EXTENDED REPORT

The economic burden associated with osteoarthritis, rheumatoid arthritis, and hypertension: a comparative study

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Objective: To compare the economic burden to society incurred by patients with RA, OA, or high blood pressure (HBP) in Ontario, Canada.

Methods: Consecutive subjects recruited by 52 rheumatologists (RA) and 76 family physicians (OA and HBP) were interviewed at baseline and 3 months. Information was collected on demographics, health status, and any comorbidities. A detailed, open ended resource utilisation questionnaire inquired about the use of medical and non-medical resources and patient and care giver losses of time and related expenses. Annual costs were derived as recommended by national costing guidelines and converted to American dollars (year 2000). Statistical comparisons were made using ordinary least squares regression on raw and log transformed costs, and generalised linear modelling with adjustment for age, sex, educational attainment, and presence of comorbidities.

Results: Baseline and 3 month interviews were completed by 253/292 (86.6%) patients with RA and 473/585 (80.9%) patients with OA and/or HBP. Baseline and total annual disease costs for RA (n = 253), OA and HBP (n = 191), OA (n = 140), and HBP (n = 142), respectively, were $9300, $4900, $5700, and US$3900. Indirect costs related to RA were up to five times higher than indirect costs incurred by patients with OA or HBP, or both. The presence of comorbidities was associated with disease costs for all diagnoses, cancelling out potential effects of age or sex.

Conclusion: The economic burden incurred by RA significantly exceeds that related to OA and HBP, while differences between patients with a diagnosis of OA without HBP or a diagnosis of HBP alone were non-significant, largely owing to the influence of comorbidities.

The 1997 National Health Interview Survey estimated that the prevalence of self reported arthritic disorders among non-institutionalised people in the United States was 16.1%, with one in six (2.9% overall) reporting that arthritis limited their activity.[1] Projections from the same survey indicated that the number of people with self reported arthritic disorders was likely to rise by 750 000 a year in the 1990s.[2] Such figures suggest that in future it will be necessary to devote increasing resources to improving the quality of life of arthritic patients by joint replacement surgery, pharmaceutical treatment, and homecare services.

Arthritic disorders pose a challenge to anyone concerned about healthcare costs, and their escalation leads to growing demands for more money to be devoted to arthritis research and caring. Cost of illness (COI) estimates for arthritic conditions are considerable when all levels of the healthcare system are taken into account. For example, in Canada, the total cost of arthritis and rheumatism in 1994 was broadly estimated to be between $C4.3 and $C7.3 billion.[3] Estimates of medical expenses (which exclude the cost of time lost from paid or unpaid work) in the same year varied between $C1.7 and $C2.5 billion dollars. The latter (often referred to as direct costs) amounted to 2.9% of the 1994 total health expenditure in Canada of $C72.5 billion, or 9.7% of the nation's gross domestic product (GDP).

COI studies are often undertaken to raise awareness among decision makers and the public about the economic burden of a disease, but their role in policy making remains unclear. Two systematic reviews concluded that the results of COI studies are not sufficiently reliable to inform policy making, citing three main reasons[4 5]: (*a*) total cost estimates for a specific disorder can vary up to 40-fold; (*b*) indirect costs

are generally overestimated (otherwise it is hard to explain how a few diseases can account for major reductions in a country's GDP); and (*c*) the costs associated with a limited list of diseases can easily exceed total medical care expenditure. If the results of COI studies are to be more useful in the future, it is recommended that the investigators should (*a*) estimate indirect costs more conservatively; (*b*) estimate incidence based costs; (*c*) if possible, analyse cost trends in order to gain more insight into the dynamic processes involved; (*d*) directly incorporate COI results in economic evaluations; and (*e*) perform one general COI study instead of several individual ones.[5]

The present investigation is a comparative COI study in patients with three disorders: high blood pressure (HBP), osteoarthritis (OA), and rheumatoid arthritis (RA). HBP was selected for comparison because it is very common in Western societies.[6] The objectives are to (*a*) measure the direct and indirect costs of illness associated with each disorder; (*b*) determine the relative contribution of diagnosis to the direct and indirect costs; and (*c*) estimate the costs attributable to other factors, such as age, education, sex, and the number of active comorbidities.

