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ORIGINAL ARTICLE

Economic Impact of Juvenile Idiopathic Arthritis

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Objective. **Juvenile idiopathic arthritis (JIA) is a potentially devastating chronic pediatric disease. Although high costs have been well described in adult arthritis, little is known about the economic impact of JIA. Our objective was to describe direct medical costs for children with JIA compared with controls.**

Methods. **Consecutive clinic attendees (n = 155) with JIA were enrolled from 2 tertiary referral pediatric centers. Outpatient clinic controls without JIA (n = 181) were recruited at the respective centers. Data on direct medical costs were obtained at 3-month intervals. Average annualized direct medical costs were calculated, expressed in 2005 Canadian dollars.**

Results. **The total difference in annualized average direct medical costs for children with JIA versus controls was $1,686 (95% confidence interval $875, $2,500). JIA subjects had substantially higher costs concerning medication use, visits to specialists and allied health care professionals, and diagnostic tests. Multiple linear regression models for the JIA sample revealed that higher active joint count was independently associated with greater total direct medical costs. Also, JIA type was a predictor of greater direct costs, with higher costs for patients with polyarthritis (rheumatoid factor positive or negative) or systemic JIA.**

Conclusion. **The economic impact of JIA is substantial, and higher active joint count is independently associated with greater costs. This may be of particular significance given the emergence of new, costly medications for use in JIA. Insights into the relationship between disease activity and cost in JIA should assist policy makers regarding resource allocation in the setting of competing demands. Ultimately, decisions regarding access to therapies should be considered in terms of overall cost-benefit ratios.**

KEY WORDS. Juvenile idiopathic arthritis; Juvenile arthritis; Economic; Cost.

INTRODUCTION

Musculoskeletal disorders have a large impact at both the individual and societal level. In adults, inflammatory arthritis is known to have a massive economic impact (1–4). Juvenile idiopathic arthritis (JIA) is the most common rheumatic disease in childhood. Up to 18 children in 100,000 develop JIA each year; estimates of prevalence are as high as 150 per 100,000 (5). In adult rheumatoid arthritis (RA), disease activity is an established important determinant of health care use (6). Although JIA is a relatively common chronic pediatric disease, little is known about its economic impact. Knowledge about which factors most influence cost in JIA is needed to help clinicians and decision makers allocate scarce resources.

In analyses of direct costs in a disease such as JIA, all resources used in the treatment of that illness are considered. A large portion of direct costs in inflammatory arthritis is related to use of health services, including visits to physicians (and allied health care professionals) (7). To date, only 1 study has been published estimating the economic cost for children with JIA; this study was performed almost 2 decades ago (8), when therapeutic approaches

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were quite different. Moreover, to our knowledge, no one has published data on the determinants of health costs in children with JIA. Therefore, our objective was to describe direct medical costs in a recent cohort of children with JIA compared with controls, and to establish determinants of total direct medical costs in the JIA sample.

MATERIALS AND METHODS

The study took place at 2 Canadian centers, one in Montreal (Montreal Children's Hospital) and one in Vancouver (British Columbia Children's Hospital). Research ethics boards at both centers approved the study. Consecutive clinic attendees with a diagnosis of JIA were invited to participate, and consent and/or assent was obtained from the child and parent (n = 155); similarly, controls without JIA were obtained from outpatient clinics (n = 181) at the 2 centers. These clinic controls were primarily children without chronic illnesses; some came from orthopedic clinics, where they were being followed for a previous fracture, and the remainder came from family medicine clinics. The parents who consented provided information on the relevant demographics and completed a standardized questionnaire on medications and health service use in the preceding 3 months. The questionnaire was administered at baseline and at 3-month visits after enrollment up to the study end point at 2 years.

The questionnaire used to collect data on medical costs was a modification of the economic portion of the Stanford Health Assessment Questionnaire. Similar versions have been used (9–12) for various rheumatic diseases in adults, including RA. The questionnaire inquires about the use of all medications and health services during the preceding 3 months without attributions to any one disease or condition. Parents were asked to report on medication use, the frequency of child visits to health care professionals, the use of laboratory tests and imaging, and other studies, emergency room visits, outpatient surgery, inpatient stays, and assistive devices (e.g., ambulation aids, splints, etc.). We also recorded information on time loss from work for parents, as well as days missed from school for our subjects.

