The incidence of spinal surgery in Canada

Greg McIntosh, BHK; Hamilton Hall, MD; Tony Melles, BSc, PT

Objective: To estimate the incidence of spinal surgery in 5 Canadian provinces over a 12-month period.

Design: Cumulative incidence study.

Setting: Five provinces (63% of Canada's population).

Participants: All patients who underwent spinal surgery between July 1, 1992, and June 30, 1993, in British Columbia, Alberta, Ontario, New Brunswick and Newfoundland.

Main outcome measure: Overall spinal surgery rates per province and by age and sex.

Results: In the 5 provinces over the allotted 12-month period, 12 329 spinal surgical procedures were performed. The overall rate of spinal surgery for the 5 provinces was 80 per 100 000 population. Ontario had the lowest rate of 61 per 100 000; British Columbia had the highest at 89 per 100 000. Men aged 40 to 49 years in Newfoundland had the highest overall rate at 210 per 100 000. Calculation of relative risks determined that Newfoundland's under-20 age groups for both sexes were almost 3 times as likely to undergo spinal surgery as the same age groups in Ontario (male relative risk = 2.73, female relative risk = 2.84). Males in British Columbia and Alberta had a statistically significant increased risk of surgery across all age groups except for those under 20 years old, and females in British Columbia showed a statistically significant increased risk of surgery across all age groups compared with those in Ontario. Males underwent 57.7% of all spine operations.

Conclusions: The incidence of spinal surgery is not uniform across Canada. Overall, the per capita rate is lower than in the United States. The explanation for this divergence remains unclear.

Objectif : Estimer l'incidence des interventions chirurgicales à la moelle épinière dans cinq provinces canadiennes pendant 12 mois.

Conception : Étude d'incidence cumulative.

Contexte : Cinq provinces (63 % de la population du Canada).

Participants : Tous les patients qui ont subi une intervention chirurgicale à la moelle épinière entre le 1er juillet 1992 et le 30 juin 1993 en Colombie-Britannique, en Alberta, en Ontario, au Nouveau Brunswick et à Terre-Neuve.

Principale mesure de résultats : Taux globaux d'interventions chirurgicales à la moelle épinière par province et selon l'âge et le sexe.

Résultats : Dans les cinq provinces en cause au cours de la période de 12 mois étudiée, on a procédé à 12 329 interventions chirurgicales à la moelle épinière. Le taux global d'interventions chirurgicales à la moelle épinière pour les cinq provinces s'est établi à 80 pour 100 000 habitants. L'Ontario a enregistré le taux le plus bas à 61 pour 100 000 et la Colombie-Britannique, le plus élevé à 89 pour 100 000. Les hommes âgés de 40 à 49 ans à Terre-Neuve ont présenté le taux global le plus élevé, à 210 pour 100 000. Le calcul des risques relatifs a permis d'établir que les groupes de moins de 20 ans des deux sexes à Terre-Neuve étaient presque trois fois plus susceptibles de subir une intervention chirurgicale à la moelle épinière que les mêmes groupes d'âge en Ontario (risque relatif = 2,73 chez les hommes et 2,84 chez les femmes). Les hommes de la Colombie-Britannique et de l'Alberta présentaient un risque d'intervention chirurgicale beaucoup élevé sur le plan statistique dans tous les groupes d'âge sauf chez les moins de 20 ans et les

From the Research Department, Canadian Back Institute, Toronto, Ont.

Presented at the annual conference of the Canadian Association for Disorders of the Spine, Toronto, Ont., Sept. 6, 1996

Accepted for publication Aug. 18, 1997

Correspondence to: *Greg McIntosh, Canadian Back Institute, 1200-330 Front St. W, Toronto ON M5V 3B7; gmcintosh@cbi.ca*

femmes de la Colombie-Britannique présentaient un risque d'intervention chirurgicale beaucoup moins élevé sur le plan statistique chez tous les groupes d'âge par rapport à ceux de l'Ontario. Les hommes ont subi 57,7 % de toutes les interventions pratiquées à la moelle épinière.

