The association of female sex with application of evidence-based practice recommendations for perioperative care in hip fracture surgery

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ABSTRACT

BACKGROUND: Sex and gender inequality is prevalent in health care, and affects receipt of health care services and outcomes. Our objective was to measure the association between sex and receipt of evidence-based perioperative care for hip fracture in Ontario.

METHODS: This was a population-based retrospective cross-sectional analysis. We identified all Ontario residents aged 66 years and older who had hip fracture surgery between 2014 and 2016. After protocol registration, we measured the adjusted association between female sex and perioperative geriatric care (primary outcome), anesthesia consultations, regional analgesia and neuraxial anesthesia (secondary outcomes) using multilevel multivariable adjusted logistic regression. Prespecified sensitivity analyses were also performed.

RESULTS: We identified 22 661 patients who had hip fracture surgery; 16 162 (71.3%) were women. Women were less likely to receive perioperative geriatric care (adjusted odds ratio [OR] 0.80, 95% confidence interval [CI] 0.72 to 0.88) and anesthesia consultations (adjusted OR 0.89, 95% CI 0.80 to 0.98); women were more likely to have timely surgery (adjusted OR 1.26, 95% CI 1.17 to 1.36). Receipt of neuraxial anesthesia (adjusted OR 0.98, 95% CI 0.93 to 1.04) and regional analgesia (adjusted OR 1.00, 95% CI 0.94 to 1.07) were not different between sexes.

INTERPRETATION: More than 2 out of 3 patients who had hip fracture surgery were women; however, women were less likely to receive perioperative geriatric care and anesthesia consultations. Given the effectiveness of these interventions for improving outcomes, population-level hip fracture outcomes may be improved by decreasing sex-based disparities in application of evidence-based recommended perioperative care. **Protocol registration:** ClinicalTrials.gov, no. NCT03422497

Sex and gender inequality is prevalent in health care, differentially affecting men and women's access to health services and outcomes.[1] Inequalities can arise from unequal accommodation of specific biological health needs or access to health care owing to sociocultural biases. Being a woman predicts receiving lower quality primary,[2] cardiac,[3–5] critical[6] and chronic disease care.[7,8] The World Health Organization recommends monitoring health systems from a sex and gender perspective to create knowledge and policy relevant to improving equal access to care.

Hip fractures substantially contribute to adverse population health outcomes in older people.[9,10] Hip fractures disproportionately affect women; 70% of all patients who undergo hip fracture surgery are women, and about 1 in 100 older women have a hip fracture each year.[11,12] Hip fractures have a serious impact on function and survival. Many older people do not regain their prefracture level of mobility, and 25% die in the year following their injury.[13–15] Most hip fractures are treated surgically,[16] and outcomes are sensitive to processes of care. For example, delayed access to surgery increases mortality,[17,18] and certain anesthetic interventions[19,20] and application of orthogeriatric care[21,22] improve survival.

As most people who experience a hip fracture are women, identifying inequalities in care pertaining to hip fracture surgery could highlight areas to improve population-level outcomes.[23] We tested the hypothesis that female sex would be associated with receipt of lower quality care, indicated by lower rates of evidence-based perioperative practices recommended by a provincial multidisciplinary expert panel in Ontario,[24] which could be accurately measured using population-based administrative data. Specifically, we sought to identify whether sex was associated with receipt of perioperative geriatric medicine care (primary

outcome), surgical delay of 48 hours or less, preoperative anesthesiology consult, receipt of regional anesthesia and receipt of neuraxial anesthesia.