METHODS

Subject recruitment

Subjects were recruited from the practices of family physicians (OA and HBP) and rheumatologists (RA) in Ontario, Canada, between May 1999 and May 2000. A

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Abbreviations: COI, cost of illness; GDP, gross domestic product; GLM, generalised linear modelling; HBP, high blood pressure; OA, osteoarthritis; OLS, ordinary least squares; RA, rheumatoid arthritis

random sample of 1936 of 3446 Ontario family physicians, members of the Canadian College of Family Physicians, was contacted in five separate mailings. Seventy six agreed to participate and enrolled seven consecutive patients each—five with OA (with or without HBP) and two with HBP only. There were no statistically significant differences in sex, time since year of graduation, and age between the participating and non-participating family physicians. All rheumatologists registered in the province in 1999 (n = 135) were approached to recruit patients with RA, 52 participated and enrolled at least five consecutive subjects each. Responding rheumatologists did not differ in time since graduation, sex, and regional location of practice from non-respondents; 16 worked in an academic setting and the remaining 36 in the community.

Patients with OA and/or HBP were required to have been diagnosed by a physician and to be more than 55 years old. Patients with RA had to satisfy the 1987 American College of Rheumatology (ACR) diagnostic criteria[7] and be aged at least 18 years. All participants had to be able to communicate in English and were required to provide written consent.

Data collection

Patients completed two telephone surveys, one at baseline and one 3 months later. The first included questions about the respondent's demographic characteristics, such as his or her marital status and educational attainment. Subjects were also asked whether they had any of 23 specific comorbidities and, if so, whether they had been treated for them in the previous year. Disease-specific and generic health related quality of life were assessed at both interviews using the SF-36 (Short Form-36, version 1) questionnaire, a measure of general health, and physical and emotional wellbeing,[8] and the Health Assessment Questionnaire.[9 10]. Physician's global assessment of the patient's disease status was assessed on a five point Likert scale (1, very poor; 5, very well).

At the baseline and follow up interview, data on the use of all healthcare resources, not just disease related, over the previous 3 months were captured by a health resource utilisation questionnaire covering the following items:

- All consultations with health professionals, including the type of professional, the number of visits, the most important treatment prescribed, and the most important test or procedure performed.
- All visits, admissions, or procedures performed in a hospital, including the type of hospital department, the reason for the visit, the length of stay, and the most important test or procedure carried out.
- The numbers and types of tests performed independently of a visit to a health professional—for example, blood tests.
- All drugs taken (both prescribed and over the counter), including brand or generic names, the reasons/indications for use, the dosage, and the frequency and duration of administration.
- All adaptive aids, devices, and assistive household equipment purchased, including a description of the item, and details of any reimbursement and of any costs incurred by the patient.
- All community services or resources used (for example, home care, transportation services for people with disability such as WheelTrans, and food delivery services such as Meals On Wheels), including the type of service, the frequency of use, and the monthly cost borne by the patient.
- Any time lost from paid employment incurred by the patient or his/her main care giver as a result of the former's health problems.

- The amount of time for which the patient had difficulty working because of his or her health problems, and the percentage reduction in maximum working capacity.
- The amount of time for which the patient was unable to do chores around the house or similar activities because of health problems.
- Any paid help received by the patient because of a limited ability to do household chores (the time for which help was needed, or its cost).
- Any unpaid help the patient received because of a limited ability to do household chores (the time for which help was needed).

Cost assignment

All costs were assigned according to methods endorsed by the Canadian Coordinating Office for Health Technology Assessment.[11] Medical expenses and indirect costs were multiplied by the American Canadian purchasing power parity for medical and health care, which was $1.23 for each $C1.00 in 1998. Indirect costs were multiplied by a factor of 0.84, the purchasing power parity based on the GDP.[12]

Direct costs

Costs of visits to health professionals, of procedures performed, and of investigative tests undertaken were obtained from the Ontario Schedule of Benefits, 1 April 1999 version.[13] The costs of consultations with health professionals not covered under the Ontario Health Insurance Plan, such as chiropractors and massage therapists, were obtained from the relevant professional bodies. For non-regulated health professionals, an average billing rate was calculated on the basis of information provided by at least five practices in the Greater Toronto area.

The first step in calculating the cost of hospitalisation, including overnight stays, was to classify patients into case mix groups using a coding algorithm published by the Canadian Institute for Health Information.[14] The resource intensity weight of each group was then determined by referring to a document provided by the Ontario Joint Policy and Planning Committee.[15] Finally, the 1998 cost per weighted case for hospital stays in Ontario was multiplied by the resource intensity weight to give an estimate of the costs per patient of overnight hospital stays. Costs of ambulatory hospital clinic visits were assigned according to information in the 1999 Alberta Ambulatory Care Costing Survey.[16] Each visit was given one of 391 codes and the appropriate cost was applied.

Costs of drugs were calculated on the basis of wholesale prices listed in the catalogue of a large Ontario based pharmaceutical supplier (Kohl and Frisch Ltd, September 1999). Prescription drugs were subject to a 10% pharmacy dispensing fee, and a prescription fee of $C6.47. A 40% profit mark-up was added to the price of over the counter agents. Costs per unit were calculated by dividing the cost per package by the number of units it contained. The overall cost of each drug per patient was calculated by multiplying the unit cost by the number of administrations.