Our average annualized direct medical cost estimates were calculated by multiplying health service utilization levels by the appropriate unit prices, which were calculated as follows. For physician services and professional as well as most technical components of laboratory tests and imaging procedures, we estimated Canadian unit prices as an average between reimbursements in Quebec and Ontario according to government fee schedules, because these 2 provinces account for the largest part of health expenditures in Canada. For nonphysician services, costs were obtained from provincial professional associations. Some technical components of diagnostic procedure costs were obtained from private clinic outpatient laboratories. Costing of assistive devices was performed using prices suggested by provincial insurance programs or information from suppliers. Acute-care hospital costs were estimated according to the Canadian Institute for Health Information methodology, which assigns weights based on the case mix group of the admission, and using data provided by the Institute of Health Economics and Ontario Case-Costing project. Costs of emergency room visits and ambulance use were calculated using data from Statistics Canada (13), the Institute of Health Economics, and other sources. Estimates of prescription and nonprescription medication costs were calculated as the product of the weighted average cost per milligram, total daily dose, and therapy duration, with cost data obtained from the Quebec public medication insurance program, and adding a retail mark-up of 10%. Costs were expressed in 2005 Canadian dollars and were compared for JIA subjects versus controls.

For the JIA sample, data on disease type at onset (according to the Edmonton version of the International League Against Rheumatism classification criteria [14]) and disease activity (active joint count [15]) were also collected. Multiple linear regression analyses were performed to establish whether clinical characteristics were associated with total direct cost in the JIA sample. Covariates included age, sex, race, JIA type, active joint count, and disease duration at study entry. We also included a variable to adjust for whether an individual was recruited from Montreal or Vancouver. We used bootstrap methods to calculate 95% confidence intervals (95% CIs) for the coefficients estimated from the model where the outcome was total direct cost in dollars, because the distribution for this outcome deviated from normality. We also repeated the regression model transforming the outcome by taking the logarithm of total direct cost, which has a more normal distribution.

RESULTS

Regarding demographics, the average age at enrollment was similar in the JIA sample (10.0 years; 95% CI 9.4, 10.7) versus the controls (10.5 years; 95% CI 9.9, 11.1). As expected, given that boys are less likely to develop JIA, the JIA sample had a larger percentage of girls (69.7%; 95% CI 61.8, 76.8) than the controls (47.8%; 95% CI 40.3, 55.3). None of the controls had juvenile arthritis (due to our exclusion criteria); the chronic conditions most commonly reported by the control group included asthma (n = 40), other breathing disorder (n = 8), epilepsy (n = 7), and diabetes (n = 1).

For the JIA sample, the mean disease duration at enrollment was 4.3 years (95% CI 3.7, 4.8). Within the JIA group, 20.3% had polyarthritis; 8.9% had systemic JIA; and the remainder had oligoarthritis (43.1%), enthesitis-related/psoriatic arthritis (19.8%), or were unclassified (7.9%). The mean active joint count at baseline was 3.0 (95% CI 1.5, 4.5) for those with polyarthritis and 1.3 (95% CI 0.8, 1.8) for the others. Of the JIA subjects with polyarthritis, 22.9% were rheumatoid factor positive. Considering all patients at baseline, 32.3% were taking methotrexate, 4.3% were taking sulfasalazine, 2.6% were taking hydroxychloroquine, and 8.5% were taking prednisone. Throughout the followup period, 6 subjects received etanercept and 2 received infliximab (with no other biologic agent exposures).

The total difference in annualized average direct medi-

Table 1. Direct cost components and total direct medical cost (2005 Canadian dollars) for the JIA sample and controls*

Direct cost components	JIA sample (n = 155)		Controls (n = 181)		Difference (JIA – controls)	
	Point estimate	95% CI	Point estimate	95% CI	Point estimate	95% CI
Medications	$1,306	$844, $1,769	$87	−$15, $190	$1,219	$749, $1,689
Specialists (physicians)	$349	$319, $378	$112	$95, $130	$236	$203, $270
General practitioners	$33	$23, $42	$26	$18, $33	$7	−$5, $19
Nonphysicians†	$374	$299, $448	$169	$59, $278	$205	$74, $336
Tests‡	$316	$253, $379	$146	$106, $185	$170	$97, $244
Devices§	$48	$23, $72	$101	$46, $155	−$53	−$112, $7
Emergency room visits	$80	$58, $103	$99	$60, $137	−$19	−$63, $25
Outpatient surgery	$116	$37, $194	$176	$68, $283	−$60	−$192, $72
Acute-care hospitalization	$290	$34, $547	$399	$26, $772	−$109	−$558, $341
Inpatient rehabilitation	$90	−$143, $323	$0	$0, $0	$90	−$142, $321
Total direct cost	$3,002	$2,330, $3,672	$1,315	$845, $1,782	$1,686	$875, $2,500

