Reporting and evaluating wait times for urgent hip fracture surgery in Ontario, Canada

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ABSTRACT

BACKGROUND: Although a delay of 24 hours for hip fracture repair is associated with medical complications and costs, it is unknown how long patients wait for surgery for hip fracture. We describe novel methods for measuring exact urgent and emergent surgical wait times (in hours) and the factors that influence them.

METHODS: Adults aged 45 years and older who underwent surgery for hip fracture (the most common urgently performed procedure) in Ontario, Canada, between 2009 and 2014 were eligible. Validated data from linked health administrative databases were used. The primary outcome was the time elapsed from hospital arrival recorded in the National Ambulatory Care Reporting System until the time of surgery recorded in the Discharge Abstract Database (in hours). The influence of patient, physician and hospital factors on wait times was investigated using 3-level, hierarchical linear regression models.

RESULTS: Among 42 230 patients with hip fracture, the mean (SD) wait time for surgery was 38.76 (28.84) hours, and 14 174 (33.5%) patients underwent surgery within 24 hours. Variables strongly associated with delay included time for hospital transfer (adjusted increase of 26.23 h, 95% CI 25.38 to 27.01) and time for preoperative echocardiography (adjusted increase of 18.56 h, 95% CI 17.73 to 19.38). More than half of the hospitals (37 of 72, 51.4%), compared with 4.8% of surgeons and 0.2% of anesthesiologists, showed significant differences in the risk-adjusted likelihood of delayed surgery.

INTERPRETATION: Exact wait times for urgent and emergent surgery can be measured using Canada's administrative data. Only one-third of patients received surgery within the safe time frame (24 h). Wait times varied according to hospital and physician factors; however, hospital factors had a larger impact.

Hip fracture repair that is delayed more than 24 hours after hospital presentation is associated with increased medical complications[1] and health care costs.[2,3] Despite known consequences for delays, it is unknown how long patients wait for hip fracture repair and other urgent and emergent procedures across Canada.[4] Studies about urgent and emergent surgical wait times have been conducted at single centres,[3,5–10] and time was measured imprecisely.[11–14] Although variables capturing exact wait times from hospital arrival were introduced to Canadian hospital discharge abstracts in 2009, studies have not used these data to describe and evaluate wait times for urgent surgery.[1,14,15]

We investigated these new time-to-surgery data among a population-based cohort of patients requiring surgery for hip fracture, the most common urgently performed surgical procedure in Canada.[16] Our objectives were to use these data to measure wait times for surgery for hip fracture, identify modifiable factors influencing them, and determine whether variation is due to treatment by different hospitals or physicians, or both.

Methods

Data sources and setting

We conducted a population-based cross-sectional cohort study of patients with hip fractures who were treated in Ontario. Data were obtained from several administrative databases linked at the Institute for Clinical Evaluative Sciences (ICES, www.ices.on.ca). These databases have been used previously to study patients with hip fracture,[12,17–19] in which sensitivity and positive predictive values for diagnosis of hip fracture are 95% (Appendix 1A, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.170830/-/DC1).[20] We chose to study hip fractures because surgery for hip fracture is the most common urgently performed procedure in Canada,[16] and wait times are already used as quality-of-care indicators worldwide.[21–23]

Participants

We considered adults aged 45 years and older who underwent surgery for hip fracture in Ontario from Apr. 1, 2009, through

Mar. 31, 2014, to be eligible. Accrual began when exact surgery start times were introduced in the databases utilized, enabling us to calculate precise wait times for each patient (in hours) in the cohort.[15] We excluded patients aged 45 years and younger, as well as others unrepresentative of patients with osteoporotic hip fractures, consistent with prior[1,2] and ongoing[24] hip fracture research (Supplementary Table 1, Appendix 1B, contains the full list of exclusion criteria).

Outcome measure

The primary dependent variable was the total time elapsed (in hours) between arrival at the emergency department (at the first hospital, if interfacility transfer occurred)[25] recorded in the National Ambulatory Care Reporting System and surgery for hip fracture recorded in the Discharge Abstract Database. We assessed the relative contribution of specific phases of care to observed wait times by calculating separately the time spent in the emergency department, during hospital transfer and after hospital admission.