Methods

Design, setting and data sources

This was a population-based cross-sectional study conducted in Ontario, Canada, where physician and hospital-based care is provided to all residents through a public health care system. Hospitals are funded using global budgets and, since 2013, have received patient-based funding for hip fracture care. The transition to patient-based funding was supported by nonbinding evidence-based practice recommendations prepared by a multidisciplinary expert panel convened by Health Quality Ontario, the provincial advisor on quality of health care.[24]

In Ontario, health care encounters are recorded in administrative data sets using standardized methods;[25,26] these records were linked deterministically using encrypted patient-specific identifiers at ICES.[26] Data sets used included the following: the Ontario Drug Benefits Database (prescription drug claims); the Discharge Abstract Database (DAD, hospital admissions); the Ontario Health Insurance Plan (OHIP) database (physician service claims); the Assistive Devices Program Database (medical devices); the Continuing Care Reporting System (CCRS, long-term and respite care); the Home Care Database (home-based health care services); the National Ambulatory Care Reporting System (emergency care); the Registered Persons Database (death dates); and the ICES Physician Database (information on physician specialty, demographic characteristics and training). The analytic data set was created by an independent analyst using data normally collected at ICES. The senior author (D.I.M.) performed the analysis. A protocol was registered a priori at ClinicalTrials.gov (NCT03422497), and the results are reported using recommended guidelines.[27,28]

Cohort

We identified all Ontario residents aged 66 years and older on the day of their emergency surgery for hip fracture. Hip fracture surgeries were identified using validated codes (S72 for hip fracture, then 1VA53, 1VA74, 1VC74 or 1SQ53; κ 0.95; positive predictive value 0.95).[29,30] We limited our sample to urgent admissions to exclude elective hip replacements. The study start date was Apr. 1, 2014 (the year after care recommendations were published), and the end date was Mar. 31, 2016 (the last date at which all data were available).

Exposure and outcomes

Biological sex was identified from the DAD as a binary variable. We defined 5 evidence-based practice recommendations, each as dichotomous outcomes. Perioperative geriatric care (identified using validated billing codes cross-referenced to the ICES Physician Database[31]) was the primary outcome because its effectiveness is supported by high-level evidence for decreased mortality and length of stay.[21] Secondary outcomes were as follows: surgical delay of more than 48 hours (identified from the DAD[17,32]), which is associated with increased mortality and complications;[17,18] preoperative anesthesiology consults (identified using previously studied billing codes[33,34]), which is associated with decreased case cancellations, costs and length of stay; regional analgesia (identified using previously studied billing codes[35]), which improves analgesia and decreases pneumonia;[20] and neuraxial anesthesia (identified from validated fields in the DAD[36]), which is associated with decreased length of stay and thromboembolism risk.[37,38] Specifics of validation studies are provided in Appendix 1 (available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180564/-/DC1).

Covariates

Covariates were selected based on clinical and epidemiological knowledge of factors that could influence receipt of perioperative processes of care, and, in particular, consideration of a systematic review of risk-prediction models for outcomes after hip fracture surgery[39] (as we hypothesized that patients at higher risk of adverse outcomes would be more likely to be provided recommended care processes). Demographic characteristics were identified from the DAD and from the Canadian census. Standard methods were used to identify Elixhauser comorbidities using *International Statistical Classification of Diseases and Related Health Problems, 10th revision* (ICD-10) codes from the DAD in the 3 years preceding surgery.[40] Preoperative residence in a long-term care facility was identified from the CCRS. We calculated the Hospital-patient One-year Mortality Risk (HOMR) score, an externally validated model for 1-year all-cause mortality with excellent discrimination and calibration.[41] Certain prescriptions for medications filled in the 6 months before surgery were identified (i.e., opioids, anticoagulants, antiplatelet agents, antipsychotics, benzodiazepines and dementia medications). The Johns Hopkins Adjusted Clinical Groups system was used to identify health care resource utilization bands and frailty-defining diagnoses.[42] We also recorded the specific surgical procedure and a unique identifier for each hospital.

Statistical analysis

This was a population-based cross-sectional analysis; all available participants were included. The lowest incidence outcome was geriatric care (n = 1962). Conservatively, we could support up to 196 covariates for modelling.[43]

Characteristics were compared between men and women using standardized differences, where values greater than 0.10 were considered to represent substantial differences.[44]

Exposure and outcome data were complete for all analyses. Rurality status was missing for 23 people (0.1%) and was imputed with the most common value (not rural).

