The burden of second hip fractures: provincial surgical hospitalizations over 15 years

Pierre Guy, MD, MBA
Boris Sobolev, PhD
Katie Jane Sheehan, PhD
Lisa Kuramoto, MSc
Kelly Ann Lefavre, MD, MSc

Accepted Oct. 11, 2016; Early-released
Feb. 1, 2017

Correspondence to:

K.J. Sheehan
School of Population and Public Health
University of British Columbia
Floor 7, 828 West 10th Ave
Vancouver BC V5Z1M9
sheehakj@mail.ubc.ca

DOI: 10.1503/cjs.008616

Background: Second hip fractures account for up to 15% of all hip fractures. We sought to determine if the proportion of hip fracture surgeries for second hip fracture changed over time in terms of patient and fracture characteristics.

Methods: We reviewed the records of patients older than 60 years hospitalized for hip fracture surgery between 1990 and 2005 in British Columbia. We studied the proportion of surgeries for second hip fracture among all hip fracture surgeries. Linear regression tested for trends across fiscal years for women and men.

Results: We obtained 46 341 patient records. Second hip fracture accounted for 8.3% of hip fracture surgeries. For women the proportion of second hip fracture surgeries increased linearly from 4% to 13% with each age decade ($p = 0.001$) and across fiscal years ($p = 0.002$). In men the proportion of second hip fracture surgeries was 5% for each age decade between the ages of 60 and 90 years across fiscal years, increasing to 8% for men older than 90 years across fiscal years ($p = 0.20$). These sex-specific trends were similar for both pertrochanteric and transcervical fracture types.

Conclusion: Second hip fracture surgeries account for an increasing proportion of hip fracture surgeries and may require more health care resources to minimize poorer reported outcomes. Future research should determine whether more health care resources are required to manage these patients and optimize their outcomes.

Contexte : Les secondes fractures de la hanche représentent jusqu'à 15 % de la totalité des fractures de la hanche. Nous avons tenté de déterminer si la proportion de chirurgies de seconde fracture de la hanche avait évolué au fil du temps sur le plan des caractéristiques des patients et des fractures.

Méthodes : Nous avons examiné les dossiers des patients de 60 ans et plus qui avaient été hospitalisés pour une chirurgie de fracture de la hanche entre 1990 et 2005, en Colombie-Britannique. De ce total, nous avons ensuite déterminé le nombre de chirurgies de seconde fracture de la hanche. L'analyse de régression linéaire a déterminé les tendances au cours des années financières pour les femmes et les hommes.

Résultats : Nous avons obtenu 46 341 dossiers de patient. Les secondes fractures de la hanche représentaient 8,3 % de la totalité des chirurgies de fracture de la hanche. Chez les femmes, la proportion de seconde fracture de la hanche augmentait de façon linéaire de 4 % à 13 % pour chaque tranche d'âge de 10 ans ($p = 0,001$) et sur l'ensemble des années financières ($p = 0,002$). Chez les hommes, la proportion de chirurgies de seconde fracture de la hanche était de 5 % pour chaque tranche d'âge de 10 ans entre 60 et 90 ans et sur l'ensemble des années financières, et augmentait à 8 % pour les hommes de plus de 90 ans sur l'ensemble des années financières ($p = 0,20$). Ces tendances selon le sexe étaient similaires tant pour les fractures pertrochantériennes que pour les fractures transcervicales.

Conclusion : Les chirurgies de seconde fracture de la hanche représentent une proportion croissante de la totalité des chirurgies de fracture de la hanche et pourraient nécessiter davantage de ressources en soins de santé pour minimiser les résultats moins bons signalés. Les recherches futures devraient déterminer s'il faut davantage de ressources de soins de santé pour la prise en charge de ces patients et l'optimisation de leurs résultats.