For each patient, we recorded acute conditions that may benefit from medical treatment (and delay) before surgery. Specific conditions were taken from the National Institute for Health and Care Excellence 124 guideline.[26]

We assessed several characteristics previously shown to influence surgical delays in other single-centre studies, including age, sex and medical comorbidity.[3,5–10] Characteristics determined after surgery were not considered, even if these factors were surrogates for patient case mix, such as surgery duration, discharge disposition or length of stay.[27] Comorbidities listed on hospital discharge abstracts in the 5 years before the patient's hip fracture were categorized according to the Deyo–Charlson Comorbidity Index.[28] Previously validated algorithms identified frail patients[29] and those with diabetes,[30] hypertension,[31] chronic obstructive pulmonary disease,[32] congestive heart failure, coronary artery disease[33] or polytrauma (defined as an Injury Severity Score ≥ 16) at the time of their injury. We used median neighbourhood household income quintiles as a proxy for socioeconomic status,[34–36] and we identified patients residing in rural areas using the Rurality Index of Ontario.[36] We also considered antiplatelet and anticoagulant prescriptions dispensed to patients within 1 year before surgery for those with Ontario Drug Benefit coverage (i.e., all those > 65 years of age).[37] Each fracture and procedure type were recorded.

We assessed and assigned physician- and hospital-related factors at the time of each patient's operation. These included years since each surgeon's Canadian orthopedic certification ("surgeon experience") and the number of hip fracture procedures performed in the year preceding the index event ("surgeon and hospital volume"). Each hospital's capacity for performing nonelective surgery was operationalized as the average daily number of any nonelective (or "urgent") procedures performed at the hospital, orthopedic or otherwise, in the year preceding the index event. Hospitals were also categorized as being either "academic," "large community" or "small/medium community" (> 400 or < 400 beds, respectively).[38] We identified patients directly transferred from other hospitals and other health care institutions (e.g., long-term care) by standard protocols.[25] The time of hospital arrival was categorized as "working hours" 8 am–4 pm, "evening" 4 pm–12 pm, or "overnight" 12 midnight–8 am, and "weekend" or "weekday." We also described the proportion of surgical procedures occurring overnight (12 midnight–8 am) using surgeon billing codes.[19,39] Finally, we recorded preoperative internal medicine consultations, anesthesia consultations and echocardiograms that occurred between hospital arrival and the time of surgery.

Statistical analysis

We used simple (single-level) linear regression to relate the above predictors ("potential factors influencing wait times for surgery") to surgical wait times, analyzed as a continuous variable in hours.[40–42] We used standardized β coefficients with 95% confidence intervals (CIs) to report increases and decreases in wait times (in hours) associated with each predictor variable. We also used 3-level hierarchical linear regression models to explore the relative contribution of physician and hospital factors to variation in wait times. The random-effects output from this model provided each physician's and hospital's unique adjusted wait time difference compared with the cohort average (i.e., increase or decrease in adjusted wait time [in hours] and 95% CI). We performed the physician-level analysis twice, considering surgeons and anesthesiologists in separate models that were cross-classified to account for physicians working at more than 1 hospital (Appendix 1C).[43,44]

To quantify the relative effect of individual physicians and hospitals on variability in wait times, we measured the proportion of physicians and hospitals that were "outliers" compared with their peers. "Low outliers" — physicians and hospitals with wait times significantly lower than average — were those with upper limits of the 95% CI wait time less than 0. Conversely, "high outliers" — physicians and hospitals with wait times that were significantly longer than average — were those with lower limits of their 95% CI wait time greater than 0.[45,46] To validate the effect of individual physicians and hospitals on variability in wait times, we reran the 3-level hierarchical regression model with clinical outcomes (30-d mortality, surgical complications) and medical costs in place of wait times (Appendix 1D).

All analyses were performed on linked, coded data at the Institute for Clinical Evaluative Sciences using SAS software (SAS version 9.3, SAS Institute), and we set type I error probability to 0.05. We excluded patients with missing data (< 1% for all variables considered [Table 1]) from the regression models.

Ethics approval

The study protocol was approved by the Research Ethics Board at Sunnybrook Health Sciences Centre, Toronto.