CONCLUSIONS : L'incidence des interventions chirurgicales à moelle épinière n'est pas uniforme au Canada. Dans l'ensemble, le taux par habitant est moins élevé qu'au États-Unis. La raison de cet écart reste à préciser.

The soaring cost of health care is not solely an American phenomenon. Canadian health expenditures continue to rise and have been estimated at 8.5% of the gross domestic product, third among developed countries behind the United States (11.5%) and Germany (8.6%).[1] Provincial health plans seemed to work well initially, but the foundation of the system continues to erode, with escalating health care costs and the growing expectations of the Canadian population. Politicians, physicians, hospital administrators, hospital workers and the public are increasingly frustrated as provincial health costs consume nearly one-third of the provincial budgets.

Because of the high prevalence of back pain, its treatment takes up a significant proportion of provincial health care costs. Lifetime prevalence rates are estimated to be as high as 90%.[2] Although most sufferers of back pain recover within 3 months, the 10% of those who have chronic pain consume 80% of the associated costs.[3,4]

Conservative care remains the most appropriate choice for treating almost all patients with back pain; however, for a few, there are definite indications for surgery. Analysis of back surgery rates allows for the evaluation of the proportion of patients receiving operative intervention. The purpose of this study was to estimate and compare the incidence of spinal surgery for 5 provinces in Canada.

METHODS

Data were studied for all patients in the provinces of British Columbia, Alberta, Ontario, New Brunswick and Newfoundland who underwent back or neck operations between July 1, 1992, and June 30, 1993. Since complete data from all hospitals in the remaining provinces and territories were not available, these were not included in the analysis.

Our data were gathered according to a coding system. Government legislation requires hospitals to code each surgical procedure. These codes are forwarded to the Canadian Institute for Health Information (CIHI) (formerly the Health Medical Records Institute). At CIHI, a computer program assigns each of these codes to the appropriate case mix group (CMG) code (Table I). The CIHI then makes the data available to database companies. We compiled the information by province using the health care database at Compusearch, a database company. The data were part of the 4 CMG codes that make up the back and neck operative procedures within major clinical category 8 (MCC-8) — diseases and disorders of the musculoskeletal system and connective tissue — based on the International Classification of Diseases, ninth revision (ICD-9).[5]

Frequencies of spinal surgery were tabulated by province and by sex and age. Although the exact age of the patients at the time of surgery was not available, the frequency of spinal surgery was recorded for each 5-year increment from birth to 90 years and over. For ease of presentation of the results, the age groups were collapsed into decades.

Rates of spinal surgery were based on the number of procedures in relation to provincial populations. Table II shows the population totals and proportion of males from the 1991 Canada census.[6] Table III displays the total number of spinal procedures by sex and province. Overall rates of spinal surgery (Fig. 1) were calculated using a crude incidence rate formula as follows: number of spinal surgical procedures per province divided by the provincial population multiplied by 100 000.

Age group-specific rates of spinal surgery by sex (Tables IV and V) were based on the number of procedures in relation to the age/sex provincial populations (Table VI). The data in Table II show the demographic similarities between the 5 provinces; thus, age and sex results were not standardized.[7]

RESULTS

Between July 1, 1992, and June 30, 1993, 12 329 spinal procedures were performed in the 5 provinces. Males underwent 57.7% of all the spine operations. The mean rate of spinal surgery for the 5 provinces was 80 per 100 000. British Columbia had the highest crude spinal surgery rate, at 89 per 100 000 and Ontario had the lowest rate, at 61 per 100 000 (Fig. 1). These rankings were consistent when further analysed by sex.

Tables IV and V depict the provincial rates by sex. In Newfoundland, for the under-20 year age group, the surgery rate was approximately twice that of the other provinces for both sexes. The peak rate of spinal surgery for men in British Columbia was in the 40 to 49 and 50 to 59 years age groups; for women the peak rate was

in the 50 to 59 years age group. In Alberta, the peak rate for men was in the 40 to 49 years age group; for females the peak rate was in the 60 years and over age group. In the remaining 3 provinces the peak rate for both sexes was in the 40 to 49 years age group except for men in Ontario, for whom the peak was in the 50 to 59 years age group.

