The role of patient education in the management of childhood asthma. *Prev Med* 1985; 14: 670-687
73. Evans D, Clark NM, Feldman CH et al: A school health education program for children with asthma aged 8-11 years. *Health Educ Q* 1987; 14: 267-279
74. Lewis CE, Rachelefsky GS, Lewis MA et al: A randomized trial of asthma care training (ACT) for kids. *Pediatrics* 1984; 74: 478-486
75. Maiman LA, Green LW, Gibson G et al: Education for self treatment by adult asthmatics. *JAMA* 1979; 241: 1919-1922
76. Hughes DM, McLeod M, Garner B et al: Controlled trial of a home and ambulatory program for asthmatic children. *Pediatrics* 1991; 87: 54-61
77. Huss K, Squire EN, Carpenter GB et al: Effective education of adults with asthma who are allergic to dust mites. *J Allergy Clin Immunol* 1992; 89: 836-843



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