Purchase prices of adaptive aids and devices were obtained from suppliers in the Greater Toronto area, including Shoppers Home Health Care (Doncaster), Therapists' Choice, and Therapy Supply. The cost of equipment partially funded by the provincial Assistive Device Program was obtained from the 1999 Wheelchair, Positioning and Ambulation Aids Manual. For services provided by the Community Care Access Centre, such as nursing, treatment, and home making services, the unit cost for each OA/HBP/RA case (based on the ICD-9CM code) was applied using a costing template provided by the Toronto Community Care

Access Centre in February 2000. Costs related to other community services or resources used by patients, including transportation services, such as WheelTrans, and food delivery services, such as ''Meals On Wheels'', were determined by eliciting an average cost from the organisation concerned.

Indirect costs

Time lost from paid work by patients or their carers/supporters was initially recorded in days or hours. Days were then converted to hours using Statistics Canada data (year 1998; http://www.statcan.ca) showing that an average working day of paid employment is 8.0 hours long. To calculate income lost because of absence from work or difficulty with paid employment, the average provincial hourly wage of someone matched for age and sex with the patient or carer was determined from data at the Institute of Health Economics (1997–98).[11] This figure was then multiplied by the number of hours of work reportedly lost. Costs for the time a patient had difficulty working in a paid job were added, after adjustment for the estimated degree of reduction in his or her work capacity.

Time costs incurred through a patient's inability to do chores were obtained in two ways. Firstly, by multiplying the number of hours lost by a professional homemaker's hourly wage of $10. When a patient reported time lost in days, each day was reckoned to represent 3.6 hours (Statistics Canada, 1998; http://www.statcan.ca). Secondly, the costs of paid and unpaid help received by patients for household chores were calculated by adding the amount paid by patients to an amount based on the time care givers spent providing unpaid help. The latter was determined by multiplying the time reported by patients by the hourly wage of a professional homemaker matched for age and sex. Results of the two methods were compared, and the higher value was selected to avoid double counting and to represent the total monetary cost of the patient's inability to do chores during the 6 month period covered by both study interviews.

Analysis

Baseline and 3 month data for participants who completed the protocol were analysed, and the average total 6 month cost per patient was calculated for each of the following health related resource use categories:

- Visits to health professionals
- Hospitalisations
- Tests and investigations
- Drugs
- Total direct costs, including costs pertaining to health professional visits, hospitalisation, laboratory tests, drugs, community services such as home care, and purchases of adaptive devices
- Total indirect costs, including relevant time costs incurred by patients and care givers, and time costs due to the patient's inability to perform household chores.

The following variables were tested in multivariable statistical comparisons of total, direct, and indirect costs: (a) diagnosis (HBP, OA, or RA); (b) educational attainment (coded as: 1, less than high school; 2, high school; 3, college or university); (c) number of comorbidities treated in the preceding year, maximum 23; (d) sex; (e) age.

A generalised linear modelling (GLM) approach with a logarithmic link function was used to analyse datasets without zero dollar cost estimates (total costs and direct costs).[17] Simulation studies have shown that ordinary least squares (OLS) regression of log transformed costs may be the preferred option, particularly in the presence of heavily skewed residuals. A disadvantage of OLS is the need to retransform predicted log transformed costs back to the original scale in order to calculate predicted costs and compare them with the observed cost estimates. However, this can be overcome by manipulating the log scale residuals.[18 19] Both GLM based and OLS based comparisons were performed and the difference between predicted costs and observed costs was calculated for each.

Datasets with zero dollar cost estimates (indirect costs) were analysed using a proportional odds model owing to the potential for clumping.[20] Five cost categories were constructed, one for zero costs and four more corresponding to quartiles of the non-zero costs. The proportional odds assumption was checked with the score test. In a second approach, a logistic regression was fitted with the binary outcome of zero or non-zero cost estimates and an OLS model was then fitted to the remaining non-zero, log transformed costs.[20]

RESULTS

Recruitment

A total of 585 patients with OA or HBP were recruited, 70 did not meet eligibility criteria, 15 declined to participate, and seven could not be contacted, leaving 493. A further 20 dropped out (OA and HBP 7, OA 8, HBP 5) to give a final total of 473 participants, of whom 331 had OA (191 OA and HBP, 140 with OA alone) and 142 had HBP only. Patients with RA were recruited between October 1999 and May 2000. Of 292 volunteers, 20 were ineligible, could not be contacted or refused, and 19 dropped out after baseline for a final total of 253 (fig 1).