All sex-outcome associations were measured using unadjusted and multivariable adjusted logistic regression. All adjusted models included age (restricted cubic spline with 5 knots), neighbourhood income quintile (5-level categorical variable), rurality (binary), procedure (5-level categorical), HOMR score (continuous linear), each Elixhauser comorbidity (binary),

each specified drug class (binary), year of surgery (categorical), resource utilization band (4-level categorical), frailty (binary) and long-term care residence (binary). Adjusted models accounted for clustering of patients in hospitals (the highest level of our data hierarchy[45]) using generalized estimating equations and an exchangeable covariance structure. During peer review, adjusted differences in probabilities were requested (methods described in Appendix 2, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180564/-/DC1).

Following the recommendations of Morgan and colleagues,[46] we investigated the role of other social stratifiers that were available in our data (i.e., neighbourhood income quintile as a proxy for socioeconomic status, rural residence, age and presence of dementia) in influencing the receipt of evidence-based practice recommendations. We tested multiplicative interaction terms between sex and each variable listed above. Where the interaction term was significant ($p < 0.05$), we calculated the effect estimate at each level of the interacting variable. Exploratory analyses investigating sex-specific rates of care processes before publication of evidence-based practice recommendations and whether receiving more recommended care processes was associated with mortality are provided in Appendix 3 (available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180564/-/DC1).

SAS version 9.4 (SAS Institute) was used for all analyses.

Ethics approval

Data used for this study were routinely collected and de-identified, legally exempting it from research ethics review.

Results

We identified 22 661 patients who had hip fracture surgery; 16 162 (71.3%) were women. In the 30 days after surgery, 1621 patients died (7.2%; 960 women and 661 men). On average, women were older and had higher rates of rheumatic disease, and men had a higher prevalence of chronic obstructive pulmonary disease, diabetes and malignancy (Table 1).

Geriatric care

Women were less likely than men to receive geriatric care (648 [10.0%] v. 1314 [8.1%], respectively; unadjusted odds ratio [OR] 0.79, 95% confidence interval [CI] 0.72 to 0.88). After multilevel, multivariable adjustment, this significant negative association persisted (OR 0.80, 95% CI 0.72 to 0.88; the fully adjusted model is shown in Table 2). The adjusted difference in probabilities was –2.01% (95% CI –2.21 to –1.83).

Table 1 (part 1 of 2): Baseline characteristics of 22 661 patients who had hip fracture surgery, by sex