In 2014 the incidence of hip fracture was 521 per 100 000 in Canada.¹ This translated to approximately 22 000 admissions to acute care, of which 90% of patients underwent surgery.² Each hip fracture carries an estimated direct health care cost of \$27 000 (Canadian).³ In fact, hip fractures are estimated to account for 72% of the total cost of fractures.^{4,5} Resource allocation for hip fracture surgeries are often based on analyses for first hip fractures alone by excluding patients who presented with a history of prior fracture.^{6–9} However, previous reports indicate that second hip fractures account for up to 15% of all hip fractures.^{10–19} These second hip fractures are associated with poorer postoperative outcomes, including complications,²⁰ transitions to long-term care²⁰ and mortality.²¹

Omsland and colleagues²² reported that the number of patients surviving first hip fracture surgery increased over 10 years. The risk of second hip fracture persists for at least 10 years after the first hip fracture.²³ Therefore, increased survival after a first hip fracture should lead to an increase in second hip fractures. Yet, it is unknown whether the proportion of patients undergoing hip fracture surgery for second hip fracture changed over time. It is also unknown whether patient and fracture characteristics changed over time. The primary objective of this study was to determine if the proportion of surgeries for second hip fracture changed over 15 years of follow-up in British Columbia, Canada. We also sought to estimate the proportion of second hip fracture over 15 years of follow-up by characteristics of patients and their fractures.

METHODS

Data sources

We retrieved all records of hospitalizations for hip fracture surgery from Apr. 1, 1985, to Mar. 31, 2005, in British Columbia. The data for this study were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.²⁴ This database is a linkable, patient-oriented database that captures administrative information on patient demographics, health care and health services for all British Columbia residents. Each hospitalization record has an admission date, separation date, most responsible diagnosis, primary diagnosis, postadmission comorbidity diagnosis, level of care, and patient sex and date of birth. Diagnoses were coded according to the International Classification of Diseases (ICD), 9th Revision (ICD-9),²⁵ and surgical treatments were coded according to the Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures.²⁶ Although the province of British Columbia began using

the ICD 10th revision (ICD-10) in 2001–2002, the data were converted back to ICD-9 for uniformity. The University of British Columbia ethics board approved our study.

Inclusion/exclusion criteria

A total of 74 940 records of hospitalization for hip fracture surgery during the study period were retrieved. We excluded 2298 records of potentially pathological hip fractures by identifying patients with at least 1 hospitalization record that was cancer-related (most responsible diagnosis ICD-9 code 140–239, or diagnosis type 162, 174, 185, 189, 203, 196–198). A further 5708 records that were complication-related (most responsible diagnosis 996–999), orthopedic aftercare-related (most responsible diagnosis V57, V58, V63–V68, V71) or that had levels of care other than acute (level of care code D, E, I, L, R, or S) were also excluded.

Construction of care episodes

A hip fracture care episode was defined as the surgical management of a hip fracture from admission to discharge from hospital. Multiple records of hip fracture with readmission within 1 day were considered hospital transfers

Table 1. Characteristics of 46 341 episodes of hip fracture in British Columbia, Canada, 1990–2004*

Characteristic	Hip fracture episode; no. (%)	
	First (n = 42 475)	Second (n = 3866)
Sex		
Women	30 588 (72.0)	3119 (80.7)
Men	11 262 (26.5)	693 (17.9)
Unknown	625 (1.5)	54 (1.4)
Age, yr		
60–69	4069 (9.6)	197 (5.1)
70–79	12 105 (28.5)	813 (21.0)
80–89	19 476 (45.9)	1938 (50.1)
≥ 90	6825 (16.1)	918 (23.7)
Fracture subtype		
Pertrochanteric	19 907 (46.9)	2013 (52.1)
Transcervical	22 486 (52.9)	1853 (47.9)
Unknown	82 (0.2)	0 (0)
Fiscal period of discharge†		
1990–1995	15 626 (36.8)	1293 (33.4)
1996–1999	11 580 (27.3)	1083 (28.0)
2000–2004	15 269 (35.9)	1490 (38.5)
Hospital length of stay, wk		
< 1	8707 (20.5)	576 (14.9)
1–2	13 199 (31.1)	1293 (33.4)
> 2	20 569 (48.4)	1997 (51.7)

*Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

†Fiscal year is from April to March.

and treated as a single episode. Of the 66 934 records of hospitalization, 59 523 care episodes were constructed. Of these, 1371 care episodes were excluded: 761 that occurred within 90 days and were related to the preceding care episode, 399 with a length of stay of 3 days or less, 140 with patients younger than 60 years as a condition of our data request, and 71 related to a third or later hip fracture.