Demographic and baseline characteristics

As expected, patients with RA were generally younger than the groups with OA and HBP, with 109/253 (43.1%) patients below the age of 55. Patients with RA also included a higher proportion of women, and were more likely to be in full time employment (table 1). However, the proportion of employed among the 144 patients with RA over age 55 was 12.5%, similar to the employment rate observed among patients with HBP. Patients with RA tended to be more disabled and scored less well on the global health measure. They had fewer comorbidities than patients with OA with or without HBP, but not fewer comorbidities than patients with HBP. Among the 331 patients with OA, 185 had knee OA, 99 hip OA, 99 hand OA, and 176 OA in the spine; many patients had more than one part affected by OA.

Health resource use

A large majority of patients with RA (94.5%) had at least one investigative test in the 6 month period, compared with 77.0% of those in the OA and HBP group, 82.9% with OA alone, and 73.2% with HBP alone (table 2). The need for inpatient hospitalisation was low in all four groups, as was the use of community services, including home care. Almost 20% of patients with RA had purchased adaptive aids and devices in the previous 6 months, compared with 6.8% of those with OA and HBP, 7.9% of those with OA alone, and one patient (0.7%) with HBP.

Productive time spent in the household and workplace was lower among patients with RA than in the OA or HBP groups. More than 53% of patients with RA reported being unable to perform household chores, and even more (60%) said they received unpaid help. Although more patients with RA reported taking time off from paid work because of their health, they were also more likely to be part of the active workforce.
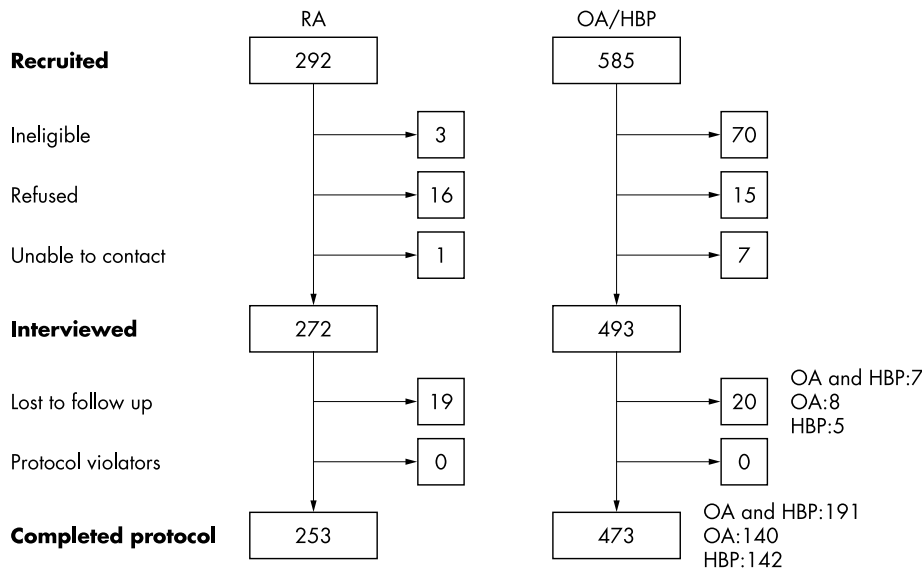
Figure 1 Recruitment flow diagram of patients with rheumatoid arthritis (RA), osteoarthritis (OA), or high blood pressure (HBP).

Cost of illness

Total 6 month costs related to RA were $4674, compared with $2456 for OA and HBP, $2856 for OA, and $1963 for HBP (table 3). Direct costs accounted for just over 80% of the total among patients with OA and HBP, but only 55.1% in RA. Almost half of all direct costs in all patient groups were attributable to drug costs. Arthritis prescription drugs accounted for a large proportion of drug costs in patients with RA, as did visits to specialists (which, in turn, comprised a larger proportion of health professional visits). Similarly, expenditure on tests was higher in RA. The indirect cost of RA was estimated to be $2098 per 6 month period—considerably higher than that of OA with or without HBP, or HBP (table 3). HBP was also diagnosed among 72 (28.5%) patients with RA; total costs were $5105 and $4540 per 6 month period for those with and without HBP.

Tabulation of costs for each diagnosis and some of the variables selected for use in the regression model (except global health status) revealed a linear trend toward increased costs with worsening global health status, and (though less linear) with increasing numbers of comorbidities (table 4). No other such trends were seen.