Characteristic	No. (%) of patients* Female *n* = 16 162	Male *n* = 6499	ASD†
Demographics			
Age at surgery, yr, mean (± SD)	84 (± 8)	82 (± 8)	0.25
Income quintile			
1 (lowest)	3368 (20.8)	1323 (20.4)	0.01
2	3315 (20.5)	1299 (20.0)	0.01
3	3225 (20.0)	1321 (20.3)	0.01
4	3182 (19.7)	1284 (19.8)	0.00
5 (highest)	3072 (19.0)	1272 (19.6)	0.02
Rural residence	2066 (12.8)	914 (14.1)	0.04
Comorbidities			
Alcohol abuse	236 (1.5)	319 (4.9)	0.19
Atrial arrhythmia	1468 (9.1)	808 (12.4)	0.11
Blood-loss anemia	3216 (20.0)	1308 (20.1)	0.00
Cardiac valve disease	537 (3.3)	284 (4.4)	0.06
Coagulopathy	351 (2.2)	210 (3.2)	0.06
Chronic obstructive pulmonary disease	1746 (10.8)	970 (14.9)	0.12
Cerebrovascular disease	723 (4.5)	406 (6.3)	0.08
Disease of pulmonary circulation	413 (2.6)	163 (2.5)	0.01
Dementia	3424 (21.2)	1319 (20.3)	0.02
Depression	785 (4.9)	296 (4.6)	0.01
Deficiency anemia	117 (0.7)	44 (0.7)	0.00
Diabetes mellitus without complications	2183 (13.5)	1013 (15.6)	0.06
Diabetes mellitus with complications	2139 (13.2)	1304 (20.1)	0.19
Dialysis	163 (1.0)	160 (2.5)	0.11
Drug abuse	61 (0.4)	36 (0.6)	0.03
Heart failure	1858 (11.5)	892 (13.7)	0.07
Hemiplegia	94 (0.6)	65 (1.0)	0.04
Hypertension without complications	7310 (45.2)	2869 (44.2)	0.02
Hypertension with complications	103 (0.6)	76 (1.2)	0.06
Liver disease	134 (0.8)	100 (1.5)	0.07
Malignancy	815 (5.0)	679 (10.5)	0.21
Metastasis	234 (1.5)	184 (2.8)	0.09
Obesity	250 (1.6)	82 (1.3)	0.03
Peptic ulcer disease	221 (1.4)	127 (2.0)	0.05
Peripheral vascular disease	323 (2.0)	245 (3.8)	0.11
Psychosis	139 (0.9)	54 (0.8)	0.01
Renal disease	544 (3.4)	458 (7.1)	0.17
Rheumatic disease	238 (1.5)	48 (0.7)	0.70
Venous thromboembolism	114 (0.7)	65 (1.0)	0.03
Weight loss	482 (3.0)	269 (4.1)	0.06
Frailty	10 699 (66.2)	4257 (65.5)	0.01

Table 1 (part 2 of 2): Baseline characteristics of 22 661 patients who had hip fracture surgery, by sex

Characteristic	No. (%) of patients* Female *n* = 16 162	Male *n* = 6499	ASD†
1-year mortality risk			
HOMR score, mean (± SD)	39 (± 5)	38 (± 5)	0.20
Medications			
Anticoagulant	2482 (15.4)	1301 (20)	0.12
Antiplatelet agent	1231 (7.6)	650 (10)	0.08
Antipsychotic	2047 (12.7)	756 (11.7)	0.03
Benzodiazepine	3168 (19.6)	937 (14.4)	0.14
Opioid	4043 (25.0)	1634 (25.1)	0.00
Dementia medication	1429 (8.8)	545 (8.4)	0.01
Health care resource use			
Long-term care facility	2845 (17.6)	968 (14.9)	0.07
Resource utilization band			
2 (lowest)	145 (0.9)	44 (0.7)	0.02
3	2198 (13.6)	518 (8.0)	0.18
4	4170 (25.8)	1176 (18.1)	0.19
5 (highest)	9649 (59.7)	4761 (73.3)	0.29
Procedure			
Implantation of internal device, hip joint	6234 (38.6)	2856 (44.0)	0.11
Fixation, hip joint	2863 (17.7)	1111 (17.1)	0.02
Fixation, femur	7037 (43.5)	2515 (38.7)	0.10
Implantation of internal device, pelvis	28 (0.2)	17 (0.3)	0.02

Note: ASD = absolute standardized difference, HOMR = Hospital-patient One-year Mortality Risk, SD = standard deviation.
*Unless stated otherwise.
†Values greater than 0.10 indicate a substantial difference.

Secondary processes of care

The proportion of men and women receiving secondary processes of care are shown in Table 3, along with unadjusted and adjusted ORs, and adjusted probability differences. Women were less likely to receive a preoperative anesthesiology consultation, and men were more likely to wait more than 48 hours for surgery. There was no difference between sexes in the odds of neuraxial anesthesia or regional analgesia.

Effect modification

Women from low-income neighbourhoods were less likely to receive geriatric care than men from low-income neighbourhoods (lowest income quintile OR 0.69, 95% CI 0.55 to 0.87), but there was no effect apparent in the highest income quintile (OR 1.15, 95% CI 0.91 to 1.44; interaction p = 0.006). Women with dementia were less likely to receive an anesthesiology consultation than men with dementia (OR 0.83, 95% CI 0.74 to 0.93; interaction p = 0.04). All other interaction terms were not significant. The results of exploratory analyses are provided in Appendix 3. Briefly, before publication of practice recommendations, women were less likely than men to receive geriatric medicine care, anesthesiology consultations, neuraxial anesthesia and timely surgery. Across both sexes, patients receiving more recommended processes of care had lower odds of mortality.