Care episodes related to first and second hip fractures were identified for each patient using the unique provincial health numbers. To reduce the possibility of classifying a second hip fracture as a first hip fracture, we adopted a “wash-out” and “look back” strategy. Hip fracture surgeries performed between Apr. 1, 1985, and Mar. 31, 1990, were excluded to prevent misclassification.²⁷ For patients presenting with hip fracture from Apr. 1, 1990, onwards, records from Apr. 1, 1985, were reviewed for previous hip fracture admissions. These 2 rules led to the exclusion of 11 877 hip fracture cases. The final cohort comprised 46 341 patients aged 60 years or older with hip fracture care episodes between Apr. 1,

1990, and Mar. 31, 2005. We then designated the earliest hip fracture care episode as the first hip fracture and the next hip fracture care episode as the second hip fracture.

Statistical analysis

We compared characteristics of first and second hip fracture surgeries, including the patient's sex, age at hip fracture, and subtype of hip fracture. Two subtypes of hip fracture were defined by diagnosis: transcervical fractures (ICD-9 codes 820.0, 820.1, 820.8 and 820.9) and pertrochanteric fractures (ICD-9 codes 820.2 and 820.3). Hip fractures of unspecified type (ICD-9 codes 820.8 and 820.9) were classified as transcervical fractures to account for the change in coding from ICD-9 to ICD-10 in 2001.

We studied the proportions of second hip fracture surgeries among all hip fracture surgeries. These proportions were estimated by sex, across age groups, by fracture type, and across fiscal years. The proportion of pertrochanteric subtype among second hip fractures was

Table 2. Number (and proportion) of second hip fractures by age and hip fracture subtype for women*

Fiscal year*	Pertrochanteric					Transcervical				
	60–69	70–79	80–89	≥ 90	All age groups	60–69	70–79	80–89	≥ 90	All age groups
1990	4/208 (1.9)	13/581 (2.2)	37/748 (4.9)	24/295 (8.1)	78/1832 (4.3)	0/208 (0.0)	20/581 (3.4)	31/748 (4.1)	6/295 (2.0)	57/1832 (3.1)
1991	3/189 (1.6)	17/596 (2.9)	33/826 (4.0)	22/318 (6.9)	75/1929 (3.9)	2/189 (1.1)	16/596 (2.7)	35/826 (4.2)	13/318 (4.1)	66/1929 (3.4)
1992	4/198 (2.0)	17/620 (2.7)	32/907 (3.5)	28/328 (8.5)	81/2053 (3.9)	6/198 (3.0)	29/620 (4.7)	47/907 (5.2)	21/328 (6.4)	103/2053 (5.0)
1993	4/174 (2.3)	25/631 (4.0)	44/948 (4.6)	22/359 (6.1)	95/2112 (4.5)	2/174 (1.1)	18/631 (2.9)	43/948 (4.5)	18/359 (5.0)	81/2112 (3.8)
1994	3/172 (1.7)	24/636 (3.8)	61/1013 (6.0)	19/327 (5.8)	107/2148 (5.0)	3/172 (1.7)	24/636 (3.8)	36/1013 (3.6)	12/327 (3.7)	75/2148 (3.5)
1995	4/159 (2.5)	22/629 (3.5)	55/1023 (5.4)	31/376 (8.2)	112/2187 (5.1)	2/159 (1.3)	20/629 (3.2)	49/1023 (4.8)	25/376 (6.6)	96/2187 (4.4)
1996	5/169 (3.0)	20/657 (3.0)	56/1089 (5.1)	24/356 (6.7)	105/2271 (4.6)	4/169 (2.4)	21/657 (3.2)	64/1089 (5.9)	18/356 (5.1)	107/2271 (4.7)
1997	2/159 (1.3)	22/612 (3.6)	58/1112 (5.2)	30/384 (7.8)	112/2267 (4.9)	4/159 (2.5)	26/612 (4.2)	51/1112 (4.6)	27/384 (7.0)	108/2267 (4.8)
1998	3/165 (1.8)	15/589 (2.5)	74/1149 (6.4)	27/461 (5.9)	119/2364 (5.0)	4/165 (2.4)	28/589 (4.8)	55/1149 (4.8)	27/461 (5.9)	114/2364 (4.8)
1999	4/162 (2.5)	14/601 (2.3)	68/1190 (5.7)	35/403 (8.7)	121/2356 (5.1)	3/162 (1.9)	20/601 (3.3)	50/1190 (4.2)	28/403 (6.9)	101/2356 (4.3)
2000	3/160 (1.9)	20/617 (3.2)	65/1149 (5.7)	40/423 (9.5)	128/2349 (5.4)	5/160 (3.1)	24/617 (3.9)	62/1149 (5.4)	24/423 (5.7)	115/2349 (4.9)
2001	4/168 (2.4)	21/625 (3.4)	65/1284 (5.1)	28/441 (6.3)	118/2518 (4.7)	5/168 (3.0)	29/625 (4.6)	85/1284 (6.6)	27/441 (6.1)	146/2518 (5.8)
2002	2/131 (1.5)	14/551 (2.5)	50/1176 (4.3)	36/484 (7.4)	102/2342 (4.4)	5/131 (3.8)	14/551 (2.5)	67/1176 (5.7)	25/484 (5.2)	111/2342 (4.7)
2003	4/172 (2.3)	17/596 (2.9)	61/1213 (5.0)	48/540 (8.9)	130/2521 (5.2)	5/172 (2.9)	24/596 (4.0)	72/1213 (5.9)	35/540 (6.5)	136/2521 (5.4)
2004	3/185 (1.6)	20/564 (3.5)	51/1241 (4.1)	40/468 (8.5)	114/2458 (4.6)	3/185 (1.6)	15/564 (2.7)	73/1241 (5.9)	15/468 (3.2)	106/2458 (4.3)
All years	52/2571 (2.0)	281/9105 (3.1)	810/16 068 (5.0)	454/5963 (7.6)	1597/33 707 (4.7)	53/2571 (2.1)	328/9105 (3.6)	820/16 068 (5.1)	321/5963 (5.4)	1522/33 707 (4.5)

*Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

†Fiscal year is from April to March.

compared between sexes using the χ^2 test. We used linear regression to test for linear trends across age decades and fiscal years for men and women.

All analyses were completed using SAS software version 9.2 for Windows (SAS Institute Inc., 2002–2003).

RESULTS

Between Apr. 1, 1990, and Mar. 31, 2005, 46 341 hip fracture surgeries occurred among patients aged 60 years and older in British Columbia, Canada. One in 12 hip fracture surgeries was for a second hip fracture (8.3%, 95% confidence interval [CI] 8.1–8.6).

There were differences in the distributions of fracture type, age and sex between first and second hip fractures (Table 1). More patients had pertrochanteric fractures at

the second than the first hip fracture surgery (52% v. 47%), more patients were older than 80 years at the second than the first hip fracture surgery (74% v. 62%), and a greater proportion of patients at the second than the first hip fracture surgery were women (81% v. 72%).

The proportion of surgeries for second hip fracture changed during the study period. This proportion was higher in women (9.3%, 95% CI 8.9–9.6) than men (5.8%, 95% CI 5.4–6.2). For women the proportion increased significantly ($p = 0.002$) from 7.4% ($n = 135$) in 1990 to 9.0% ($n = 220$) in 2004 (Table 2). For men the proportion did not increase significantly ($p = 0.20$) but varied from 3.7% ($n = 24$) in 1990 to 5.3% ($n = 47$) in 2004 (Table 2).

For women the proportion of second hip fracture surgeries increased linearly with each age decade from 4% to

Fig. 1. Proportion of second hip fractures by fiscal year and age at the time of fracture among women and men. Horizontal lines represent average annual proportion of second hip fractures for each age group. A significant linear trend for increasing proportion of second hip fractures by fiscal year and age was observed for women ($p = 0.002$) but not men ($p = 0.20$). Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

13% ($p = 0.001$) and across fiscal years (Fig. 1). In men the proportion of second hip fracture surgeries was 5% for each age decade between the ages of 60 and 90 years across fiscal years, increasing to 8% for men older than 90 years across fiscal years ($p = 0.20$; Fig. 1). These sex-specific trends were similar for both pertrochanteric and transcervical fracture types (Table 2 and Table 3).

DISCUSSION

One in 12 hip fracture surgeries performed during the study period was for a second hip fracture. This proportion increased over 15 years of follow-up in British Columbia, Canada. Older women accounted for the increasing proportion of second hip fracture surgeries over time.