Role of diagnosis and other factors

The GLM approach was used first to test how strong an influence important covariables had on total costs. However, use of this model resulted in a less than perfect fit, with residuals heavily skewed to the right (kurtosis of 13.5). A far better fit was achieved with OLS regression on the log transformed total costs, which gave residuals that were approximately normally distributed and centred on zero with a kurtosis of 0. Despite differences in model fit, the statistical significance of the findings of both tests was similar (table 5). A diagnosis of RA and the number of comorbidities, including that of HBP for patients with RA, significantly influenced total costs ($p < 0.0001$), mostly by influencing direct costs. A diagnosis of OA with HBP also had a significant effect on the direct costs when compared with HBP alone (table 5), whereas no significant differences were observed between OA alone versus HBP alone. Results were no different when the analysis was limited to patients with RA who were over the age of 55. A diagnosis of OA overall, with or without HBP, was not significantly associated with higher direct healthcare costs after adjustment for the number of comorbid disorders (data not shown in the tables). The presence of comorbidities was a powerful predictor of costs. Together with the other co variables, it explained 31% of the variance in log transformed total costs, and 24% of that in log transformed direct costs.

When indirect costs were analysed with OLS on log transformed non-zero costs, excluding all patients with zero costs, no obviously significant contributor was identified. The picture was not much clearer when patients with zero costs were included by applying a proportional odds model to the indirect costs categorised into five groups (zero costs comprised group 1, and the remainder were assigned to quartiles). None of the covariables used emerged as significant factors, but a diagnosis of RA was associated with higher indirect costs (table 5).

Table 1	Patient demographics and selected disease characteristics			
	RA (n = 253)	OA and HBP (n = 191)	OA (n = 140)	Hypertension (n = 142)
Age (years), mean (SD)	57.1 (13.3)	71.7 (8.1)	69.7 (8.1)	68.2 (8.5)
Female, No (%)	202 (79.8%)	143 (74.9%)	97 (69.3%)	87 (61.3%)
Employed full time, No (%)	78 (30.8%)	15 (7.9%)	12 (8.6%)	18 (12.7%)
MD global*, mean (SD)†	2.4 (0.9)	2.8 (0.9)	2.7 (0.9)	2.1 (0.9)
HAQ disability index‡, mean (SD)	1.2 (0.7)	0.9 (0.6)	1.0 (0.6)	0.4 (0.4)
Global score, question 1 SF36§, mean (SD)	3.8 (1.2)	3.0 (0.9)	2.9 (1.0)	2.6 (0.9)
Comorbidities¶, mean (SD)	3.1 (2.0)	4.0 (2.0)	3.5 (2.1)	2.8 (1.6)

SD, standard deviation; BMI, body mass index (kg/m^2).
*MD global: 1 = very well, 5 = very poor; †maximum of MD global for OA or HBP if patient has both; ‡HAQ disability index: 0 = best, 3 = worst; §global score, question 1 SF36: 1 = excellent, 5 = very poor; ¶comorbidities: max = 23.

Table 2 Use of healthcare resources by patients with RA, OA, and hypertension in a 6 month period