Interpretation

We conducted a population-based, sex-stratified analysis of evidence-based practice recommendations for perioperative care for hip fracture in Ontario. Women were significantly less likely than men to receive the primary study outcome, geriatric medicine care, as well as preoperative anesthesiology consultations. Men were more likely to have delayed surgery. These findings lead us to make the following observations.

Overall, women were less likely than men to access important health resources, including perioperative care from a geriatrician and preoperative anesthesiology consultations. Multiple studies, including a systematic review of randomized trials, show that perioperative geriatric care decreases mortality and length of stay after hip fracture surgery.[21,22] Given that 70% of hip fractures occur in women, and given the substantial effect sizes associated with orthogeriatric care (40% relative decrease in in-hospital mortality, standardized mean difference −0.25 for length of stay[21]), increasing uptake of this intervention for women should be a top priority. Anesthesiology consultations are associated with decreased case cancellations, hospital length of stay and costs.[34,47,48] Overall, our findings suggest that increasing access to geriatric and anesthesia care for women with hip fracture could substantially and positively improve patient- and system-centred outcomes in cases of hip fracture.

To improve uptake of evidence-based practice recommendations for women, greater understanding is required to characterize the underlying reasons for unequal sex-based distribution of recommended care. Unequal distribution in health care between the sexes can result from complex and interrelated reasons, including biological differences or sociocultural biases, such as social norms, access to resources, decision-making and power differentials.[46]

Consistent with previous studies,[49,50] men in our study were at higher risk of death after surgery. Therefore, sex-based prognosis based on biological differences could have contributed to clinicians' decisions about application of scarce resources, such as multidisciplinary consultation for patients with hip fracture. Clinicians may have believed that men would benefit more from geriatric and preoperative anesthesia care. In this case, care was applied unequally between sexes; however, it may have been applied in an equitable manner, whereby available resources were prioritized for the sex perceived to be most disadvantaged.

Sociocultural biases could also explain unequal application of recommended care. The orthopedic literature already features examples of social bias (i.e., long-standing and repeated reinforcement of social norms influencing behavioural interactions with female patients) affecting gender-based differences in care.[51] The odds of a surgeon recommending total joint arthroplasty was 22 times higher for men than for women, despite identical presentations.[52] This finding was attributed in part to surgeons' increased likelihood to attribute women's symptoms to emotional, rather than physical, causes.[53] Furthermore, the critical care literature suggests that a lack of access to resources may lead to older critically ill women being less likely than men to receive invasive life-sustaining therapies, despite being more likely to die of their critical illness.[6] Specifically, as women tend to outlive male spouses, they are often widowed in older age, and may have less social capital, such as an engaged social network advocating for application of high-quality care.

Sex and gender represent one of many possible social stratifiers that can influence access to care; therefore, it is recommended in a gender-based analysis that the influence of other social stratifiers be considered.[46] In our study, women who also belonged to marginalized populations appeared to be further disempowered. We found that geriatric medicine consultations were less frequently applied for women from low-income neighbourhoods, and anesthesiology consultations were less frequent for women with dementia.[54] However, administrative data do not provide adequate granularity to identify all postulated sociocultural drivers of decision-making;[46] future prospective and qualitative research will be needed to develop a more complete understanding of causal mechanisms.

In addition to understanding why sex- and gender-based inequalities were found in hip fracture care, future research will also need to address the implications of these inequalities in terms of health outcomes, while exploring possible solutions.[55] Our exploratory analyses, which must be cautiously interpreted as they were not the primary objective of this study, suggest that older people with hip fracture who receive more evidence-based care processes have lower odds of 30-day mortality, and that the gap in provision of evidence-based care processes for women compared with men has decreased in recent years compared with the period before publication of evidence-based practice recommendations. Specifically designed studies will be required to determine whether these findings represent causal relations.