Results

We included 42 230 patients in our study. These patients were treated by 522 surgeons and 963 anesthesiologists from 72 hospitals. Patient mean (standard deviation [SD]) age was 80.77 (SD 10.67) years and most were female (n = 29 759, 70.5%). Mean wait time for surgery after arrival at the emergency department was 38.76 (SD 28.84) hours. Mean time spent in the emergency department was 7.58 (SD 11.87) hours. Almost half of all patients received a preoperative internal medicine consultation (n = 20 781, 49.2%), 11 410 (27.0%) received a preoperative anesthesia consultation, and 2354 (5.6%) underwent an echocardiogram before surgery. Nearly 1 in 5 patients older than 65 years (18.9%) were prescribed antiplatelet or anticoagulant medications within a year before their hip fracture. About 9% (n = 4136) of patients presented for surgery with an acute condition that may have benefitted from medical treatment (and delay) before surgery. Other characteristics of the cohort are displayed in Table 1.

Although most patients (> 75%) were admitted to hospital within 6 hours of presentation at the emergency department (mean 7.58 h [SD 11.87]), only 14 174 (33.5%) received surgery within the recommended time frame (24 h) (Figure 1).[1,47,48] The proportion of patients with hip fracture is also reported by their time of presentation, admission and surgery in Appendix 2, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.170830/-/DC1. Whereas 5837 patients (13.8%) arrived overnight, only 441 patients (1.0%) received surgery during this time.

Results of the linear regression model relating potential risk factors to delayed surgery are shown in Table 2. Patient transfer for surgery was associated with more than 1 day of additional delay for surgery (adjusted increase of 26.23 h, 95% CI 25.38 to 27.01). Preoperative consultations by internal medicine (adjusted increase of 6.43 h, 95% CI 6.06 to 6.80) and anesthesia

Table 1 (part 1 of 1): Baseline characteristics of patients undergoing surgery for hip fracture in Ontario between 2009 and 2014

Characteristic	No. (%)* of patients n = 42 230
Wait times	
Time from presentation to surgery, mean ± SD; h	38.76 ± 28.84
Time spent in the emergency department, mean ± SD; h	7.58 ± 11.87
Time from admission to surgery, mean ± SD; h	31.18 ± 26.54
Surgery conducted > 48 h after presentation at the emergency department	11 088 (26.3)
Patients	
Age, mean ± SD; yr	80.77 ± 10.67
Female sex	29 759 (70.5)
Rural residence	3611 (8.6)
Income quintile	
1 (lowest)	9503 (22.5)
2	8592 (20.3)
3	7991 (18.9)
4	8086 (19.1)
5 (highest)	7853 (18.6)
Missing data	285 (0.7)
Medical comorbidity	
Deyo–Charlson Comorbidity Index score	
0	6812 (16.1)
1	5966 (14.1)
2	3785 (9.0)
≥ 3	6223 (14.7)
No admission to hospital within the previous 5 yr	19 444 (46.0)
Frailty	7220 (17.1)
Diabetes	12 457 (29.5)
Hypertension	33 304 (78.9)
Chronic obstructive pulmonary disease	8139 (19.3)
Coronary artery disease	3119 (7.4)
Congestive heart failure	9567 (22.7)
Institutionalized before admission	12 432 (29.4)
Antiplatelet or anticoagulant prescription†	7977 (18.9)
Injury characteristics	
Polytrauma (ISS ≥ 16)	329 (0.8)
Fracture type	
Femoral neck	21 208 (50.2)
Intertrochanteric	18 544 (43.9)
Subtrochanteric	2478 (5.9)

Table 1 (part 2 of 2): Baseline characteristics of patients undergoing surgery for hip fracture in Ontario between 2009 and 2014

Characteristic	No. (%)* of patients n = 42 230
Physicians	
Surgeon	
No. of cases of hip fracture seen in previous yr, mean ± SD	40.00 ± 22.17
Years since Canadian orthopedic certification, mean ± SD	12.60 ± 9.63
Preoperative workup	
Preoperative consultation with internal medicine	20 781 (49.2)
Preoperative consultation with anesthesia	11 410 (27.0)
Preoperative echocardiogram	2354 (5.6)
Type of surgery conducted	
Sliding hip screw or cannulated screws	19 116 (45.3)
Arthroplasty	16 248 (38.5)
Intramedullary nail	6866 (16.3)
System	
Hospital	
Patient transferred from another facility	2467 (5.8)
No. of cases of hip fracture in previous yr, mean ± SD	250.22 ± 112.30
No. of urgent surgeries per d, mean ± SD	4.52 ± 2.61
Type	
Academic	12 167 (28.8)
Large community	15 940 (37.7)
Medium community	13 741 (32.5)
Missing data	382 (0.9)
Timing of patient presentation	
Weekend	12 136 (28.7)
Evening	16 426 (38.9)
Working hours	19 967 (47.3)
Overnight	5837 (13.8)
Surgery conducted overnight	441 (1.0)
Year surgery conducted	
2009	7848 (18.6)
2010	8139 (19.3)
2011	8295 (19.6)
2012	8643 (20.5)
2013	9305 (22.0)

Note: ISS = Injury Severity Score, SD = standard deviation.
*Unless specified otherwise.
†Data for antiplatelet or anticoagulant prescriptions were available and reported only for patients aged 65 years and older.