The male 40 to 49 years age group in Newfoundland had the highest spinal surgery rate (210 per 100 000). Of the females, the 60 years and over age group in Alberta had the highest rate (159 per 100 000). The lowest rate for working-age males (over 19 and less than 60 years) was in Ontario's 20 to 29 years age group, at 50 per 100 000. The lowest rate for working-age females (over 19 and less than 60 years) was 23 per 100 000 in the 20 to 29 years age group in Alberta, Ontario and Newfoundland.

Poisson regression for random events (count data) was applied to calculate relative risks (SAS statistical software), with the use of a binomial distribution and modelling the logit of an event (surgery yes/no). Statistical significance was set at $p < 0.05$ and assessed with use of the Wald χ^2 probability. Relative risks were calculated separately for males and females by age group for each province with Ontario as the reference (Tables VII and VIII).

For males, the highest increased risk of having spinal surgery was in Newfoundland for the under-20 years age group (Table VII); this group was almost 3 times as likely to undergo spinal surgery as Ontario males in the same age group. Neither increased risk nor protective effect (RR = 1) was observed in New Brunswick's under-20 years age group. British Columbia and Alberta had significantly increased risk of surgery across all age groups except for their under-20 years age groups. Also, there was a significantly increased risk in the 30 to 39, 40 to 49, and 50 to 59 years age groups for all provinces compared with Ontario.

Table VIII shows that like men, the highest increased risk of women undergoing spinal surgery was also in Newfoundland in the under-20 years age group; this group was almost 3 times as likely to undergo spinal surgery as Ontario females in the same age group. Neither increased risk nor protective effect (RR = 1) was observed in Alberta and Newfoundland (20 to 29 years age groups) and New Brunswick (under-20 and 50 to 59

Table I

Back and Neck Operative Procedures and Hospital Codes That Were Used in Compiling the Incidence of Spinal Surgery in Canada*

Hospital code	Description
CMG 358 and 359	
9301	Atlas–axis spinal fusion
9302	Other cervical spinal fusion
9303	Dorsal spinal fusion
9304	Dorsolumbar spinal fusion with Harrington rod
9305	Other dorsolumbar spinal fusion
9306	Lumbar spinal fusion
9307	Lumbosacral spinal fusion
9308	Refusion of the spine
9309	Other spinal fusion
CMG 360 and 409	
1602	Reopening of laminectomy site
1609	Other exploration and decompression — spinal canal
161	Division — intraspinal nerve root
163	Excision/destruction in spinal cord/meninges
1643	Repair of vertebral fracture
1649	Other repair and plasty operation — spinal cord
165	Free adhesion — spinal cord and nerve root
1682	Biopsy of cord or meninges
1689	Other diagnostic procedure — spinal cord and structure
1690	Insert catheter in spinal canal
1693	Insert/replace spinal neurostimula
1694	Removal of neurostimula — spinal canal
1697	Revision of spinal thecal shunt
1698	Removal of spinal thecal shunt
1699	Other operation — spinal cord and structures neck
9231	Excision of intervertebral disc
9234	Other destruction of intervertebral disc

CMG = case mix group
*The 4 categories of CMG codes are from the *International Classification of Diseases*, ninth revision.
CMG 358 = back and neck procedures with spinal fusion without complication and/or comorbidity
CMG 359 = back and neck procedures with spinal fusion with complication and/or comorbidity
CMG 360 = back and neck procedures without spinal fusion without complication and/or comorbidity
CMG 409 = back and neck procedures without spinal fusion with complication and/or comorbidity

years age groups). British Columbia showed a significantly increased risk of surgery across all age groups compared with Ontario.

Discussion

Analysis of Canadian surgical rates compared with those of other countries is difficult because of varying study designs. Davis[8] studied rates of hospitalization for cervical and lumbar spine surgery between 1979 and 1990 for US adults over the age of 25 years. In 1990, the incidence of surgery was 98 per 100 000 for the cervical spine and 323 per 100 000 for the lumbar spine. When comparing the 2 studies, Canadian rates are approximately 5 times lower.