Table 2 (part 1 of 2): Logistic regression models for perioperative geriatric care

Covariate	Odds ratio (95% CI)
Unadjusted	
Female sex (v. male)	0.79 (0.72 to 0.88)
Adjusted*	
Female sex (v. male)	0.80 (0.72 to 0.88)
Year of surgery (2014/15 v. 2015/16)	1.05 (1.00 to 1.10)
Age, yr	
Linear segment	0.63 (0.17 to 2.34)
RCS segment 1	1.65 (0.47 to 5.76)
RCS segment 2	0.14 (0.00 to 17.20)
RCS segment 3	5.35 (0.04 to 773.17)
Not rural residence (v. rural residence)	2.17 (1.91 to 2.47)
Neighbourhood income quintile	
1 (lowest)	1.04 (0.95 to 1.14)
2	0.96 (0.88 to 1.06)
3	0.84 (0.76 to 0.93)
4	1.03 (0.93 to 1.13)
5 (highest)	Ref. (1.00)
Comorbidities	
Alcohol abuse (v. none)	1.51 (1.14 to 2.01)
Atrial arrhythmia (v. none)	0.91 (0.76 to 1.09)
Blood-loss anemia (v. none)	1.08 (0.96 to 1.21)
Cardiac valve disease (v. none)	1.13 (0.90 to 1.43)
Coagulopathy (v. none)	0.92 (0.68 to 1.25)
Chronic obstructive pulmonary disease (v. none)	0.92 (0.79 to 1.07)
Cerebrovascular disease (v. none)	0.99 (0.79 to 1.24)
Disease of pulmonary circulation (v. none)	1.17 (0.89 to 1.54)
Dementia (v. none)	1.30 (1.14 to 1.48)
Depression (v. none)	1.59 (1.31 to 1.92)
Deficiency anemia (v. none)	0.68 (0.37 to 1.24)
Diabetes mellitus without complications (v. none)	0.96 (0.83 to 1.11)
Diabetes mellitus with complications (v. none)	1.06 (0.92 to 1.22)
Dialysis (v. none)	1.22 (0.80 to 1.86)
Drug abuse (v. none)	1.24 (0.65 to 2.35)
Heart failure (v. none)	1.15 (0.99 to 1.34)
Hemiplegia (v. none)	0.91 (0.49 to 1.69)
Hypertension without complications (v. none)	1.01 (0.91 to 1.11)
Hypertension with complications (v. none)	1.18 (0.72 to 1.96)
Liver disease (v. none)	0.71 (0.43 to 1.18)
Malignancy (v. none)	0.77 (0.61 to 0.96)
Metastasis (v. none)	0.80 (0.51 to 1.25)
Obesity (v. none)	0.90 (0.58 to 1.41)
Peptic ulcer disease (v. none)	1.13 (0.79 to 1.62)
Peripheral vascular disease (v. none)	0.84 (0.61 to 1.15)
Psychosis (v. none)	1.67 (1.07 to 2.61)

Table 2 (part 2 of 2): Logistic regression models for perioperative geriatric care