We previously reported that among survivors of a first hip fracture the risk of second hip fracture persists

for at least 10 years.²³ Here we demonstrate that this risk led to an increase in the proportion of second hip fracture surgeries over time. In keeping with earlier literature we found that second hip fractures account for 8.3% of all hip fracture surgeries.^{28–31} We also found that patients presenting with a second hip fracture are more likely to be older, more likely to be women, and more likely to have pertrochanteric fractures than patients presenting with a first hip fracture.^{28–31} There was an increase in the proportion of hip fracture patients undergoing surgery for a second hip fracture over time. The proportion of women undergoing surgery for second hip fracture grew from 8% to 10% over the 15 fiscal years, whereas the proportion of men remained stable at 6%. Considering aging in combination with higher mortality for men following hip fracture, there may have been fewer men than women susceptible to a second hip fracture.^{32,33}

Table 3. Number (and proportion) of second hip fractures by age and hip fracture subtype for men*

Fiscal year†	Pertrochanteric; age, yr					Transcervical; age, yr				
	60–69	70–79	80–89	≥ 90	All age groups	60–69	70–79	80–89	≥ 90	All age groups
1990	2/115 (1.7)	3/228 (1.3)	6/240 (2.5)	0/63 (0.0)	11/646 (1.7)	3/115 (2.6)	5/228 (2.2)	3/240 (1.3)	2/63 (3.2)	13/646 (2.0)
1991	2/105 (1.9)	2/201 (1.0)	9/236 (3.8)	4/77 (5.2)	17/619 (2.7)	2/105 (1.9)	4/201 (2.0)	6/236 (2.5)	3/77 (3.9)	15/619 (2.4)
1992	3/113 (2.7)	5/230 (2.2)	9/278 (3.2)	3/84 (3.6)	20/705 (2.8)	1/113 (0.9)	5/230 (2.2)	7/278 (2.5)	2/84 (2.4)	15/705 (2.1)
1993	4/122 (3.3)	7/237 (3.0)	11/281 (3.9)	1/90 (1.1)	23/730 (3.2)	3/122 (2.5)	7/237 (3.0)	8/281 (2.8)	4/90 (4.4)	22/730 (3.0)
1994	6/110 (5.5)	13/228 (5.7)	7/328 (2.1)	4/79 (5.1)	30/745 (4.0)	4/110 (3.6)	4/228 (1.8)	12/328 (3.7)	0/79 (0.0)	20/745 (2.7)
1995	3/124 (2.4)	8/215 (3.7)	7/316 (2.2)	5/92 (5.4)	23/747 (3.1)	1/124 (0.8)	8/215 (3.7)	9/316 (2.8)	2/92 (2.2)	20/747 (2.7)
1996	0/119 (0.0)	11/279 (3.9)	13/344 (3.8)	4/93 (4.3)	28/835 (3.4)	5/119 (4.2)	3/279 (1.1)	7/344 (2.0)	6/93 (6.5)	21/835 (2.5)
1997	6/96 (6.3)	4/246 (1.6)	8/338 (2.4)	6/89 (6.7)	24/769 (3.1)	4/96 (4.2)	8/246 (3.3)	5/338 (1.5)	6/89 (6.7)	23/769 (3.0)
1998	5/111 (4.5)	6/269 (2.2)	8/379 (2.1)	8/101 (7.9)	27/860 (3.1)	2/111 (1.8)	13/269 (4.8)	13/379 (3.4)	1/101 (1.0)	29/860 (3.4)
1999	4/109 (3.7)	5/248 (2.0)	9/369 (2.4)	1/108 (0.9)	19/834 (2.3)	2/109 (1.8)	8/248 (3.2)	7/369 (1.9)	2/108 (1.9)	19/834 (2.3)
2000	4/96 (4.2)	7/259 (2.7)	16/384 (4.2)	7/122 (5.7)	34/861 (3.9)	3/96 (3.1)	4/259 (1.5)	16/384 (4.2)	9/122 (7.4)	32/861 (3.7)
2001	4/114 (3.5)	14/266 (5.3)	12/365 (3.3)	4/128 (3.1)	34/873 (3.9)	3/114 (2.6)	4/266 (1.5)	5/365 (1.4)	1/128 (0.8)	13/873 (1.5)
2002	3/102 (2.9)	8/263 (3.0)	14/404 (3.5)	1/126 (0.8)	26/895 (2.9)	1/102 (1.0)	7/263 (2.7)	13/404 (3.2)	7/126 (5.6)	28/895 (3.1)
2003	4/137 (2.9)	4/293 (1.4)	16/387 (4.1)	9/138 (6.5)	33/955 (3.5)	2/137 (1.5)	9/293 (3.1)	11/387 (2.8)	5/138 (3.6)	27/955 (2.8)
2004	4/113 (3.5)	7/258 (2.7)	9/365 (2.5)	7/145 (4.8)	27/881 (3.1)	2/113 (1.8)	7/258 (2.7)	5/365 (1.4)	6/145 (4.1)	20/881 (2.3)
All years	54/1686 (3.2)	104/3720 (2.8)	154/5014 (3.1)	64/1535 (4.2)	376/11 955 (3.1)	38/1686 (2.3)	96/3720 (2.6)	127/5014 (2.5)	56/1535 (3.6)	317/11 955 (2.7)

*Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

†Fiscal is from April to March.

Poorer postsurgical outcomes are seen following second hip fracture than first hip fracture.^{15,28} Second hip fracture is associated with excess mortality above that anticipated for an increase in age.²¹ Excess mortality after hip fracture surgery is associated with factors inherent to the patient and complications of their injury and treatment.^{34,35} To prevent complications and death, patients with second hip fractures may require a more aggressive treatment approach and more health care resources than patients with a first hip fracture.³⁶ For those who survive, patients with a second hip fracture are less likely to regain prefracture function and more likely to transition to long-term care than patients with a first hip fracture.²⁰

We previously reported that the risk of a second hip fracture is similar for men and women who survive after a first hip fracture.²³ However, more men than women die following first hip fracture.³² Here, we demonstrate that women account for a higher proportion of second hip fracture surgeries than men. Further, similar to Omsland and colleagues,³³ we note these women were older, as from age 60–90 years the proportion of second hip fracture surgeries relative to all hip fracture surgeries increased linearly with each age decade.

We conducted a secondary analysis of hospitalization records with a limited number of variables for adjustment. Data on hip fractures sustained before 1985 were not available. To avoid misclassifying first fractures as second ones, we use a “wash-out” strategy by excluding cases performed from 1985 to 1990, expecting that this would account for most second fractures. A second hip fracture may have been misclassified as a first hip fracture; however, the probability of misclassifying a hip fracture decreases with time after known first hip fracture.³³ Data on the type of surgery were not available. Arthroplasty is more commonly prescribed for patients with transcervical hip fractures.³⁷ Arthroplasty influences the risk of death with greater blood loss, infections and anesthetic complications than internal fixation.^{38,39} However, there were fewer transcervical hip fractures among patients undergoing surgery for second hip fractures in our study. We demonstrate an increasing proportion of hip fracture surgeries for second hip fracture. Data on health care resource utilization were not available. Furthermore, the data did not provide any indication of osteoporosis therapy.

CONCLUSION

The results of our study indicate that second hip fractures accounted for 8.3% of all hip fracture surgeries in British Columbia between 1990 and 2005. Over 15 years this proportion increased linearly for women and remained stable in men. Future research should deter-

mine whether more health care resources are required to manage these patients and optimize their outcomes.

Acknowledgements: This study, its authors and manuscript preparation was funded by the Canadian Institutes of Health Research (CIHR), the Centre for Clinical Epidemiology and Evaluation and the Centre for Hip Health and Mobility at the University of British Columbia. The funding bodies had no role in the study design, data collection, analysis, interpretation or manuscript preparation and submission. P. Guy has received grants from CIHR related to this work. He also receives funding from the Natural Sciences and Engineering Research Council of Canada, the Canadian Foundation for Innovation and the British Columbia Specialists Services Committee for work around hip fracture care not related to this manuscript. He has also received fees from the BC Specialists Services Committee (for a provincial quality improvement project on redesign of hip fracture care) and from Stryker Orthopedics (as a product development consultant). He is a board member and shareholder in Traumis Surgical Systems Inc. and a board member of the Canadian Orthopedic Foundation. He also serves on the speakers' bureaus of AO Trauma North America and Stryker Canada. K. Sheehan is a postdoctoral fellow whose salary is paid with CIHR funding related to this work. All inferences, opinions and conclusions drawn in this manuscript are those of the authors, and do not reflect the opinions or policies of the data steward(s).