(adjusted increase of 5.90 h, 95% CI 5.48 to 6.33), as well as preoperative echocardiography (adjusted increase of 18.56 h, 95% CI 17.73 to 19.38) were also associated with significant delays after adjustment.

Results of our hierarchical linear regression models are shown in Figures 2A–C. More than half of the hospitals (37 of 72, 51.4%) showed significant differences in the likelihood of delays in surgery for hip fracture that were not attributable to patient case mix and physician random effects (Figure 2A). Conversely, only 25 of 522 (4.8%) surgeons and 2 of 963 (0.2%) anesthesiologists were outliers or significantly different in their likelihood of performing delayed surgery after adjustment for patient and hospital factors. Similarly, adjusted odds of mortality, surgical complications and medical costs varied between hospitals (9.7%, 16.7% and 38.8% were outliers for each outcome, respectively) but not between physicians (no surgeons and anesthesiologists were significantly different for these outcomes) (Appendix 1D).

Interpretation

Wait times varied significantly depending on where patients were treated, with more than half of hospitals (51.4%) showing significant differences in the likelihood of delayed surgery for hip fracture that was not attributable to patient or physician factors. Transfers, preoperative consultations, echocardiography and prescriptions for anticoagulants are important and modifiable causes of delay. Two-thirds (66%) of the participants did not receive surgery within the safe time frame (24 h).[1,47,48] Variation within Ontario's public health care system warrants performance improvement at the hospital level.

Variation in wait times was attributable to treatment at different hospitals, as opposed to treatment by different physicians. As such, initiatives for quality improvement may target hospital-level processes preferentially rather than individual physician practices. In contrast, and contrary to calls for physician-level reporting,[50–52] the finding that wait times, clinical outcomes and costs were similar between physicians after accounting for patient and hospital factors suggests such reporting may be less informative than hospital-level information. Examples of hospital-level interventions include medical and surgical comanagement models,[53] and policies for preoperative consultations, echocardiography and anticoagulant reversal,[10] which may ensure that coordinated care does not compromise the provision of timely surgery. Policies between hospitals should also address patients who require transfer for surgery, balancing the risk of treatment at smaller centres[38] with delays associated with these transfers, both of which are known risk factors for mortality.[38,54,55] A successful surgical coverage algorithm in this regard was developed in Manitoba, where rural hospitals were matched to surgical hospitals that agreed to accept patients from rural areas regardless of bed availability.[10] Other solutions may be to designate "urgent surgical centres"[56] with