	RA (n = 253)		OA and HBP (n = 191)		OA (n = 140)		HBP (n = 142)	
	No (%)	Mean (range)	No (%)	Mean (range)	No (%)	Mean (range)	No (%)	Mean (range)
At least one visit to a health professional	253 (100)		191 (100)		140 (100)		142 (100)	
Family physician visits	215	4.8 (1–33)	191	4.4 (1–22)	140	4.2 (1–24)	142	4.3 (1–15)
Non-surgical specialist visits	253	4.2 (1–35)	67	2.6 (1–13)	60	2.4 (1–23)	40	2.1 (1–9)
Surgical specialists	87	2.0 (1–10)	55	1.6 (1–7)	42	1.8 (1–12)	32	1.5 (1–4)
Allied health professionals	97	9.4 (1–60)	66	9.5 (1–40)	55	8.6 (1–36)	35	9.3 (1–48)
Dentists	115	1.8 (1–9)	34	1.6 (1–4)	33	1.6 (1–6)	40	1.3 (1–3)
At least one test or investigation	239 (94.5)		147 (77.0)		116 (82.9)		104 (73.2)	
x Ray	117	2.3 (1–12)	76	1.4 (1–5)	68	1.5 (1–4)	36	1.5 (1–13)
CT or MRI	7	1 (N/A)	8	1.1 (1–2)	8	1.3 (1–2)	6	1.2 (1–2)
Ultrasound	40	1.2 (1–2)	21	1.2 (1–3)	11	1.2 (1–2)	15	1.1 (1–2)
Electrodiagnostic tests (ECG, etc)	17	1.2 (1–3)	15	1.2 (1–3)	13	1.2 (1–2)	15	1.2 (1–3)
Laboratory tests	228	5.3 (1–27)	98	2.0 (1–26)	84	1.8 (1–12)	79	1.9 (1–7)
Bone density	23	1.0 (1–2)	15	1.0 (1–1)	10	1.1 (1–2)	6	1.0 (1–1)
Other tests or investigations	26	2.1 (1–25)	17	1.2 (1–4)	9	1 (1–1)	5	1.2 (1–3)
Patients hospitalised	9 (3.6)		9 (4.7)		7 (5.0)		5 (3.5)	
Took drugs	253 (100)	9.0 (2–28)	191 (100)	7.5 (1–18)	140 (100)	6.7 (1–17)	142 (100)	6.3 (1–16)
Arthritis drugs	253	3.6 (1–7)	182	1.7 (1–4)	131	1.8 (1–4)	116	1.4 (1–5)
Antihypertensive drugs	72	1.6 (1–4)	182	1.9 (1–5)	38	1.6 (1–3)	141	1.9 (1–5)
Gastroprotective drugs	97	1.1 (1–3)	61	1.1 (1–2)	45	1.1 (1–2)	23	1.2 (1–3)
Complementary medicine products	227	3.0 (1–12)	159	2.6 (1–7)	117	2.9 (1–10)	106	2.6 (1–12)
Other drugs	198	2.5 (1–13)	157	2.8 (1–10)	116	3.0 (1–9)	109	2.5 (1–7)
Community services used	27 (10.7)	6.0 (1–30)	23 (12.0)	4.9 (1–15)	16 (11.4)	6.0 (2–23)	2 (1.4)	7.0 (2–12)
Adaptive aids or devices purchased	50 (19.8)	1.9 (1–7)	13 (6.8)	1.1 (1–2)	11 (7.9)	1.1 (1–2)	1 (0.7)	1 (N/A)
Unable to do chores (h)	135 (53.4)	207.5 (2–1186)	58 (30.4)	124.1 (3–800)	43 (30.7)	243 (6–1440)	18 (12.7)	172 (20–540)
Needed paid help	68 (26.9)	N/A	30 (15.7)	N/A	11 (7.9)	N/A	10 (7.0)	N/A
Needed unpaid help (h)	149 (58.9)	202 (2–1638)	31 (16.2)	112.2 (4–444)	24 (17.1)	162.7 (12–626)	18 (12.7)	134.0 (23–728)
Patient time off work (h)	42 (16.6)	136.9 (6–1208)	1 (0.5)	160 (N/A)	5 (3.6)	77.2 (8–128)	6 (4.2)	272.1 (24–760)
Caregiver time off work (h)	16 (6.3)	46.8 (3–336)	1 (0.5)	2 (N/A)	1 (0.7)	18 (N/A)	0 (0.0)	8.0 (8.0–8.0)

RA, rheumatoid arthritis, OA, osteoarthritis, HBP, high blood pressure (hypertension).

DISCUSSION

This was a detailed, patient based COI study in patients with RA and OA in Canada, and one of only a few to attempt a comparison.[21] Costs of disease were estimated in patients with RA, OA, or HBP recruited consecutively from the offices of family physicians and rheumatologists in Ontario. Estimated total annual costs were approximately: RA $9300; OA with HBP $4900; OA alone $5700; and HBP alone, US$3900. The findings confirm that patients with RA face higher costs than do those with OA or HBP, while no significant differences in disease costs were found between OA alone or HBP alone. The higher costs associated with RA were accounted for by both higher time and productivity costs and by higher expenditures on tests and visits to specialists. Additionally, the number of comorbidities had a similarly strong association with disease costs for all diagnoses, cancelling out potential effects of age or sex.

Table 3 Cost of illness estimates for 6 months

	RA (n = 253)		OA and HBP (n = 191)		OA (n = 140)		HBP (n = 142)	
	$	%	$	%	$	%	$	%
Total costs	**4674**		**2456**		**2856**		**1963**	
Direct costs: total	*2575*	*55.1*	*2024*	*82.4*	*1976*	*69.2*	*1536*	*78.3*
Drugs: total	1237		974		768		786	
Arthritis drugs	769	62.2	143	14.7	163	21.2	59	7.5
Antihypertensive drugs	52	4.2	304	31.2	60	7.8	283	36.0
Gastroprotective drugs	110	8.9	96	9.9	88	11.5	50	6.4
Complementary medicine products	66	5.3	47	4.9	51	6.7	32	4.1
Other prescription drugs	240	19.4	383	39.4	406	52.9	361	46.0
Health professionals: total	554		339		384		316	
Family doctors	71	12.8	113	33.3	110	28.6	115	36.4
Non-surgeon specialists	146	26.3	58	17.0	69	17.9	50	15.9
Surgeon specialists	55	9.9	31	9.1	27	6.9	24	7.6
Dentists/dental surgeons	227	40.9	82	24.1	109	28.3	83	26.3
Allied health professionals	56	10.1	56	16.5	70	18.2	44	13.8
Separately ordered tests: total	278		110		119		100	
Hospitalisations: total	264		393		439		313	
Inpatient hospitalisation costs	153	57.8	243	61.9	300	68.4	237	75.8
Outpatient visit costs	86	32.5	64	16.2	60	13.7	27	8.8
Additional OHIP billings	25	9.6	86	21.9	79	18.0	48	15.4
Community services	186	–	203	–	219	–	19	–
Aids and devices	57	–	6	–	47	–	3	–
Indirect costs: total	*2098*	*44.9*	*432*	*17.6*	*880*	*30.8*	*427*	*21.7*
Lost time doing chores incl. paid help	1729	82.4	418	96.8	845	96.0	262	61.4
Time lost from work	326	15.5	14	3.2	33	3.8	164	38.3
Support person time lost from work	44	2.1	0	0.0	2	0.2	1	0.3