Covariate	Odds ratio (95% CI)
Comorbidities cont'd	
Renal disease (v. none)	0.74 (0.57 to 1.30)
Rheumatic disease (v. none)	0.82 (0.52 to 1.30)
Venous thromboembolism (v. none)	1.45 (0.92 to 2.28)
Weight loss (v. none)	0.97 (0.76 to 1.24)
Frailty (v. none)	1.23 (1.09 to 1.38)
1-year mortality risk	
HOMR score (per 1-unit increase)	1.01 (1.00 to 1.02)
Medications	
Anticoagulant (v. none)	0.95 (0.83 to 1.10)
Antiplatelet agent (v. none)	0.77 (0.64 to 0.93)
Antipsychotic (v. none)	1.03 (0.88 to 1.21)
Benzodiazepine (v. none)	0.92 (0.82 to 1.03)
Opioid (v. none)	1.04 (0.92 to 1.18)
Dementia medication (v. none)	1.18 (1.00 to 1.39)
Health care resource use	
Long-term care before admission	0.40 (0.34 to 0.47)
Resource utilization band	
2 (lowest)	Ref. (1.00)
3	0.65 (0.35 to 1.21)
4	0.90 (0.49 to 1.64)
5 (highest)	1.30 (0.71 to 2.37)
Procedure	
Fixation, femur	Ref. (1.00)
Implantation of internal device, hip joint	1.00 (0.78 to 1.28)
Fixation, hip joint	1.01 (1.00 to 1.02)
Implantation of internal device, pelvis	1.22 (0.80 to 1.86)

Note: CI = confidence interval, HOMR = Hospital-patient One-year Mortality Risk, RCS = restricted cubic spline, Ref. = reference category.
*Adjusted for the variables listed below.

Limitations

Based on our observational study, we can provide only measures of association (not causation) in the relation between sex and care provision. We used health administrative data, which was not initially recorded for research purposes and is at risk of misclassification bias. However, our cohort, exposures and outcomes were defined using validated measures, and were complete for all participants. Furthermore, our use of population-based data may allow our findings to be generalized to other jurisdictions with similar health and social systems. We also preregistered our protocol and adjusted for a robust set of postulated confounders using multilevel multivariable models. Although our choice of effect modifiers was informed by recommend best practice,[46] measures of religion, race, ethnicity and sexuality were not available in our data. We could only account for measured confounders; granular measures of participants' functional and physiologic status were not available and could confound our findings. Furthermore, we evaluated perioperative processes only. Further study is required to determine whether other aspects of the recommendations by Health Quality Ontario for hip fracture care are unequally provided, and it must be recognized that these recommendations are not binding.[24] Finally, our measure of exposure was biological sex; administrative data in Canada do not routinely contain information on self-identified gender.

Conclusion

More than 70% of patients receiving hip fracture surgery were women; however, female sex was associated with lower odds of receiving perioperative geriatric care and preoperative anesthesiology consultations. Prospective and qualitative research is needed to develop a complete understanding of the drivers of sex-based inequality in application of best practices for perioperative care in hip fracture surgery. This new knowledge could be used to inform

Table 3: Receipt of secondary processes of care, by sex

Process of care	No. (%) of patients: Female *n* = 16 162	No. (%) of patients: Male *n* = 6499	Crude OR (95% CI)	Adjusted* OR (95% CI)	Adjusted* probability difference,†
Anesthesiology consultation	1318 (8.2)	616 (9.5)	0.85 (0.77 to 0.94)	0.89 (0.80 to 0.98)	−1.06 (−1.21 to −0.93)
Wait ≤ 48 hours	14 232 (88.1)	5446 (83.8)	1.42 (1.31 to 1.55)	1.26 (1.17 to 1.36)	3.96 (3.71 to 4.26)
Regional analgesia	2901 (18.0)	1137 (17.5)	1.03 (0.96 to 1.11)	1.00 (0.94 to 1.07)	0.6 (−0.39 to 0.84)
Neuraxial anesthesia	9108 (56.4)	3523 (54.2)	1.08 (1.02 to 1.15)	0.98 (0.93 to 1.04)	2.27 (−1.66 to 2.95)

Note: CI = confidence interval, HOMR = Hospital-patient One-year Mortality Risk, OR = odds ratio.
*All adjusted analyses included age, neighbourhood income quintile, rurality, procedure, HOMR score, each Elixhauser comorbidity, each specified drug class, year of surgery, resource utilization band, frailty and long-term care residence.
†A description of the adjusted probability methods is provided in Appendix 2.

knowledge-translation strategies (such as refinement and targeting of recommendations) to improve patient- and system-level outcomes for older people with hip fracture.

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