The sex distribution for each provincial population is similar; thus, comparisons between provinces are appropriate. Spangfort[9] stated that most surveys of spinal surgery rates indicate that twice as many men as women will undergo surgery. Although we found that more men had spinal surgery than women, we did not find that proportion to be the case. The peak age range of surgery corresponds to Andersson's findings,[10] which showed that the maximum frequency of symptoms is between 35 and 55 years. Alberta was the exception.

The lack of effect of gender is misleading. Census data show an almost equal distribution of the sexes across the 5 provinces (Table II). But since more men report back pain than women,[11] there may be a gender effect that is hidden by the use of population-based rates, especially in Alberta.

Consistent with previous research, we calculated population-based rates for spinal surgery per 100 000 population. Since spinal surgery without a history of pain is uncommon (Dr. M. Ford, Orthopedic Surgeon, Orthopaedic and Arthritic Hospital, Toronto: personal communication, 1996) the spinal surgery rate would be more accurately estimated by using a denominator consisting of those who suffer from spine pain (a population at risk) rather than an overall population. To accomplish this, the formula would be adjusted to include "period prevalence" to help increase accuracy as follows: number of spine surgeries divided by (province population multiplied by period prevalence) multiplied by 100 000.

Prevalence includes how many people in a population have the condition in question and includes those with chronic, ongoing back and neck pain from previous years.[12,13] Period prevalence involves a specified length of time and is considered cumulative; thus, period prevalence (a cumulative measure of how many patients undergo surgery) would be preferable to annual incidence, which is an estimate based on new episodes in a given year.[13] Because Canadian epidemiologic research on prevalence statistics is lacking, period prevalence would have to be estimated. Until such numbers are researched, population-based rates remain the most accurate, and assessing the effect of sex is limited.

An acceptable rate of spinal surgery remains undefined. Advocates of conservative care and reduced surgical intervention believe that surgeons operate unnecessarily. Some surgeons argue that a low surgical rate reflects a larger population of suffering patients who would benefit from a spinal operation. Davis[8] speculated that the increase in spinal surgery from 1979 to 1990 in the US may be based on technology. During the 1980s, magnetic

Table II

Population[6] by Sex for 5 Provinces

Sex	British Columbia	Alberta	Ontario	New Brunswick	Newfoundland
Total	3 282 045	2 545 545	10 084 880	723 900	568 480
Female	1 656 080	1 268 170	5 131 805	366 710	284 645
Male	1 625 965	1 277 375	4 953 075	357 190	283 835
% male	49.5	50.2	49.1	49.3	49.9

Table III

Number of Spinal Procedures by Sex for 5 Provinces

Sex	British Columbia	Alberta	Ontario	New Brunswick	Newfoundland
Total	2925	2142	6201	573	488
Female	1267	896	2620	231	203
Male	1658	1246	3581	332	285
% male	56.7	58.2	57.8	57.9	58.4

resonance imaging (MRI) became a widely used method of investigation, and a variety of previously undetected spinal abnormalities became the justification for more spinal surgery. It may be that the greater availability of MRI in the US than in Canada is contributing to the discrepancy in the rates of spinal surgery between the 2 countries.