* JIA = juvenile idiopathic arthritis; 95% CI = 95% confidence interval.
† Includes outpatient visits to physiotherapy, occupational therapy, social workers, nurses, etc.
‡ Includes laboratory tests, imaging, and other investigations (e.g., pulmonary function testing, etc.).
§ Includes ambulatory aids, splints, etc.

cal costs for the JIA group versus controls was $1,686 (95% CI $875, $2,500) (Table 1), the great majority of this difference in costs being due to medication costs. The difference in average annual costs for medications in the JIA group versus controls was $1,219 (95% CI $749, $1,689). The JIA subjects also had higher costs related to visits to specialists, allied health care professionals, and diagnostic tests (including imaging, laboratory, pulmonary function testing, etc.).

Multiple linear regression models for the JIA sample revealed that higher active joint count was independently associated with greater total direct medical costs (Table 2). In addition, JIA type at onset was a predictor of greater direct medical costs, with higher costs for patients with polyarthritis or systemic JIA. The regression models did not clearly identify the other covariates (age, sex, race, disease duration) as determinants of cost.

DISCUSSION

To date, the impact of JIA on health care cost has not been well described. Our work demonstrates that patients with JIA have high costs, particularly costs related to medications, visits to health care professionals, and diagnostic tests. These costs were higher for JIA subjects even compared with those of clinic controls, who almost certainly had greater health resource use than the generally healthy pediatric population. In fact, our clinic controls had relatively high rates of emergency room visits, assistive devices, surgeries, and inpatient stays, likely related to the fact that some were recruited from orthopedic outpatient clinics. When comparing the total direct medical costs in JIA with recent estimates for asthma (16), a common chronic pediatric disease, JIA would appear to be more costly, with most of the cost difference being due to higher medication costs in the JIA population (Table 3).

The cost of JIA extends into adulthood, as Minden et al (17) demonstrated in their assessment, which determined that the average direct annual cost for adults with JIA was 1,925 euros per year ($3,136 in 2005 Canadian dollars). This amount is similar to the annualized estimate of direct health costs in our pediatric sample. The only other study of the economic burden of JIA in a pediatric sample was

Table 2. Regression models predicting direct cost in the JIA sample*

	Coefficient	95%CI†
Outcome as total cost (2005 Canadian dollars)		
Demographics		
Age, years	−23	−156, 107
Male sex	347	−1,094, 1,526
White race	969	−987, 2,882
JIA type at disease onset‡		
Polyarthritis	2,489	1,145, 4,254
Systemic JIA	4,583	349, 8,206
Clinical factors		
Active joint count	714	167, 1,278
JIA duration, years	6	−140, 166
Outcome as log of total costs		
Demographics		
Age, years	−0.002	−0.041, 0.037
Male sex	0.106	−0.236, 0.449
White race	0.375	−0.196, 0.946
JIA type at disease onset		
Polyarthritis	0.641	0.288, 0.995
Systemic JIA	1.301	0.71, 1.893
Clinical factors		
Active joint count	0.127	0.065, 0.19
JIA duration, years	−0.019	−0.068, 0.029

* All estimates are adjusted for the other variables listed in the Table. JIA = juvenile idiopathic arthritis; 95% CI = 95% confidence interval.
† For the regression model where total cost (Canadian 2005 dollars) is the outcome, 95% CI was generated using bootstrapping methods, because the cost in dollars is not normally distributed.
‡ This analysis compares each of these 2 JIA types at disease onset (polyarthritis, systemic JIA) with a comparator group consisting of all other types that were not polyarthritis or systemic JIA (i.e., oligoarthritis, unclassified, etc.).