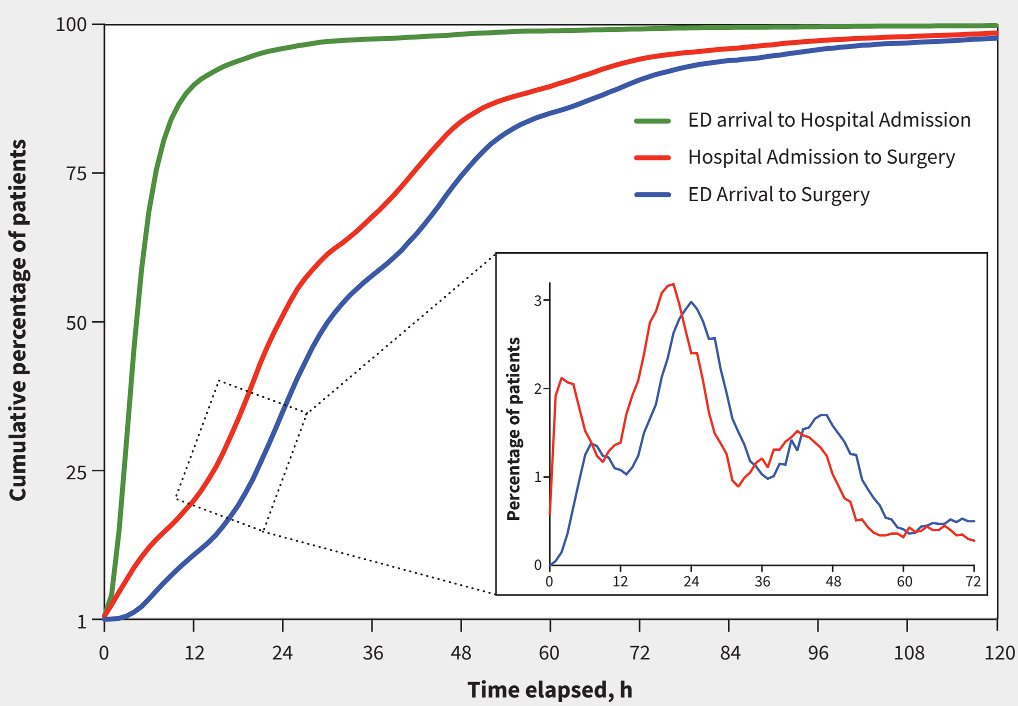

Figure 1: Cumulative percentage of patients with hip fracture by time elapsed (in h) from arrival at the emergency department (ED) to hospital admission (green line), hospital admission to undergoing surgery (red line) and arrival at the ED to undergoing surgery (blue line). One-third of patients (n = 14 174, 33.5%) underwent surgery within the safe time frame (24 h). The inset shows the exact proportion of patients receiving surgery by the time elapsed, illustrating that wait times for surgery for hip fracture follow a sinusoidal distribution.

Table 2: Linear regression model relating potential risk factors to wait times for surgery (modelled as a continuous variable)*

Variable	Adjusted increase or decrease in wait time (95% CI), h
Patient characteristic	
Age, per yr	0.042 (0.023 to 0.061)
Female sex	−1.11 (−1.50 to −0.710)
Rural residence	−0.200 (−0.874 to 0.476)
Income quintile (1 [lowest] v. 5 [highest])	0.041 (−0.511 to 0.592)
Income quintile (2 v. 5)	−0.182 (−0.746 to 0.382)
Income quintile (3 v. 5)	−0.032 (−0.604 to 0.540)
Income quintile (4 v. 5)	0.364 (−0.206 to 0.934)
Medical comorbidity	
Charlson group (v. no previous hospital admissions)	
0	1.01 (0.494 to 1.528)
1	1.13 (0.553 to 1.704)
2	1.438 (0.752 to 2.125)
3	2.19 (1.55 to 2.83)
Frailty	0.368 (−0.162 to 0.900)
Diabetes	0.081 (−0.331 to 0.494)
Hypertension	0.501 (0.037 to 0.966)
Chronic obstructive pulmonary disease	0.140 (−0.329 to 0.609)
Coronary artery disease	0.628 (−0.084 to 1.34)
Congestive heart failure	3.10 (2.63 to 3.57)
Preadmission institutionalization	0.267 (−0.157 to 0.692)
Antiplatelet or anticoagulant prescription†	5.80 (5.31 to 6.29)
Injury characteristics	
Polytrauma (ISS ≥ 16)	−1.67 (−3.72 to 0.353)
Subtrochanteric fracture (v. femoral neck)	0.275 (−0.653 to 1.20)
Intertrochanteric fracture (v. femoral neck)	0.335 (−0.195 to 0.866)
Physician characteristics	
Surgeon	
No. of cases of hip fracture in previous yr	−0.025 (−0.033 to −0.017)
Years since Canadian orthopedic certification	−0.028 (−0.047 to −0.009)
Preoperative workup	
Preoperative consultation with internal medicine	6.43 (6.06 to 6.80)
Preoperative consultation with anesthesia	5.90 (5.48 to 6.33)
Preoperative echocardiogram	18.56 (17.73 to 19.38)
Type of surgery	
Arthroplasty (v. intramedullary nail)	−1.68 (−2.25 to −1.12)
Sliding hip screw or cannulated screws (v. intramedullary nail)	0.884 (0.154 to 1.61)
System characteristics	
Hospital	
Patient transferred from another facility	26.24 (25.38 to 27.09)
No. of cases of hip fracture in previous yr	−0.014 (−0.017 to −0.012)
Mean no. of urgent surgeries per d	1.08 (0.947 to 1.21)
Academic (v. medium community hospital)	3.15 (2.52 to 3.78)
Large (v. medium community hospital)	4.20 (3.73 to 4.66)
Timing of presentation	
Admission over weekend	−2.71 (−3.10 to −2.32)
After-hours presentation (v. working hours)	−1.68 (−2.22 to −1.14)
Overnight presentation (v. working hours)	1.00 (0.621 to 1.38)
Year of surgery	
2009 (v. 2013)	1.53 (0.970 to 2.09)
2010 (v. 2013)	2.49 (1.94 to 3.05)
2011 (v. 2013)	1.42 (0.874 to 1.97)
2012 (v. 2013)	0.265 (−0.275 to 0.805)