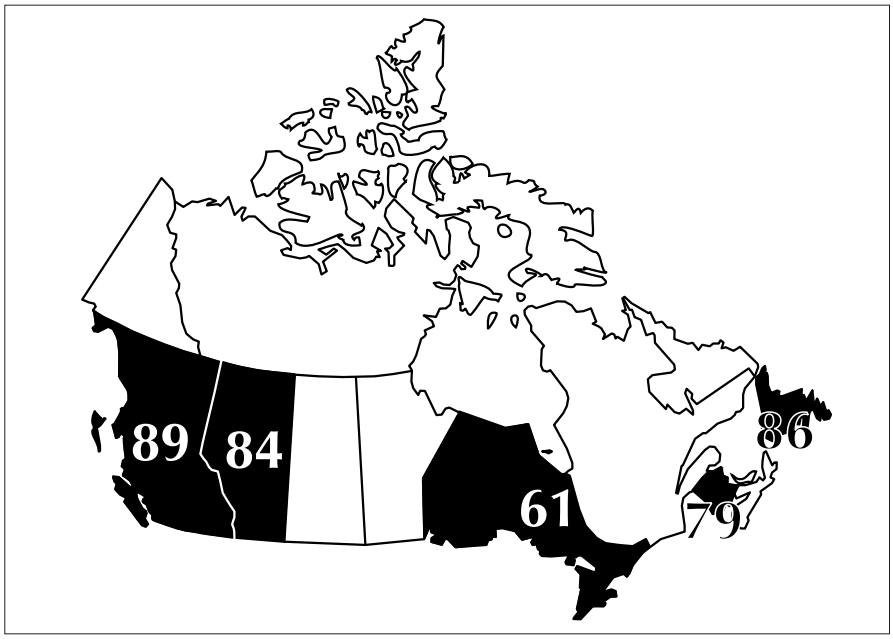

FIG. 1. Spine surgery rates per 100 000 for 5 provinces (July 1992 to June 1993).

A lack of financial incentive for surgeons selecting a surgical treatment may also affect the number of operations. American surgeons bill as much as US$15 000 for a 3-level lumbar spine fusion with instrumentation. In contrast, Canadian surgeons can earn as little as US$400 for the same procedure (H. Hall, Medical Director, Canadian Back Institute: personal communication, 1996).

Due to current Canadian health care policies, low surgical rates in Canada may be the result of limited access to orthopedic surgeons and neurosurgeons, since longer waiting lists and limited operating time will affect the surgical decision-making process. Some investigators have hypothesized that the surgeon-to-population ratio may affect surgery rates. Peterson and

Table IV

Rates of Spinal Surgery by Decade of Life for Men in 5 Provinces

Age group, yr	Province, no. of spinal procedures/100 000 population				
	British Columbia	Alberta	Ontario	New Brunswick	Newfoundland
< 20	8	9	7	7	19
20–29	71	65	50	72	62
30–39	162	157	116	159	189
40–49	173	182	121	168	210
50–59	173	164	122	141	192
≥ 60	121	145	93	115	69

Table V

Rates of Spinal Surgery by Decade of Life for Women in 5 Provinces

Age group, yr	Province, no. of spinal procedures/100 000 population				
	British Columbia	Alberta	Ontario	New Brunswick	Newfoundland
< 20	13	10	8	9	24
20–29	37	23	23	42	23
30–39	108	75	66	96	88
40–49	122	132	95	120	169
50–59	125	138	83	87	132
≥ 60	109	159	74	81	89

Table VI

Number of Spinal Procedures and Provincial Population According to Patient Age and Sex

Age groups by province	Spinal procedures, no		Provincial population, no	
	Men	Women	Men	Women
British Columbia				
< 20	36	55	447 590	426 385
20–29	174	90	246 245	246 075
30–39	462	312	285 100	290 045
40–49	404	278	234 190	228 740
50–59	272	190	157 620	151 850
≥ 60	310	342	255 220	312 985
Total	1658	1267	1 625 965	1 656 080
Alberta				
< 20	34	38	399 235	379 805
20–29	139	50	214 185	213 980
30–39	386	177	245 670	236 875
40–49	301	211	165 755	159 740
50–59	175	142	106 750	102 560
≥ 60	211	278	145 780	175 210
Total	1246	896	1 277 375	1 268 170
Ontario				
< 20	99	111	1 402 900	1 331 400
20–29	411	192	819 830	826 260
30–39	995	583	857 275	884 060
40–49	830	659	683 910	690 095
50–59	581	397	477 420	480 790
≥ 60	665	678	711 740	919 200
Total	3581	2620	4 953 075	5 131 805
New Brunswick				
< 20	8	9	106 960	101 855
20–29	41	24	56 900	56 905
30–39	96	59	60 540	61 695
40–49	83	58	49 505	48 295
50–59	55	28	31 930	32 260
≥ 60	59	53	51 355	65 700
Total	342	231	357 190	366 710
Newfoundland				
< 20	18	21	93 295	88 730
20–29	29	11	47 030	47 560
30–39	88	42	46 465	47 900
40–49	80	63	38 140	37 295
50–59	46	30	23 935	22 800
≥ 60	24	36	34 970	40 360
Total	285	203	283 835	284 645