OA, osteoarthritis, HBP, high blood pressure (hypertension).

Table 4 Cost estimates for the three categorical covariables used in the statistical models

	RA (n = 253)		OA and HBP (n = 191)		OA (n = 140)		HBP (n = 142)	
	Total costs ($)	No (%)	Total costs ($)	No (%)	Total costs ($)	No (%)	Total costs ($)	No (%)
Number of comorbidities								
0	3861	120 (47.4)	1640	87 (15.1)	2038	51 (36.4)	1239	83 (58.5)
1	3842	49 (19.4)	2964	41 (27.2)	1551	30 (21.4)	1807	31 (21.8)
2	6317	35 (13.8)	2186	28 (20.1)	4008	30 (21.4)	2919	15 (10.6)
≥ 3	6323	49 (19.4)	4102	35 (37.7)	4455	29 (20.7)	5855	13 (9.2)
Education								
Less than high school	4435	71 (28.1)	2572	71 (35.1)	3060	45 (32.1)	1559	46 (32.4)
High school	4413	68 (26.9)	2481	66 (33.9)	3244	45 (32.1)	2135	57 (40.1)
College or university	4979	114 (45.1)	2272	54 (31.0)	2325	50 (35.7)	2190	39 (27.5)
Sex								
Male	4174	51 (20.2)	1907	48 (41.9)	3072	42 (30.0)	2000	55 (38.7)
Female	4800	202 (79.8)	2640	143 (58.1)	2764	98 (70.0)	1940	87 (61.3)

In this study units of health related use of resources and of time and productivity losses were collected in a very detailed questionnaire. Most cost assessment instruments used in rheumatological reports so far have had a limited coverage of all possible cost domains.[22] Furthermore, we used open ended descriptions for most units, including their intensity and their relationship to a specific health condition. Consequently, very little information may have been lost, a problem that hampers many studies, with increasing levels of aggregation of unit descriptions owing to a lack of detailed reporting. This comprehensive accounting of the use of healthcare resources strengthens the validity of the comparisons, even though patient based reporting may still lead to underestimation of the use of healthcare resources and, consequently, possibly larger differences in healthcare costs among the four diagnostic groups.

As with many COI studies, patients may not be truly representative, because participating patients do not represent those with a similar condition but who do not seek the advice of a family physician or a rheumatologist. These may be people who visit other healthcare providers (different specialists or alternative practitioners), and those who are well enough not to need professional help. However, we would expect the healthcare use of those not represented to be low, and inclusion of their data would reduce the projected total national costs. At the other end of the scale, the absence of patients in the care of an orthopaedic surgeon would be expected to raise the estimate. The cost of joint surgery undergone by four patients with OA during the present survey

period was captured, but the total medical expenditure incurred may have been underestimated to some degree.

There is concern that the economic burden of arthritic conditions, primarily OA, will increase, as the ''baby boomer'' generation gets older. It has been suggested that the costs of arthritic disorders may potentially exceed those of higher profile disorders, such as cardiovascular disease.[23] The present study provides new information to reassess the importance of disease costs that are attributable to arthritic disorders. Gabriel *et al*, in a similar study, calculated the direct and indirect costs of OA in a prevalence based cohort of patients in Olmsted County, Minnesota, and compared them with the total costs of illness among non-arthritic controls.[21] Patients with OA incurred significantly (p<0.0001) higher direct medical costs ($2044) than non-arthritic controls ($1592). In addition, medical costs were 28% higher among patients with OA (a similar figure to the present finding of 30%). However, in their statistical comparison, Gabriel and colleagues adjusted only for age and sex, both of which were found to be non-significant contributors in the present study. Indeed, adjustment of the present data for age and sex alone would have resulted in statistically significant differences between OA and HBP. The fact that such differences only became non-significant when adjustment was made for comorbidities and/or global health status confirms that disease costs increase as patients get sicker, potentially not because of their arthritis.