Note: CI = confidence interval, ISS = Injury Severity Score.
*We conducted the analysis for 40 508 patients (without statistical outliers; see Appendix 1C, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.170830/-/DC1). We adjusted all regression models for the following covariates: age, sex, year of surgery, income quintile, Charlson group, frailty, diabetes, coronary artery disease, chronic obstruction pulmonary disease, coronary artery disease, preadmission institutionalization, Injury Severity Score, and fracture and surgery type.
†Calculated in a separate linear regression model that was restricted to patients for whom prescription receipts were available (those aged 65 yr or older).

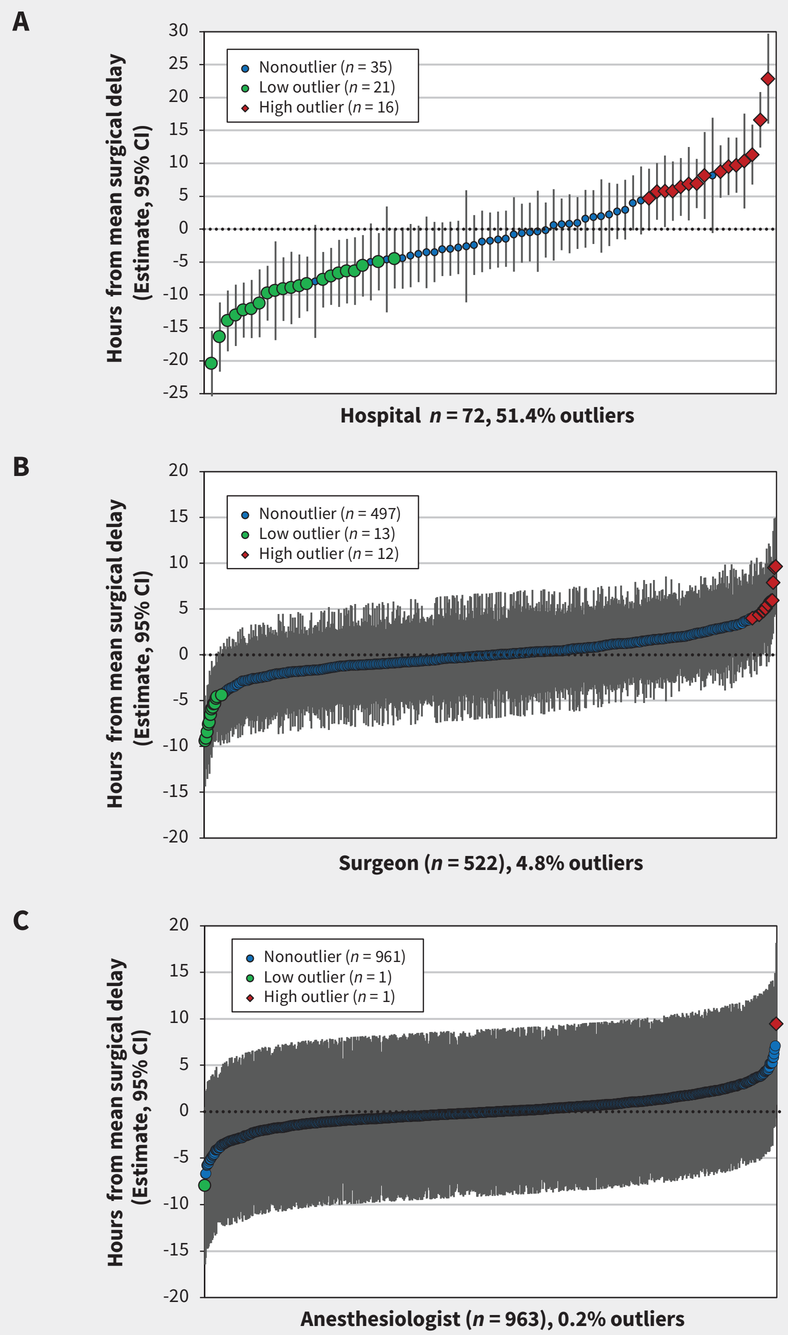

Figure 2: (A) Mean differences (in h, with 95% confidence intervals [CIs]) for each hospital from the average surgical delay in the cohort was estimated in a 3-level linear regression model, adjusted for patient case mix and surgeon random effects. We classified hospitals that were significantly more likely to have early surgery performed as "low" outliers (green) and those that were significantly more likely to have delayed surgery performed as "high" outliers (red). More than half of the hospitals (37 of 72, 51.4%) showed significant differences in the likelihood of delayed surgery not attributable to patient case mix (1 hospital fell outside the graph area (estimate = +90.1 h, 95% CI 77.2 to 103.0). We conducted the analysis for 42 025 patients (missing observations were excluded). (B) Mean differences (in h, with 95% CIs) for each surgeon from the average surgical delay in the cohort was estimated in a 3-level linear regression model, adjusted for patient case mix and hospital random effects. We classified surgeons who were significantly more likely to perform early surgery as "low" outliers (green) and those who were significantly more likely to perform delayed surgery as "high" outliers (red). Only 4.8% of the surgeons (25 of 522) showed significant differences in the likelihood of delayed surgery not attributable to patient case mix or hospital random effects. We conducted the analysis for 42 025 patients (missing observations were excluded). (C) Mean differences (in h, with 95% CIs) for each anesthesiologist from the average surgical delay in the cohort was estimated in a multilevel linear regression model, adjusted for patient case mix and hospital random effects. We classified anesthesiologists who were significantly more likely to enable early surgery as "low" outliers (green) and those who were significantly more likely to enable delayed surgery as "high" outliers (red). Only 0.2% of anesthesiologists (2 of 963) showed significant differences in the likelihood of delayed surgery not attributable to patient case mix or hospital random effects. We conducted the analysis for 11 343 patients who had preoperative anesthesia consultations (missing observations were excluded).

catchment areas large enough to sustain consistent daytime nonelective surgery volumes[57] or to transfer patients to hospitals with available operating rooms.