Table 3. Comparison of average direct costs of pediatric asthma versus juvenile idiopathic arthritis (JIA) in Canada*

	Pediatric asthma	JIA
Family physician	$91	$33
Specialist physician	$66	$349
Emergency room visits	$15	$80
Hospital admissions	$633	$290
Medications	$327	$1,306
Devices	$19	$48
Other†	$158	$895
Total direct	$1,309	$3,001

* We present Canadian 2005 dollars for both asthma and JIA. Asthma figures adapted from Ungar and Coyte (15) using the consumer price index.
† Includes tests, nonphysician visits (occupational therapy, physiotherapy, etc.), outpatient surgery, and rehabilitation.

performed almost 2 decades ago by Allaire et al (8), and estimated a much higher mean annualized direct health care cost amounting to $5,700 in 1989 US dollars ($10,801 in 2005 Canadian dollars). This finding was in part driven by much higher inpatient care costs in their sample from this earlier era (mean annualized inpatient costs were one-third of the direct medical costs). Inpatient care in the present study contributed to <13% of total direct medical costs. In general, a characteristic of current care patterns, in contrast with earlier eras, is that much fewer children with JIA are admitted to the hospital. Also, in the Allaire et al sample (8), there was a higher percentage of subjects with polyarthritis (33.3%) and systemic JIA (18.8%), which may partly explain the higher inpatient costs. Conversely, in the study by Allaire et al (8), medications contributed <10% of the total direct medical costs, but accounted for 44% of the total direct medical costs in our study.

From a societal perspective, indirect costs (that is, the burden sustained by the patient and/or caregivers) are obviously also very important. In the study by Allaire et al (8), families sustained considerable financial burden (family cost of $1,524 in 1989 US dollars, or $2,888 in 2005 Canadian dollars). Half of this was related to out-of-pocket expenses for medical services and tests; in the Canadian system, such expenses typically do not occur. Annual parental salary losses averaged $1,241 in our JIA sample (95% CI $693, $1,788) versus $404 in the control group (95% CI $192, $615). We did not find significant losses in unpaid labor for caregivers.

The burden of JIA entails more than direct costs and financial losses; our study does not quantify the long-term costs, both medical and social, of having inadequately controlled arthritis in childhood. Ongoing active inflammation and the consequent joint damage have a significant impact on the ability of an individual to be a productive member of society (17). We noted that our JIA sample did tend, on average, to have more days of missed school per year compared with controls (7.15 days versus 5.03 days), although the confidence intervals for these estimates overlapped. Also, 56.7% of children with JIA missed at least 1 school day per year, compared with 29.6% of controls (difference of 27.1%; 95% CI 16.2%, 37.3%).

Insight into factors that influence health care costs can help clinicians and decision makers in resource allocation, which is increasingly important in this time of economic constraints on health care systems. One example might be the consideration of therapy such as an anti–tumor necrosis factor agent in a patient with active arthritis who has not responded to traditional disease-modifying agents. Given the current data regarding response to etanercept or infliximab in JIA, one would expect a mean decrease of 10 in active joint count over 1 year (18), which on average might result in a decrease of $7,000 (Canadian) in health care costs over the next year. A recent abstract presentation by Brunner et al (19) also provided evidence of the manner in which JIA disease activity increases costs; this work suggested that in JIA, etanercept (compared with methotrexate alone and methotrexate plus etanercept) was cost effective in achieving remission in patients with polyarthritis. From the perspective of the health care system, one must also consider the potential for increased costs related to complications of the newer agents, which were reported to be high in one JIA sample (20).

To conclude, we believe our work is the first to quantify an association between JIA disease activity and health care costs. These data are important in helping to quantify the extent of the association and in providing some information relevant to the magnitude of the health care cost savings that might result as a consequence of better disease control. This is of particular significance given the appearance of new, costly medications for use in JIA (such as novel biologic agents [21,22]). Insight into the relationship between disease activity and health care costs should assist policy makers regarding resource allocation in the setting of competing demands. Ultimately, decisions regarding access to therapies should be considered in terms of overall cost-benefit ratios. More effective interventions, even if associated with higher initial health care costs, may well have significant long-term cost savings to society.

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AUTHOR CONTRIBUTIONS

Dr. Bernatsky had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study design. Drs. Duffy, Malleson, Feldman, and Clarke.
Acquisition of data. Drs. Duffy, Malleson, Feldman, and Clarke.
Analysis and interpretation of data. Drs. Bernatsky, Duffy, Malleson, Feldman, and Clarke, and Mr. St. Pierre.
Manuscript preparation. Drs. Bernatsky, Duffy, Malleson, Feldman, and Clarke, and Mr. St. Pierre.
Statistical analysis. Drs. Bernatsky and Clarke, and Mr. St. Pierre.