The total costs associated with OA or RA are often estimated to be in the double digit billions of dollars and,

Table 5 Results of regression analyses run separately for total, direct, and indirect costs

Dependent variable*	Adj. R2	Comparisons	B (SE)	p	Explanatory variables	B (SE)	p
Total costs	0.31	RA v HBP	1.020 (0.096)	<0.0001	Education (3 levels)	0.022 (0.039)	0.577
		OA and HBP v HBP	0.249 (0.095)	0.009	Comorbidities (0–23)	0.302 (0.028)	<0.0001
		OA v HBP	0.132 (0.102)	0.196	Sex	−0.029 (0.072)	0.685
					Age (years)	0.002 (0.003)	0.437
Direct costs	0.24	RA v HBP	0.702 (0.085)	<0.0001	Education	0.014 (0.035)	0.552
		OA and HBP v HBP	0.217 (0.084)	0.010	Comorbidities (0–23)	0.276 (0.025)	<0.0001
		OA v HBP	0.050 (0.090)	0.580	Sex	0.095 (0.064)	0.139
					Age (years)	0.006 (0.003)	0.033
Indirect costs†	0.14	RA v HBP	0.396 (0.118)	0.118	Education	0.029 (0.080)	0.716
		OA and HBP v HBP	−0.189 (0.261)	0.468	Comorbidities (0–24)	0.027 (0.032)	0.399
		OA v HBP	0.343 (0.276)	0.215	Sex	−0.230 (0.177)	0.194
					Age (years)	−0.008 (0.006)	0.128
			OR (95% CI)			OR (95% CI)	
Indirect costs‡	N/A	RA v HBP	1.71 (0.82 to 3.55)	0.040	Education	0.99 (0.79 to 1.26)	0.961
		OA&HBP v HBP	0.70 (0.33 to 1.50)	0.010	Comorbidities (0–24)	1.07 (0.98 to 1.18)	0.133
		OA v HBP	1.53 (0.68 to 3.40)	0.200	Sex	0.81 (0.48 to 1.35)	0.415
					Age (years)	0.99 (0.97 to 1.01)	0.283

*Dependent variable: log (costs per patient); †log (non-zero indirect costs); ‡proportional odds.

in Canada, were claimed to be "in the neighbourhood of $C23 billion". However, the total national cost of OA cannot be accurately assessed without reliable estimates of the prevalence of the disease. Data the from the US National Health Interview Survey published by the Centres for Disease Control and Prevention showed that in 1997 the prevalence of arthritic conditions (as determined by specific ICD codes, and with at least some activity limitation) was $2.9 \pm 0.3\%$.[1] If it is assumed that RA limits activity to some extent in every case and has a prevalence of 0.7%,[24] and further assumed that the remaining patients all have OA, the prevalence of OA with some form of activity limitation is 2.2%. Extrapolation of these numbers to the Canadian population (31 281 092 in the year 2000) and using the cost data reported here, shows that the total cost of RA is of the order of $C2.01 billion, and that of OA approximately $C3.26 billion. The combined figure of $C5.27 billion is clearly lower than the $C23 billion mentioned above, and would account for approximately 0.7% of the estimated Canadian GDP for the year 2000. Combined direct medical costs would be around $C3.2 billion, or 0.4% of the GDP for 2000—far less than most published estimates. This total amount might be at the low end of currently published estimates, owing to a possible underrepresentation of patients with surgery, given the sampling frame of this study. Extrapolation of the cost estimates found in this study to the entire population, however, may provide a more realistic picture of the economic burden of arthritic disorders in Canada, given the frequent overestimation of costs in COI studies.[4]

The relationship between direct medical costs and indirect costs (due to productivity losses or time contributed by care givers) is highly dependent on the estimation methods used. Clarke and associates found that indirect costs were only 34% of direct costs in RA,[25] whereas the present data indicate that they are 20% higher. Kobelt and associates estimated indirect costs to be, on average, 3.2-fold greater than direct costs.[26] Estimation of indirect costs is controversial, and current methods give insufficient weight to the potential economic gains that could be achieved by curing diseases that mainly affect women.[27] However, counting these potentially achievable improvements in productivity as "losses" to society is seldom acceptable to economists—which accounts for the widespread recommendation that indirect costs be excluded from economic evaluations.[28] An alternative method, the friction cost approach, only includes productivity costs during the period that is needed to restore the initial production level.[29] Indirect costs measured in this study would potentially overestimate by up to 80% the indirect costs incurred by society, compared with the friction cost approach.

In conclusion, this prospective evaluation of disease related costs among patients with RA, OA, or HBP showed that expenditure attributable to RA exceeds that related to OA and HBP, while differences between patients with a diagnosis of OA without HBP and a diagnosis of HBP were nonsignificant. The influence of comorbidities on differences in total costs between diseases is significant and needs to be accounted for in future COI studies.

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