Canadian surgeons may wait until after their elective procedures are completed before operating on urgent surgical patients. The finding that wait times for weekends were shorter is contrary to reports from other countries, and indirect evidence of this practice. That less than 5% of surgeons and less than 1% of anesthesiologists showed significant differences in delays is evidence that physicians may not be doing (or cannot do) enough to improve wait times for their patients. Policy that guarantees elective cases would be completed later in the day, even if nonelective cases are prioritized before them, may improve wait times for urgent procedures without the need to increase capacity in operating rooms.

We also found that reporting wait times from arrival at the emergency department is feasible because only 3% of patients were missing these data, and the time spent waiting in hospital transfer and the emergency department (mean 7.58 h [SD 11.87]) can be measured, which may provide another target for improved patient flow. An advantage of these Canadian data compared with data from the United States is the ability to capture exact wait times in hours (versus days) and the time elapsed in transfer between hospitals.[48,58] Other potential applications of these data include more accurately identifying after-hours surgery,[19] durations of surgery[59] and overlapping surgical procedures.[1,60,61]

Limitations

Although specific reasons for delay could not be assessed in the data that were sampled, risk-adjusted differences observed between hospitals should not reflect clinical reasons, but rather processes of care at different hospitals. Furthermore, because only about 9% of patients presented with acute medical conditions that warranted delay, the scenario of rushing patients to surgery despite suspicious symptoms appears to be the exception rather than the rule. We have described new time variables that identify exact wait times (in hours) in Canada's administrative data.[15] The variables have high face validity, including detecting differences when they were expected, such as longer delays among patients with comorbidity.[5–10] Missing data for emergency department arrival times were uncommon (n = 1460 or < 3%) and likely represented patients transferred from other health care institutions directly to inpatient beds. There were no missing data for surgery start times, which are used by Ontario's Surgical Efficiency Targets Program.[49]

Conclusion

Exact wait times for urgent and emergent surgery can be measured in Canada's administrative data. Only one-third of patients with hip fracture received surgery within the safe time frame (24 h). Because wait times vary according to where patients are treated, reporting and improvement efforts at the hospital level are required to ensure timely provision of urgent surgery for hip fracture. Reporting on physician performance, in contrast, may be less informative.

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