Affiliations: From the Department of Orthopedics, University of British Columbia, Vancouver, BC (Guy, Lefavre); the School of Population and Public Health, University of British Columbia, Vancouver, BC (Sobolev, Sheehan); and the Vancouver Coastal Health Research Institute, Vancouver, BC (Kuramoto).

Competing interests: As above for P. Guy and K. Sheehan. No other competing interests declared.

Contributors: P. Guy, B. Sobolev and K. Lefavre designed the study, and collected and analyzed the data, which L. Kuramoto and K. Sheehan also analyzed. K. Sheehan wrote the article, which all authors reviewed and approved for publication.

References

1. Canadian Institute for Health Information. Canadian Institute for Health Information Health Indicators Interactive Tool; hospitalized hip fracture events 2014 (2011 standard population). 2014.
2. Canadian Institute for Health Information. Benchmarks for treatment and wait time in Canada: hip fracture repair. 2014.
3. Sirois MJ, Cote M, Pelet S. The burden of hospitalized hip fractures: patterns of admissions in a level I trauma center over 20 years. *J Trauma* 2009;66:1402-10.
4. Burge R, Dawson-Hughes B, Solomon DH, et al. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. *J Bone Miner Res* 2007;22:465-75.
5. Zhu Y, Chen W, Sun T, et al. Meta-analysis of risk factors for the second hip fracture (SHF) in elderly patients. *Arch Gerontol Geriatr* 2014;59:1-6.
6. Bass E, French DD, Bradham DD. A national perspective of Medicare expenditures for elderly veterans with hip fractures. *J Am Med Dir Assoc* 2008;9:114-9.
7. Pike C, Birnbaum HG, Schiller M, et al. Direct and indirect costs of non-vertebral fracture patients with osteoporosis in the US. *Pharmacoeconomics* 2010;28:395-409.
8. Pike C, Birnbaum HG, Schiller M, et al. Economic burden of privately insured non-vertebral fracture patients with osteoporosis over a 2-year period in the US. *Osteoporos Int* 2011;22:47-56.