colleagues[14] reported an inconsistent correlation between the numbers of surgeons and the rate of spinal surgery, and Keller and associates[15] did not find a direct relationship. Although the number of practising surgeons in the 5 provinces in question is available,[16] establishing such a relationship requires finding out the number who actually perform spinal surgery. Determining this number and evaluating the relation between the ratio of surgeons to the general population is worthy of further research.

We recognize some potential weaknesses in our method. We cannot control for the problem of double-counting of individuals who had either multiple procedures or the same procedure more than once in the same year; however, the number of patients who have more than 1 spinal procedure in a 12-month period is low (Dr. M. Ford: personal communication, 1996). Thus, our data represent the number of procedures not the actual number of patients. Some patients may have travelled outside the province for their procedures and are not represented in the appropriate provincial database. These patients would, however, have been included in the provincial census. Conversely, it is possible that procedures were performed within the provinces on people from other jurisdictions. However, the rate of this occurrence is also low (Dr. M. Ford: personal communication, 1996) and has a minimal effect on the calculations.

The strengths of this methodology include a consecutive sample, use of a large database and the representation of all hospitals from each province studied. Without complex sampling procedures and weightings, calculation of surgical rates would not be possible from a random sample. Since the census data represent an entire population for a given geographic area, manipulation of the data is not

required. Also, because the 5 provinces studied range from coast to coast and are not clustered together in a specific region, adequate geographic representation is achieved.

Although hospitals, physicians or provinces each may code similar procedures differently, classifying the data into 1 categorical variable — spinal surgery, yes or no — eliminated many of the problems associated with variable coding. However, analysis according to individual procedure was not possible.

Summary and conclusions

Determination of the appropriate rate for spinal surgery may not be answerable. We propose 2 avenues for additional research. First, a study analysing variation in rates of spinal surgery between cities or regions within a province is an important next step. Second, calculation of the mean number of spinal procedures performed per surgeon per year may help define practice patterns of high- and low-volume surgeons. Also, calculation of spinal surgery rates using the population at risk as the denominator would be beneficial if Canadian prevalence rates become available.

Surgery is the subject of continuous scrutiny because of its profound impact on the patient, the dramatic nature of the intervention and the potential high cost of operative care. The rates of spinal surgery in Canada, based on the 5 provinces studied here, indicate a national variation and an overall lower rate of spinal surgery per capita than in the US; however, the explanation for these divergences remains unclear.

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Table VII

Relative Risks for Men Undergoing Spinal Surgery for Each Age Group by Province

Age group, yr	Province				
	Ontario (reference)	British Columbia	Alberta	New Brunswick	Newfoundland
< 20	1.00	1.14	1.21	1.06	2.73*
20–29	1.00	1.41*	1.29*	1.44*	1.23
30–39	1.00	1.40*	1.35*	1.37*	1.63*
40–49	1.00	1.42*	1.50*	1.38*	1.73*
50–59	1.00	1.42*	1.35*	1.42*	1.58*
≥ 60	1.00	1.30*	1.55*	1.23	0.73

*$p < 0.05$

Table VIII

Relative Risks for Women Undergoing Spinal Surgery for Each Age Group by Province

Age group, yr	Province				
	Ontario (reference)	British Columbia	Alberta	New Brunswick	Newfoundland
< 20	1.00	1.55*	1.20	1.06	2.84*
20–29	1.00	1.57*	1.01	1.82*	1.00
30–39	1.00	1.63*	1.13	1.45*	1.33
40–49	1.00	1.27*	1.38*	1.26	1.77*
50–59	1.00	1.52*	1.68*	1.05	1.59*
≥ 60	1.00	1.48*	2.15*	1.09	1.21

*$p < 0.05$

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