REFERENCES

1. Yelin EH, Felts WR. A summary of the impact of musculoskeletal conditions in the United States. Arthritis Rheum 1990;33:750–5.
2. Yelin E, Callahan LF. The economic cost and social psychological impact of musculoskeletal conditions. Arthritis Rheum 1995;38:1351–62.
3. Lubeck DP. The economic impact of arthritis. Arthritis Care Res 1995;8:304–10.
4. Cooper NJ. Economic burden of rheumatoid arthritis: a systemic review. Rheumatology (Oxford) 2000;39:28–33.
5. Andersson Gare B. Juvenile arthritis: who gets it, where and when? A review of current data on incidence and prevalence. Clin Exp Rheumatol 1999;17:367–74.
6. Lajas C, Abasolo L, Bellajdel B, Hernandez-Garcia C, Carmona L, Vargas E, et al. Costs and predictors of costs in rheumatoid arthritis: a prevalence-based study. Arthritis Rheum 2003;49: 64–70.
7. Hallert E, Husberg M, Jonsson D, Skogh T. Rheumatoid arthritis is already expensive during the first year of the disease (the Swedish TIRA project). Rheumatology (Oxford) 2004;43: 1374–82.
8. Allaire SH, DeNardo BS, Szer IS, Meenan RF, Schaller JG. The economic impacts of juvenile rheumatoid arthritis. J Rheumatol 1992;19:952–5.
9. Clarke AE, Esdaile JM, Bloch DA, Lacaille D, Danoff DS, Fries JF. A Canadian study of the total medical costs for patients with systemic lupus erythematosus and the predictors of costs. Arthritis Rheum 1993;36:1548–59.
10. Clarke AE, Petri MA, Manzi S, Isenberg DA, Gordon C, Senecal JL, et al. An international perspective on the well being and health care costs for patients with systemic lupus erythematosus. J Rheumatol 1999;26:1500–11.
11. Clarke AE, Zowall H, Levinton C, Assimakopoulos H, Sibley JT, Haga M, et al. Direct and indirect medical costs incurred by Canadian patients with rheumatoid arthritis: a 12 year study. J Rheumatol 1997;24:1051–60.
12. Lubeck DP, Spitz PW, Fries JF, Wolfe F, Mitchell DM, Roth SH. A multicenter study of annual health service utilization and costs in rheumatoid arthritis. Arthritis Rheum 1986;29: 488–93.
13. Statistics Canada. Comparable health indicators. Canada, Provinces, and Territories. Ottawa: Statistics Canada; 2004.
14. Petty RE, Southwood TR, Manners P, Braum J, Glass DN, Goldenberg J, et al, and the International League of Associations for Rheumatology. International League of Associations for Rheumatology classification of juvenile idiopathic arthritis: second revision, Edmonton, 2001. J Rheumatol 2004; 31:390–2.
15. Ravelli A, Viola S, Ruperto N, Corsi B, Ballardini G, Martini A. Correlation between conventional disease activity measures in juvenile chronic arthritis. Ann Rheum Dis 1997;56: 197–200.
16. Ungar WJ, Coyte PC, and the Pharmacy Medication Monitoring Program Advisory Board. Prospective study of the patient-level cost of asthma care in children. Pediatr Pulmonol 2001; 32:101–8.
17. Minden K, Niewerth M, Listing J, Biedermann T, Schontube M, Zink A. Burden and cost of illness in patients with juvenile idiopathic arthritis. Ann Rheum Dis 2004;63:836–42.
18. Lahdenne P, Vahasalo P, Honkanen V. Infliximab or etanercept in the treatment of children with refractory juvenile idiopathic arthritis: an open label study. Ann Rheum Dis 2003;62:245–7.
19. Brunner HI, Barron AC, Graham TB, Passo MH, Johnson AL, Lenihan J, et al. Effects of treatment on costs & Health-related Quality of Life (HRQL) of children with polyarticular course juvenile rheumatoid arthritis (JRA) [abstract]. Arthritis Rheum 2004;50 Suppl 9:S686.
20. Quartier P, Taupin P, Boudeaut F, Lemelle I, Pillet P, Bost M, et al. Efficacy of etanercept for the treatment of juvenile idiopathic arthritis according to the onset type. Arthritis Rheum 2003;48:1093–101.
21. Ilowite NT. Current treatment of juvenile rheumatoid arthritis. Pediatrics 2002;109:109–15.
22. Wilkinson N, Jackson G, Gardner-Medwin J. Biologic therapies for juvenile arthritis [review]. Arch Dis Child 2003;88: 186–91.