9. Shi N, Foley K, Lenhart G, et al. Direct healthcare costs of hip, vertebral, and non-hip, non-vertebral fractures. *Bone* 2009;45:1084-90.
10. Fukushima T, Sudo A, Uchida A. Bilateral hip fractures. *J Orthop Sci* 2006;11:435-8.
11. Johnell O, Kanis JA, Oden A, et al. Fracture risk following an osteoporotic fracture. *Osteoporos Int* 2004;15:175-9.
12. Kim SM, Moon YW, Lim SJ, et al. Prediction of survival, second fracture, and functional recovery following the first hip fracture surgery in elderly patients. *Bone* 2012;50:1343-50.
13. Lawrence TM, Wenn R, Boulton CT, et al. Age-specific incidence of first and second fractures of the hip. *J Bone Joint Surg Br* 2010;92:258-61.
14. Lonnroos E, Kautiainen H, Karppi P, et al. Incidence of second hip fractures. A population-based study. *Osteoporos Int* 2007;18:1279-85.
15. Ryg J, Rejnmark L, Overgaard S, et al. Hip fracture patients at risk of second hip fracture: a nationwide population-based cohort study of 169,145 cases during 1977-2001. *J Bone Miner Res* 2009;24:1299-307.
16. Shabat S, Gepstein R, Mann G, et al. The second hip fracture — an analysis of 84 elderly patients. *J Orthop Trauma* 2003;17:613-7.
17. van HS, Cals J, Kessels F, et al. Risk of new clinical fractures within 2 years following a fracture. *Osteoporos Int* 2006;17:348-54.
18. Vohteloo AJ, Borger van der Burg BL, Roling MA, et al. Contralateral hip fractures and other osteoporosis-related fractures in hip fracture patients: incidence and risk factors. An observational cohort study of 1,229 patients. *Arch Orthop Trauma Surg* 2012;132:1191-7.
19. Yamanashi A, Yamazaki K, Kanamori M, et al. Assessment of risk factors for second hip fractures in Japanese elderly. *Osteoporos Int* 2005;16:1239-46.
20. Van der Steenhoven TJ, Staffhorst B, Van de Velde SK, et al. Complications and institutionalization are almost doubled after second hip fracture surgery in the elderly patient. *J Orthop Trauma* 2015;29:e103-8.
21. Sobolev B, Sheehan KJ, Kuramoto L, et al. Excess mortality associated with second hip fracture. *Osteoporos Int* 2015;26:1903-10.
22. Omsland TK, Holvik K, Meyer HE, et al. Hip fractures in Norway 1999-2008: time trends in total incidence and second hip fracture rates: a NOREPOS study. *Eur J Epidemiol* 2012;27:807-14.
23. Sobolev B, Sheehan KJ, Kuramoto L, et al. The risk of another hip fracture persists for years after initial injury. *Bone* 2015;12:72-6.
24. British Columbia Ministry of Health (1985-2005): Discharge Abstract Database (hospital separations). Population Data BC. Data Extract. MOH (1985-2005); 2003. Available: www.popdata.bc.ca/data (accessed 2016 May 31).
25. World Health Organisation. Manual of the international statistical classification of diseases, injuries, and causes of death; 2011. Available: www.who.int/classifications/icd/ICD10Volume2_en_2010.pdf (accessed 2016 May 31).
26. Statistics Canada. *Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures*; 1978.
27. Lefaiivre KA, Levy A, Sobolev B, et al. Changes in hip fracture rates in British Columbia Canada, 1990-2004. *Osteoporos Int* 2011;22:2817-27.
28. Khan SK, Rushton SP, Dosani A, et al. Factors influencing length of stay and mortality after first and second hip fractures: an event modeling analysis. *J Orthop Trauma* 2013;27:82-6.
29. Rodaro E, Pasqualini M, Iona LG, et al. Functional recovery following a second hip fracture. *Eura Medicophys* 2004;40:179-83.
30. Shen SH, Huang KC, Tsai YH, et al. Risk analysis for second hip fracture in patients after hip fracture surgery: a nationwide population-based study. *J Am Med Dir Assoc* 2014;15:725-31.
31. Souder CD, Brennan ML, Brennan KL, et al. The rate of contralateral proximal femoral fracture following closed reduction and percutaneous pinning compared with arthroplasty for the treatment of femoral neck fractures. *J Bone Joint Surg Am* 2012;94:418-25.
32. Berry SD, Samelson EJ, Hannan MT, et al. Second hip fracture in older men and women: the Framingham Study. *Arch Intern Med* 2007;167:1971-6.
33. Omsland TK, Emaus N, Tell GS, et al. Ten-year risk of second hip fracture. A NOREPOS study. *Bone* 2013;52:493-7.
34. Leibson CL, Tosteson AN, Gabriel SE, et al. Mortality, disability, and nursing home use for persons with and without hip fracture: a population-based study. *J Am Geriatr Soc* 2002;50:1644-50.
35. Lu-Yao GL, Keller RB, Littenberg B, et al. Outcomes after displaced fractures of the femoral neck. A meta-analysis of one hundred and six published reports. *J Bone Joint Surg Am* 1994;76:15-25.
36. Silber JH, Kaestner R, Even-Shoshan O, et al. Aggressive treatment style and surgical outcomes. *Health Serv Res* 2010;45:1872-92.
37. Quinn RH, Murray JN, Pezold R. The American Academy of Orthopaedic Surgeons appropriate use criteria for management of hip fractures in the elderly. *J Bone Joint Surg Am* 2016;98:1222-5.
38. Neuman MD, Donegan DJ, Mehta S. Comparative effectiveness of joint reconstruction and fixation for femoral neck fracture: inpatient and 30-day mortality. *Am J Orthop* 2013;42:E42-7.
39. Bhandari M, Devereaux PJ, Swiontkowski MF, et al. Internal fixation compared with arthroplasty for displaced fractures of the femoral neck. A meta-analysis. *J Bone Joint Surg Am* 2003;85-A:1673-81.